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June 24, 1994

94-RF-06764

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### OPERABLE UNIT (OU) 2 SUBSURFACE INTERIM MEASURE/INTERIM REMEDIAL ACTION PLAN/ENVIRONMENTAL ASSESSMENT (IM/IRAP/EA) SOIL VAPOR SURVEY REPORT SGS - 373-94

Enclosed you will find ten copies of the Final OU 2 Subsurface Interim Measure/Interim Remedial Action Plan/Environmental Assessment (IM/IRAP/EA) Soil Vapor Survey Report dated June, 1994. Four of the copies are for the use and permanent records of the Department of Energy/Rocky Flats Field Office (DOE/RFFO) and the remaining six copies are for transmittal to the Environmental Protection Agency and the Colorado Department of Health. If additional copies are needed, EG&G Rocky Flats, Inc. will provide them upon request.

This report presents the results of the soil vapor survey field work for OU 1 and OU 2 as part of the Subsurface IM/IRA project and completes the Interagency Agreement (IAG) milestone entitled, "Submit Final SVS Report to DOE", revised compliance date June 27, 1994.

If you have any questions or require further information, please contact W. S. Busby at extension 8509 or D. W. Pontius at extension 8616.

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ADMIN RECORD

**FINAL**

**OPERABLE UNIT NO. 2  
SUBSURFACE INTERIM MEASURES/  
INTERIM REMEDIAL ACTION PLAN/  
ENVIRONMENTAL ASSESSMENT  
SOIL VAPOR SURVEY REPORT**

**U.S. DEPARTMENT OF ENERGY**

**Rocky Flats Plant  
Golden, Colorado**

**Environmental Restoration Program**

**June 1994**

**REPORT**

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## LIST OF ACRONYMS

ATV	.....	All Terrain Vehicle
CCl <sub>4</sub>	.....	Carbon Tetrachloride
CDH	.....	Colorado Department of Health
1,1-DCA	.....	1,1-Dichloroethane
1,1-DCE	.....	1,1-Dichloroethene
1,2-DCE	.....	cis- and trans-1,2-Dichloroethene
DNAPL	.....	Dense Non-Aqueous Phase Liquid
DOE	.....	Department of Energy
DQO	.....	Data Quality Objective
ECD	.....	Electron Capture Detector
EPA	.....	Environmental Protection Agency
ERM	.....	Environmental Restoration Management
FFACO	.....	Federal Facility Agreement and Consent Order
GC	.....	Gas Chromatograph
GET	.....	General Employee Training
HSP	.....	Health & Safety Practices Manual
HSS	.....	Health & Safety Specialist
IAG	.....	Inter-Agency Agreement
IDL	.....	Instrument Detection Limit
IHSS	.....	Individual Hazardous Substance Site
IM/IRA	.....	Interim Measure/Interim Remedial Action
IM/IRAP/EA	.....	Interim Measure/Interim Remedial Action Plan/Environmental Assessment
L/min	.....	Liter per minute
ND	.....	Not Detected
OSHA	.....	Occupational Safety & Health Administration
OU1	.....	Operable Unit No. 1
OU2	.....	Operable Unit No. 2
PARCC	.....	Precision, Accuracy, Representativeness, Completeness, and Comparability
ppbV	.....	Parts per billion by volume
PCE	.....	Tetrachloroethene
PID	.....	Photoionization Detector
PM	.....	Project Manager
PSHSP	.....	Project Specific Health & Safety Plan
QA	.....	Quality Assurance
QC	.....	Quality Control
RCA	.....	Radiologically Controlled Areas
RCRA	.....	Resource Conservation and Recovery Act
RFP	.....	Rocky Flats Plant
RI	.....	Remedial Investigation
RPD	.....	Relative Percent Difference
RPT	.....	Radiological Protection Technician

RWP	.....	Radiation Work Permit
SOP	.....	Standard Operating Procedures
SVE	.....	Soil Vapor Extraction
SVS	.....	Soil Vapor Survey
TCE	.....	Trichloroethene
TIC	.....	Tentatively Identified Compound
$\mu\text{g/L}$	.....	Micrograms per liter
VOC	.....	Volatile Organic Compound

## EXECUTIVE SUMMARY

This document presents the investigative findings of the Subsurface Interim Measures/Interim Remedial Action Plan/Environmental Assessment and Decision Document (IM/IRAP/EA) for Operable Unit No. 2 (OU2) dated September 10, 1992 for the Soil Vapor Survey (SVS) at the Rocky Flats Plant (RFP). The scope of the program is presented in the OU2 Subsurface IM/IRA SVS Work Plan dated January, 1993, herein referred to as the Final Work Plan. The SVS work is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies, and remedial/corrective actions in progress to address contamination existing within the Individual Hazardous Substance Sites (IHSS) at OU2. The OU2 Subsurface program addresses removal of residual, volatile organic compound (VOC) vapor phase contamination suspected in the unsaturated vadose zone at RFP. Soil Vapor Extraction (SVE) technology will be employed to affect the VOC's at three selected sites and six-phase heating technology will be employed at one or more of the sites to enhance the vapor removal. These activities are in support of the Interagency Agreement (IAG) generated and signed by the Department of Energy (DOE), Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) establishing milestones and schedules for environmental cleanup at RFP.

OU2 at the RFP is defined in the IAG as an area comprised of 20 IHSS's that are known in aggregate as the 903 Pad, Mound, and East Trenches Areas. The results presented within this report are of the phased SVS investigations completed at five IHSS's located within OU2. The data and findings generated from the OU2 SVS investigations will be used to identify pilot testing locations within the selected IHSS's for SVE and six-phase heating technologies.

The SVS work was divided into two phases. The first phase of the work focused on generating baseline data at three primary OU2 sites-IHSS's 112, 113, and 110. The second phase of work focused on generating baseline SVS data at two additional alternate sites (IHSS's 109 and 111.1) and generating supplemental data at each of the five IHSS's. These two phases were referred to as the Baseline and Detailed SVS surveys. The analytes tested for were 1,1-Dichloroethane (1,1-DCA), Carbon Tetrachloride (CCl<sub>4</sub>), Trichloroethene (TCE), and Tetrachloroethene (PCE).

The results from the Baseline and Detailed SVS investigations conducted during this work indicate the majority of the VOC contamination within the areas tested at OU2 as being located within five contamination areas, and the detected analytes were mostly TCE and PCE. Of the 189 points that were sampled, approximately 52 percent resulted in Total VOC values greater than 20 µg/L and 16 of the Total VOC values were above 1,000 µg/L. The highest value recorded was 32,400 µg/L of PCE at a depth of 10-feet (Sample ID No. 113-39) located inside the eastern boundary of IHSS 113. The corresponding Total VOC value was 35,712 µg/L. The greatest percentage of Total VOC sample detections above 1,000 µg/L occurred at IHSS 111.1.

The highest concentration sample locations within each OU2 IHSS are as follows:

- IHSS 110-23; 690  $\mu\text{g/L}$  PCE and 410  $\mu\text{g/L}$   $\text{CCl}_4$ ; Depth 10-feet
- IHSS 109-4; 1,400  $\mu\text{g/L}$  TCE; Depth 5-feet
- IHSS 111.1-19; 4,000  $\mu\text{g/L}$  PCE and 1,670  $\mu\text{g/L}$  TCE; Depth 5-feet
- IHSS 112; 27,000 PCE; Depth 5-feet
- IHSS 113; Two locations
  - 113-38; 6,300  $\mu\text{g/L}$  PCE and 2,600  $\mu\text{g/L}$  TCE; Depth 10-feet
  - 113-39; 32,400  $\mu\text{g/L}$  PCE and 3,300  $\mu\text{g/L}$  TCE; Depth 10-feet

In addition to the above, SVS work was also completed and is reported in this document for OU1-IHSS 119.1. The analytes tested were: 1,1-DCA,  $\text{CCl}_4$ , TCE, PCE, 1,1-Dichloroethene (1,1-DCE), and Toluene. Little or no contamination was found at IHSS 119.1. Of the 30 locations tested, approximately 23 percent resulted in Total VOC values greater than 20  $\mu\text{g/L}$  and three of the Total VOC values were above 100  $\mu\text{g/L}$ . Sample ID No. 119.1-20 reported 132  $\mu\text{g/L}$  of TCE and 66  $\mu\text{g/L}$  of 1,1-DCA and represents the location of the highest contamination recorded by this activity.

## **1.0 INTRODUCTION**

This document presents the investigative findings of the Subsurface Interim Measures/Interim Remedial Action Plan/Environmental Assessment and Decision Document (IM/IRAP/EA) of the Operable Unit No. 2 (OU2) Soil Vapor Survey at the Rocky Flats Plant (RFP). The scope of the IRAP/EA OU2 Soil Vapor Survey (SVS) Program is presented in the OU2 Subsurface IM/IRA SVS Work Plan dated January, 1993, herein referred to as the Final Work Plan. The data and findings generated from the SVS investigations conducted at the Rocky Flats Plant will be used in conjunction with Phase II Remedial Investigation (RI) data for selecting Individual Hazardous Substance Sites (IHSS's) and locating Soil Vapor Extraction (SVE) pilot testing locations within selected IHSS's to undergo SVE remedy.

Section 1 of this report provides a descriptive background of the SVS IRA Program and identifies the SVS objectives and Data Quality Objectives associated with the SVS IRA Program.

Section 2 of this report details the SVS program approach, including investigative procedures, equipment and materials utilized, and presents the SVS analytical results for each of the five OU2 IHSS's investigated.

Section 3 of this report presents conclusions and recommendations based on the OU2 SVS investigative results.

Section 4 of this report details and discusses the approach and results of the OU1 IHSS 119.1 Baseline SVS.

### **1.1 Site Location And Background**

OU2 at the Rocky Flats Plant is defined in the Federal Facility Agreement and Consent Order (FFACO), otherwise known as the Inter-Agency Agreement (IAG), as an area comprised of 20 IHSS's that are known in aggregate as the 903 Pad, Mound, and East Trenches Areas. These areas

are located east-southeast of the RFP, and lie within either the Woman Creek or South Walnut Creek drainage basins.

The primary sites for the SVS Program have been identified in the Final Work Plan as the 903 Pad (IHSS 112); the Mound Area (IHSS 113); and the East Trenches Area (IHSS 110). Additional alternate SVS sites that were investigated within OU2 included IHSS 109 and IHSS 111.1 (see Figure 1-1).

## **1.2 OU2 Subsurface IM/IRAP SVS and SVE Program Description**

The OU2 Subsurface IM/IRAP is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies, and remedial/corrective actions in progress to address contamination associated with RFP. The activities are pursuant to the Rocky Flats IAG developed between the Department of Energy (DOE), Environmental Protection Agency (EPA), and the Colorado Department of Health (CDH). The OU2 Subsurface IM/IRAP/EA Document addresses removal of residual free-phase volatile organic compound (VOC) contamination suspected in the unsaturated subsurface of OU-2 at RFP. The proposed demonstration of VOC removal actions involve pilot testing SVE/six-phase heating technology at three different hydrogeologic units within OU2. The precise locations for pilot testing the SVE systems are to be determined from the Phase II Remedial Investigation (RI) data and results of the SVS investigations presented herein.

### **1.2.1 Soil Vapor Survey Objectives**

The purpose of the SVS investigations were to collect and analyze soil vapor samples in order to map the concentration and distribution of volatile organic compound (VOC) contamination in subsurface soils at selected IHSS's that were scheduled for potential pilot testing using the Soil Vapor Extraction (SVE) technique.

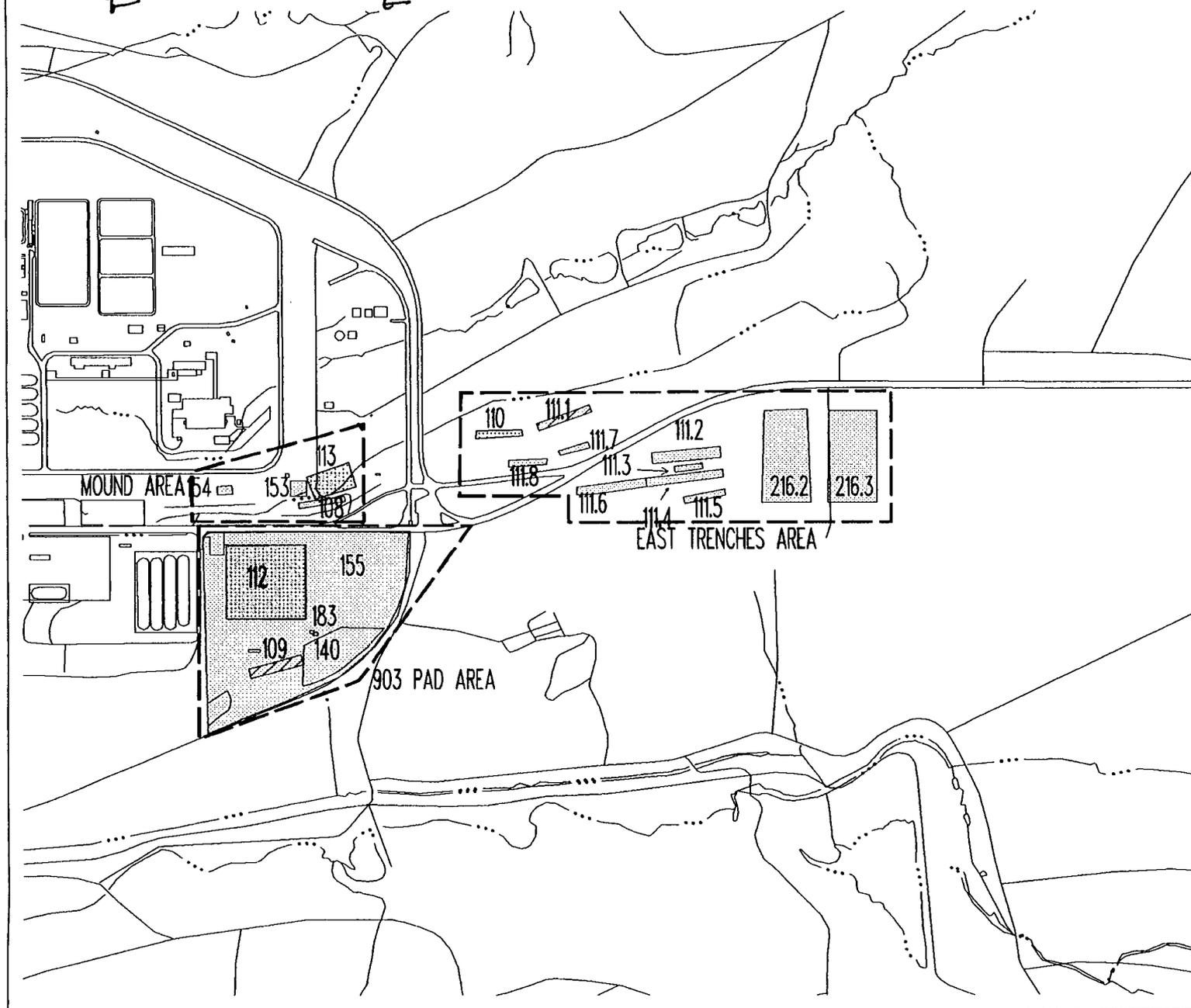
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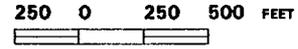
DRAWN BY: K. Stephens

DATE: February 09, 1994

FILENAME: /arc/data/soilvapor/svs3411.cmi REVISION NO: 1



- Roads
- Streams and Ponds
- Buildings
- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) AND IHSS DESIGNATION
- REMEDIAL INVESTIGATION AREAS
- PRIMARY SOIL VAPOR SURVEY SITES
- ALTERNATE SOIL VAPOR SURVEY SITES



PREPARED FOR  
**U.S. DEPARTMENT OF ENERGY**  
 ROCKY FLATS PLANT  
 GOLDEN, COLORADO

FIGURE 1-1  
**SITE MAP OF REMEDIAL INVESTIGATION AREAS, IHSSs, AND SOIL VAPOR SURVEY SITES OPERABLE UNIT NO.2**

### 1.2.2 Data Quality Objectives

Project Data Quality Objectives (DQO's) have been developed per EPA guidance and have been adopted for use for this OU2 SVS Program. Specific DQO's include the following six elements (see also Table 3-1 of Final Work Plan):

- Data Uses/Users
- Data Types
- Data Quality
- Data Quantity
- Sampling and Analytical Approach
- PARCC parameters (precision, accuracy, representativeness, completeness, and comparability)

Specific criteria corresponding to the above six Data Quality elements that were employed during the SVS investigations are provided below.

**Data Uses/Users:** Soil vapor samples were collected and analyzed in an on-site mobile laboratory to provide qualitative data regarding the presence of VOC's in the unsaturated zone at each of the five IHSS's within OU2. Data were used to locate areas of elevated VOC's and to locate pilot unit vapor extraction wells.

**Data Types:** Baseline grab samples of soil vapor were collected along established and approved initial sampling grids. Detailed soil vapor samples were collected at pre-approved locations which were designed to expand the Baseline grid or increase the grid density at areas exhibiting elevated VOC concentrations.

**Data Quality:**

- a) Prioritized data uses:
  - Location of areas of elevated VOC's
  - Location of pilot unit vapor extraction wells

- b) Appropriate analytical level
  - Level II - mobile laboratory GC
  
- c) Minimum Analyte List
  - Carbon tetrachloride (CCl<sub>4</sub>), tetrachloroethene (PCE), trichloroethene (TCE), and 1,1-Dichloroethane (1,1-DCA).
  
- d) Detection Limits

The initial Baseline SVS investigation adopted reporting units of  $\mu\text{g/L}$ . For continuity and data comparability, the follow-up SVS investigations adopted reporting units of  $\mu\text{g/L}$  as well. Minimum detection limits for the initial SVS ranged from 1.0  $\mu\text{g/L}$  to 20  $\mu\text{g/L}$  depending on the analyte screened for during the analysis. Minimum detection limits for the follow-up SVS showing equivalent limits in units of part per billion by volume (ppbV) were as follows:

<u>Compound</u>	<u>Detection Limit</u>	
	( $\mu\text{g/L}$ )	(ppbV)
1,1-DCA:	1.0	304
TCE:	0.1	22
PCE:	0.1	22
CCl <sub>4</sub> :	0.05	9.6

The above stated detection limits are based on the results of an Instrument Detection Limit (IDL) exercise performed by the mobile laboratory prior to initiating sampling activities. The IDL was performed according to Method 8000, modified for vapors, as described in USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (USEPA SW 846). Some reporting limits were greater than the minimum detection limits listed above. This condition arose when potential dilutions of soil vapor samples were carried out by the mobile laboratory during analysis. Dilutions were performed on selected samples in order to keep resultant concentrations within the linear range of the instrument calibration curves.

### **Data Quantity:**

- **Baseline sampling grid for primary sites (119 samples)**
  - IHSS 112 - 64 samples (5-foot depth)
  - IHSS 113 - 33 samples (5-foot depth)
  - IHSS 110 - 22 samples (5-foot depth)
- **Baseline sampling grid for alternate sites (36 samples)**
  - IHSS 109 - 14 samples (5-foot depth)
  - IHSS 111.1 - 22 samples (5-foot depth)
- **Total of 34 additional Detailed samples at each of the five OU2 IHSS's to expand grid or increase grid density on-site, depending on results from Baseline samples.**
  - IHSS 112 - 8 samples
    - 7 samples (5-foot depth)
    - 1 sample (10-foot depth)
  - IHSS 113 - 17 samples
    - 4 samples (5-foot depth)
    - 13 samples (10-foot depth)
  - IHSS 110 - 7 samples (10-foot depth)
  - IHSS 111.1 - 1 sample (5-foot depth)
  - IHSS 109 - 1 sample (5-foot depth)

### **Sampling and Analysis Approach:**

Shallow soil vapor samples were collected by inserting a soil vapor probe to depth of either 5-feet or 10-feet below grade (see Section 2.1.1.1). Each sample was collected and analyzed for the minimum analyte list presented above, within two hours from sample collection.

## PARCC Parameters:

- a) Precision
  - Field Duplicate  $\pm 20\%$  RPD
  - Laboratory Replicate analysis  $\pm 20\%$  RPD
- b) Accuracy
  - Calibration standards  $\pm 20\%$  RPD
  - Analysis once daily of independently prepared gas standard  $\pm 30\%$  RPD.
- c) Representativeness
  - Adherence to 3-dimensional sampling locations and procedures specified in Final Work Plan.
- d) Completeness
  - Laboratory completeness 95 %
  - Field completeness 90 %
- e) Comparability
  - Adherence to analytical protocol specified in Final Work Plan.

PARCC parameter analysis and Quality Control (QC) results for this OU2 SVS Program are presented and discussed in Appendix A of this Document.

### 1.3 Deviations From the Final Work Plan

This project deviated in two specific areas from the Final Work Plan dated January 12, 1993. The Work Plan identified two types of field SVS QA/QC samples to be collected during the SVS Program which were designated as Field Duplicate and Field Replicate samples. The Final Work Plan defined a Field Duplicate sample as a sample collected "within two feet of the original sample location," with a specified frequency of at least 5%. A Field Replicate was defined in the Final Work Plan as a sample "collected from the same location as the original (i.e., from the same probe)," with a specified frequency of 10%. Table 3-1 of the final Work Plan further set forth precision criteria for field Duplicate samples at  $\pm 20\%$  RPD, with no specified criteria for Replicate

samples (see also Section 1.2.2 of this report). Therefore, according to the Final Work Plan, Field Replicate samples which are collected from the same probe as the original sample are not to be quantitatively evaluated for QA/QC purposes. It follows that the precision of the SVS data set was to be solely evaluated through comparing SVS analytical data from Field Duplicate samples which are collected from essentially different locations, separated by approximately two feet. These QA/QC sample definitions are contrary to the general usage of the terms "duplicate" and "replicate" at the Rocky Flats Plant site, and are believed to have been inadvertently transposed as presented in the Final Work Plan.

For purposes of QA/QC evaluation within this report, a Field Duplicate sample is herein defined as a QA/QC sample which is collected from the same probe and location as the original sample, as opposed to the definition presented in the Final Work Plan. Additionally, a Field Replicate sample is herein defined as a QA/QC sample collected within two feet of the original sample location using a separate probe. Thus, the definitions of "duplicate" and "replicate" as originally presented in the Final Work Plan have been reversed for QA/QC reporting purposes within this report. This deviation from the Final Work Plan allows QA/QC evaluation of sample collection precision to be based on SVS samples collected under identical conditions, as is believed to be the intent of the SVS Program. The precision criteria of  $\pm 10\%$  RPD, and corresponding sampling frequency of 10% for Field Duplicate samples has been applied to the revised definition of Field Duplicate samples.

Since a precision measure with which to evaluate Field Replicate samples has not been addressed in the Final Work Plan, Field Replicate sample results have been excluded from the QA/QC analysis presented in Appendix A of this report. However, for purposes of reporting VOC vapor concentrations within each investigation area, both Field Duplicate and Field Replicate analytical results have been included in the data summary tables presented in Section 3, and were used to generate the isoconcentration maps presented in Appendix C of this report.

## **2.0 SOIL VAPOR SURVEY**

### **2.1 SVS Program Description**

The OU2 Subsurface IRAP/EA Program SVS was implemented using a phased approach. The first phase of the SVS work focused on recovering Baseline data at the three primary sites. Baseline sampling grids were initially established at each primary site using staggered rows of grid points spaced at approximate 30-foot intervals which resulted in uniform coverage of the target areas.

The initial Baseline survey was completed at the three primary sites (IHSS's 112, 113, and 110) during May and June of 1993. This Baseline investigation encompassed the collection and analysis of soil vapor from 119 SVS sample locations within the three primary IHSS's.

The SVS data generated from the initial Baseline investigation was used to identify potential contaminant areas within the three primary IHSS's that warranted a more detailed SVS investigation. Additionally, two alternative test sites known as IHSS 111.1 and 109 were also evaluated. In the second phase of the SVS program, additional SVS sample locations were established at the primary sites at tighter grid spacing intervals in order to further define potential source areas. The sampling approach at the two alternate sites utilized a staggered triangular grid with sampling points spaced at approximately 30-foot intervals.

The second phase of the SVS investigative effort was conducted during the months of October and November, 1993. The second SVS investigation encompassed the collection and analysis of 26 Detailed SVS samples from the three primary IHSS's, and 34 Baseline SVS samples at the two alternate IHSS's.

Following preliminary SVS data reduction and evaluation from the second investigative effort, 9 additional Detailed SVS locations were scheduled to be sampled from the 5 OU2 IHSS's, and a Baseline SVS investigation comprising 30 sample locations was scheduled for IHSS 119.1 located within OU1. This third SVS investigation was completed during December 23, 1993 through January 3, 1994.

### 2.1.1 Methodology

Site access was arranged through RFP prior to entry into each IHSS. All proposed SVS sampling locations initially underwent utility clearance and were surveyed for the presence of radioactive contaminants in accordance with SOP FO.26, Field Radiological Measurements (see also Appendix B). Soil vapor sample collection and analysis by gas chromatograph (GC) proceeded according to SOP's OPS-GT.09, Soil Vapor Sampling and Analysis, and OPS-GT.19, Field Gas Chromatographs.

This section presents the methodology employed to install soil vapor sample probes, purge and collect soil vapor from the probes into sampling containers, and analyze the collected sample using gas chromatography during the SVS investigations. The precise methods utilized during the initial May-June, 1993 investigation (herein referred to as the initial SVS) differ slightly from those employed during the subsequent October, 1993 through January, 1994 investigations (herein referred to as the follow-up SVS). These differences are described in greater detail in the following sections.

2.1.1.1 Soil Vapor Probe Design and Emplacement During the initial SVS, soil vapor probes were driven into the subsurface using a van-mounted Geoprobe system. The Geoprobe system advances probe rods downward using hydraulics with a pneumatic hammer drive. The probes were constructed of threaded, 4-foot sections of 1-inch outer diameter hardened steel rods, equipped with a tubing adapter fitting at the upper end, and a retractable or expendable drive point at the leading end. Sample tubing was attached to the upper probe fitting to permit soil vapor sampling. The probe string was driven to the intended sampling depth and the retractable shield raised to expose the open rod for sample access.

During the follow-up SVS investigations, an All Terrain Vehicle (ATV) Scorpion Rig mounted with a hydraulic probe driving system was utilized for probe emplacement. The probe assembly consisted of threaded lengths of 1-inch diameter steel rod friction-fitted with an expendable, basal drive point. After the probe was driven to the sampling depth, the assembly was raised 2-3 inches to knock the drive point away from the probe shaft.

**2.1.1.2 Sample Collection** Shortly after probe emplacement at each sampling location, sample collection was initiated. SVS sample collection was conducted in all cases by applying a vacuum to the upper probe which induced vapor flow from depth into the sampling system. During the initial SVS investigation, a diaphragm vacuum pump was activated at a flow rate of between 0.4-1.0 liters per minute (L/min) to initially purge the probe assembly of ambient air prior to sample collection. At least one complete system volume was purged from each sample location, and vacuum conditions were monitored prior to sample collection. Actual vapor flow rates during purging and sampling varied from sample to sample as a function of soil type and soil permeability.

Sample collection during the initial SVS involved inserting a pre-cleaned gas-tight hypodermic syringe equipped with a manual shut-off valve through the sample tubing at the upper probe end and pulling back on the syringe plunger to collect a sample. Following sample collection, the syringe valve was closed off to prevent sample loss and/or dilution with ambient air, and the syringe was labelled and transferred to the analytical laboratory for analysis by Field GC.

During the follow-up SVS activities, the sample collection methodology utilized the following procedures. Following retraction of the probe rod after emplacement, a segment of clean tubing was inserted onto a barbed stainless steel fitting which was threaded onto the lower probe collar, sealed with an O-ring. This step effectively removed the probe rod from the sampling system, where soil vapor was now sampled and transferred to ground surface directly through the tubing.

Initially, the probe assembly was purged of at least one complete system volume by connecting the sample tubing to a personal diaphragm sampling pump. Purge and sampling pump rates varied between 0.5 and 1.0 L/min, again varying from location to location as a function of soil type and permeability. Following purging, vapor sample collection was directed into 0.5 liter capacity pre-cleaned glass bulbs through the sample tubing. The glass bulbs were fitted with manual shut-off valves and an upstream vacuum gauge permitting continuous vacuum monitoring. After the sample event was complete, a disposable, gas-tight analytical syringe filled with sample was injected into the sampling bulb to over-pressurize the bulb. This step addressed potential bulb leakage, so that if it should occur, leakage would be directed outwards and not inwards; inward leakage would result in sample dilutions. Following bulb over-pressurization, bulbs were labelled and immediately

forwarded to the on-site laboratory for analysis by GC. Following SVS sample collection, all holes were abandoned as per SOP OPS-GT.05 Plugging and Abandonment of Boreholes.

2.1.1.3 Sample Analysis Soil vapor samples collected during the SVS investigations were analyzed using a Hewlett-Packard Model 5890 Series II GC, equipped with a photoionization detector (PID) and electron capture detector (ECD), and capillary column capabilities. Soil vapor samples were introduced into the GC by collecting an aliquot of the vaporous sample into a gas-tight analytical syringe and directly injecting the sample through the septum-sealed injection port.

All vapor samples were analyzed for the compounds PCE, TCE, 1,1-DCA, and  $\text{CCl}_4$ , at a minimum, using modified EPA Method 8010. Additional analytes, including vinyl chloride, 1,1-Dichloroethene (1,1-DCE), cis- and trans-1,2-Dichloroethene (1,2-DCE), and 1,2-Dichloroethane (1,2-DCA) were analyzed for and quantified during the initial SVS investigation. The above listed additional analytes were quantified during the follow-up SVS investigations if concentrations were found to be significant (e.g., >20 micrograms per liter ( $\mu\text{g}/\text{L}$ )). In these cases, the Tentatively Identified Compound (T.I.C.) is identified and reported in units of  $\mu\text{g}/\text{L}$ . The compounds 1,1-DCE and Toluene were included within the analyte detection list during the SVS investigation at IHSS 119.1 (see Section 4.1).

2.1.1.4 Instrument Calibration The GC was calibrated to specially prepared standards on a daily basis as per analytical laboratory protocol outlined in the Final Work Plan. During the initial SVS investigation, liquid methanolic standards were directly injected on column to achieve calibration. In this case, detector responses to liquid chemical standards were utilized to quantify soil vapor concentrations. During the follow-up SVS investigations, vaporous chemical standards were prepared within precleaned glass bulbs. After equilibration, the vapor standards were then utilized to achieve instrument calibration.

Throughout each SVS investigation, a four point calibration curve was generated and maintained through a minimum daily calibration check procedure with a correlation coefficient of at least 0.99 or greater. Analyte concentrations were reported from the respective analyte calibration curves using

the peak area/detector response method. Field duplicates and equipment blanks were collected for QA/QC purposes at minimum frequencies as specified in the Final Work Plan (see Appendix A).

2.1.1.5 Presentation of SVS Investigative Results The following sections present the analytical results and findings generated during the Baseline and Detailed SVS investigations conducted within OU2 at the three primary IHSS's 110, 112, and 113, and the two alternate IHSS's known as 111.1 and 109. SVS analytical results are presented in tabular and graphic format for each IHSS. The data tables presented in Section 3 summarize the SVS analytical laboratory results of the initial Baseline SVS for the primary sites (initial survey), and the detailed SVS data generated during the follow-up SVS activities at the primary sites and the alternate sites. It is important to note that some of the SVS analytical data from the May-June 1993 Baseline SVS investigations at IHSS's 112 and 113 were originally reported as being "less than" (<) a specified instrument detection limit (IDL), (e.g., <10 µg/L). Where concentrations were originally reported as being less than a specified IDL, these values, where originally entered, have been presented as Not Detected, or "ND" in the attached tables. This modification is based on generally accepted analytical practice where compounds that have been reported as less than a specified IDL are regarded as being statistically questionable and having high uncertainty (ASTM, 1985).

In addition to tabulated SVS data, the SVS data are also graphically presented on IHSS specific contoured base maps which are contained in Appendix C. Two types of diagrams are presented for each investigated IHSS. The first diagram of each set presents SVS sample locations and corresponding sample identification information at each IHSS. Since SVS data exists at 5-foot and 10-foot depths for several sample locations at IHSS's 110, 112, 113, and 119.1, different graphic symbols have been used in the sample location maps to distinguish between 5-foot and 10-foot depth sample locations. Sample locations presented on each diagram are based on field surveys conducted in accordance with SOP OPS-GT.17, Land Surveying. Surveyed sample locations are based on Colorado State Plane Coordinates, Central Zone.

The second set of diagrams present the detected soil vapor concentration in units of µg/L for each analyte adjacent to each sample location, and provides interpretive isoconcentration contouring of the IHSS data set as a whole as a function of sample depth. The contouring software utilized for

generation of the isoconcentration figures presented in Appendix C was ARC/INFO, Revision 6.1.1. The Spline Gridding command was employed in concert with the "tension" option, with a 5-foot grid size. This overall contouring approach interpolates a two dimensional minimum curvature spline intercept on a point data set resulting in a smooth surface which passes through individual input points. As the isoconcentration maps have been computer generated from a limited number of data points, the resultant interpolated contours may not represent actual field conditions, and should be viewed in concert with the actual field data.

Each set of IHSS contoured diagrams includes four analyte specific diagrams including the four compounds 1,1-DCA, CCl<sub>4</sub>, TCE, and PCE, in addition to a Total VOC concentration diagram which is presented as an arithmetic sum of the four analytes detected at each sample location. Where the field mobile laboratory had analyzed duplicate SVS samples or had analyzed duplicate and/or replicate SVS samples for QA/QC purposes, the concentrations reported on each diagram are the highest concentrations detected from the field laboratory for a valid SVS sample. IHSS specific SVS analytical data summary tables include analytical data for QA/QC samples. QA/QC samples include Field Duplicate samples, Field Replicate or co-located samples, and Laboratory Replicate analyses. An asterisk symbol has been included for selected QA/QC samples which denotes that the values corresponding to asterisk-marked samples were not used utilized to generate the isoconcentration contours.

Other Tentatively Identified Compounds (T.I.C.'s) detected during the SVS investigations, which are not included within the analyte list, were not included into the Total VOC concentration value, and therefore were not factored into the generation of isoconcentration contours. However, T.I.C.'s, where detected are identified and discussed for each IHSS where concentrations were found to exceed approximately 20 µg/L.

## 2.2 Testing Program, 903 Pad Area

### 2.2.1 Testing Program, Primary IHSS 112

2.2.1.1 IHSS 112 Site Background IHSS 112, the former drum storage area at the 903 Pad, experienced a reported release of approximately 5,000 gallons of fluid, estimated to contain 86 grams of plutonium. Additionally, drums stored at the 903 Pad containing radioactively contaminated cutting oil, Carbon Tetrachloride, TCE, PCE, and acetone have corroded and leaked.

The suspected locations of fluid released at the 903 Pad were determined by review of aerial photographs which reveal former drum storage locations and areas of stained soils. It is expected that carbon tetrachloride comprises the majority of the released contamination at IHSS 112 with lesser amounts of TCE and PCE.

2.2.1.2 Investigative Summary and Results (IHSS 112) The Baseline SVS investigation at IHSS 112 completed in June and July of 1993, encompassed 64 sample collections at a depth of approximately 5-feet below grade. An additional eight Detailed SVS sample locations were specified and sampled during the period from November 1993 through January 1994. A summary of the SVS analytical results from the IHSS 112 Baseline and Detailed investigations are presented in Table 2.2.1. Figure C-1 in Appendix C identifies the 72 SVS sample locations within IHSS 112. Figures C-2 through C-6 present the SVS analytical data and provide interpretive isoconcentration contours for each analyte detected at IHSS 112.

Analytical results from the initial Baseline SVS investigation indicate that the greatest overall VOC concentrations were detected from sample 112-60, located approximately 30 feet south of the southwestern margin of the IHSS boundary. Total VOC concentrations were reported as 27,081  $\mu\text{g/L}$ , with 27,000  $\mu\text{g/L}$  being attributed to the compound PCE (Figures C-5, and C-6). The highest TCE concentrations were reported from sample 112-20 located in the northwest quadrant of the IHSS boundary at a concentration of 77  $\mu\text{g/L}$  (Figure C-4). The compound  $\text{CCl}_4$  was detected at a maximum concentration of 120  $\mu\text{g/L}$  at location 112-8 (Figure C-3), while 1,1-DCA was detected at a reported high concentration of 420  $\mu\text{g/L}$  at location 112-21 (Figure C-2). Based on these

TABLE 2.2.1 IHSS 112 SVS ANALYTICAL DATA SUMMARY

SAMPLE ID	DATE	DEPTH	STATUS	Soil Vapor Analytical Results (ug/L)				
				1,1-DCA	CCI4	TCE	PCE	TOTAL VOC'S
112-1	06/23/93	5	Ba	ND	43	ND	ND	43
112-2*	06/23/93	5	Ba	ND	20	ND	ND	20
112-2FR	06/23/93	5	Ba	ND	110	ND	11	121
112-3	07/06/93	5	Ba	ND	ND	ND	ND	0
112-4	06/23/93	5	Ba	ND	23	ND	ND	23
112-5	06/23/93	5	Ba	ND	100	ND	ND	100
112-5FD*	06/23/93	5	Ba	ND	76	ND	ND	76
112-6	06/23/93	5	Ba	ND	37	ND	ND	37
112-7	06/23/93	5	Ba	ND	74	ND	13	87
112-8	06/23/93	5	Ba	ND	120	ND	ND	120
112-9	06/23/93	5	Ba	ND	4	ND	18	22
112-10	06/23/93	5	Ba	ND	ND	ND	8	8
112-11	06/25/93	5	Ba	ND	ND	ND	6	6
112-12	06/25/93	5	Ba	60	17	ND	ND	77
112-13	06/25/93	5	Ba	310	18	ND	4	332
112-14	06/25/93	5	Ba	60	15	ND	ND	75
112-15	06/25/93	5	Ba	ND	10	ND	ND	10
112-16*	06/25/93	5	Ba	ND	ND	ND	ND	0
112-16FR	06/25/93	5	Ba	ND	ND	ND	ND	0
112-17	06/25/93	5	Ba	ND	ND	ND	10	10
112-18	06/25/93	5	Ba	ND	15	10	65	90
112-19	06/25/93	5	Ba	35	4	14	60	113
112-20	06/25/93	5	Ba	260	ND	77	55	392
112-21*	06/25/93	5	Ba	150	50	ND	ND	200
112-21FD	06/29/93	5	Ba	420	58	ND	ND	478
112-22	06/29/93	5	Ba	ND	52	ND	ND	52
112-23	06/29/93	5	Ba	ND	4	ND	ND	4
112-24	06/29/93	5	Ba	ND	15	ND	15	30
112-25	06/29/93	5	Ba	ND	35	52	210	297
112-26	06/29/93	5	Ba	ND	ND	ND	9	9
112-27	06/29/93	5	Ba	ND	ND	ND	ND	0
112-28	06/29/93	5	Ba	ND	5	ND	ND	5

\*FR\* Denotes Field Replicate Sample

\*FD\* Denotes Field Duplicate Sample

\*\*\* Denotes Sample Value Not Used to Generate SVS Contours

\*Ba\* Denotes Baseline SVS Sample

\*De\* Denotes Detailed SVS Sample

**TABLE 2.2.1 IHSS 112 SVS ANALYTICAL DATA SUMMARY  
(CONTINUED)**

SAMPLE ID	DATE	DEPTH	STATUS	Soil Vapor Analytical Results (ug/L)				
				1,1-DCA	CCl4	TCE	PCE	TOTAL VOC'S
112-29	06/29/93	5	Ba	ND	ND	ND	ND	0
112-30	06/29/93	5	Ba	ND	ND	ND	ND	0
112-31	07/01/93	5	Ba	ND	28	ND	ND	28
112-32	07/01/93	5	Ba	ND	42	ND	ND	42
112-33	07/01/93	5	Ba	ND	8	ND	ND	8
112-34	07/01/93	5	Ba	ND	11	ND	ND	11
112-35	07/01/93	5	Ba	ND	ND	ND	ND	0
112-36	07/01/93	5	Ba	28	8	ND	ND	36
112-37	07/01/93	5	Ba	40	10	ND	ND	50
112-38	07/01/93	5	Ba	ND	14	ND	ND	14
112-39	07/01/93	5	Ba	ND	ND	ND	ND	0
112-40	07/01/93	5	Ba	74	ND	ND	ND	74
112-40FD*	07/01/93	5	Ba	67	ND	ND	ND	67
112-41	07/02/93	5	Ba	25	33	ND	ND	58
112-42	07/02/93	5	Ba	32	18	ND	ND	50
112-43	07/02/93	5	Ba	ND	ND	ND	ND	0
112-44	07/02/93	5	Ba	ND	ND	ND	ND	0
112-45	07/02/93	5	Ba	ND	ND	ND	ND	0
112-46	07/02/93	5	Ba	ND	ND	ND	ND	0
112-47	07/02/93	5	Ba	ND	ND	ND	ND	0
112-48	07/02/93	5	Ba	ND	ND	ND	ND	0
112-49	07/02/93	5	Ba	ND	ND	ND	ND	0
112-50*	07/02/93	5	Ba	ND	ND	ND	ND	0
112-50FD	07/02/93	5	Ba	ND	ND	ND	ND	0
112-51	07/06/93	5	Ba	ND	ND	ND	ND	0
112-52	07/06/93	5	Ba	ND	ND	ND	ND	0
112-53	07/06/93	5	Ba	ND	ND	ND	ND	0
112-54*	07/06/93	5	Ba	ND	ND	ND	ND	0
112-54FD	07/06/93	5	Ba	ND	ND	ND	ND	0
112-55	07/06/93	5	Ba	ND	ND	ND	ND	0
112-56	07/06/93	5	Ba	ND	ND	ND	ND	0

"FR" Denotes Field Replicate Sample

"FD" Denotes Field Duplicate Sample

\*\*\* Denotes Sample Value Not Used to Generate SVS Contours

"Ba" Denotes Baseline SVS Sample

"De" Denotes Detailed SVS Sample

**TABLE 2.2.1 IHSS 112 SVS ANALYTICAL DATA SUMMARY  
(CONTINUED)**

SAMPLE ID	DATE	DEPTH	STATUS	Soil Vapor Analytical Results (ug/L)				
				1,1-DCA	CCI4	TCE	PCE	TOTAL VOC'S
112-57	07/06/93	5	Ba	ND	ND	ND	ND	0
112-58	07/06/93	5	Ba	ND	ND	ND	ND	0
112-59	07/06/93	5	Ba	ND	ND	ND	ND	0
112-60	07/07/93	5	Ba	43	ND	38	27,000	27,081
112-61	07/07/93	5	Ba	ND	ND	ND	20	20
112-62	07/07/93	5	Ba	ND	ND	ND	ND	0
112-63	07/07/93	5	Ba	ND	ND	ND	ND	0
112-64	07/07/93	5	Ba	ND	ND	ND	ND	0
112-65	11/10/93	5	De	ND	0.3	4.1	7.7	12.1
112-66	11/10/93	5	De	ND	0.3	3.2	52	55.5
112-67	11/10/93	5	De	ND	ND	1	1.2	2.2
112-67FD*	11/10/93	5	De	ND	ND	1.2	1.4	2.6
112-67LR*	11/10/93	5	De	ND	ND	1.3	1.5	2.8
112-68	11/15/93	5	De	ND	156	1.4	6.8	164
112-68LR*	11/15/93	5	De	ND	151	1.4	6.6	159
112-69	11/15/93	5	De	ND	90	1.5	5.5	97
112-70	11/15/93	5	De	ND	21	0.5	2.2	23.7
112-71	11/15/93	5	De	ND	31.2	0.6	1.1	32.9
112-72	01/03/94	10	De	ND	0.1	0.3	3.3	3.7

\*FR\* Denotes Field Replicate Sample

\*Ba\* Denotes Baseline SVS Sample

\*FD\* Denotes Field Duplicate Sample

\*De\* Denotes Detailed SVS Sample

\*\* Denotes Sample Value Not Used to Generate SVS Contours

results, a review of the Total VOC contour map indicates the presence of three areas of elevated VOC's; the primary VOC area is located south of the southeastern IHSS boundary centered at sample location 112-60, while the remaining two are located within the northern half of the IHSS 112 boundary, centered at sample location 112-21, and in the general vicinity of sample locations 112-20 and 112-25. The southeastern quarter within the IHSS boundary is characterized by low to no detected VOC's.

Based on these preliminary investigative findings, an additional seven Detailed samples were collected from IHSS 112 at 5-foot depths, designated as 112-65 through 112-71 in November of 1993. Three of these samples (112-65 through 112-67) were positioned south and west of sample 112-60 which were designed to provide information as to the lateral extent of VOC contamination. Sample location 112-66 indicated a PCE concentration of 52  $\mu\text{g/L}$ . All other detected analytes from these three locations were below 10  $\mu\text{g/L}$ .

Analytical results from the remaining four Detailed samples (112-68 through 112-71) ranged from Total VOC concentrations of 164  $\mu\text{g/L}$  (112-68) to 23.7  $\mu\text{g/L}$  (112-70), which are above Baseline concentrations along the western margin of the IHSS boundary.

2.2.1.3 Tentatively Identified Compounds (IHSS 112) Tentatively Identified Compounds (T.I.C.'s) other than the four primary analytes detected during the Baseline and Detailed SVS investigations include the compounds cis-1,2-DCE, and 1,2-DCA. Significant concentrations of cis-1,2-DCE were detected from Baseline samples 112-19, 112-20, and 112-26 at concentrations of 91, 370, and 91  $\mu\text{g/L}$ , respectively. Additionally, the T.I.C. 1,2-DCA was detected from sample locations 112-1, 112-4, 112-5, and 112-10 ranging in concentrations from 23  $\mu\text{g/L}$  at 112-10 to 590  $\mu\text{g/L}$  at 112-5. As discussed in Section 2.1.1.5, these concentrations are not included into the Total VOC concentration data.

#### 2.2.2 Testing Program, Alternate IHSS 109

2.2.2.1 IHSS 109 Site Background The alternate SVS site for the 903 Pad is IHSS 109, a burial trench located approximately 300 feet south of the 903 Pad. It is believed that IHSS 109 (Trench

T-2) was used from approximately 1969 to 1971 for the disposal of nonradioactive liquid wastes. After radiation screening, solvents which were found to be nonradioactive were disposed in the trench. The solvents were disposed of in small quantities and may have included PCE, TCE, carbon tetrachloride, paint thinner and small quantities of construction related chemicals. The presence of soil and ground water contamination in this area coupled with the history of solvent disposal suggests Trench T-2 as a source area for TCE contamination in this section of the 903 Pad Area.

2.2.2.2 Investigative Summary and Results (IHSS 109) The Baseline SVS investigation at IHSS 109 was conducted from November 10 through November 12, 1993, encompassing the collection of soil vapor from 14 sampling locations at 5-foot depths designated as 109-1 through 109-14. The sample location strategy utilized a staggered array of equidistant probe locations along the outer margins of Trench T-2. An additional Detailed sample location designated as 109-15 was sampled on January 3, 1994. Table 2.2.2 presents a summary of SVS analytical results for IHSS 109. Figure C-7 in Appendix C identifies the 15 Baseline and Detailed sampling locations at IHSS 109. Figures C-8 through C-12 present the SVS analytical data and provide interpretive isoconcentration contours for each analyte detected at IHSS 109.

Analytical results from the SVS investigation at IHSS 109 indicate that the primary analyte detected from shallow soil vapor is TCE. This finding corroborates historic evidence cited in Section 2.2.2.1. The greatest Baseline Total VOC concentrations were detected from sample locations positioned towards the middle of Trench T-2 (see Figure C-12). This finding led to the specification of Detailed sample location 109-15, which is positioned approximately 20 feet south-southwest of location 109-4.

TCE detections ranged from a maximum detection of 1400  $\mu\text{g/L}$  at location 109-4 to no detected TCE at location 109-2. Additional TCE detections in excess of 100  $\mu\text{g/L}$  were realized at locations 109-3, 109-5, 109-11, and 109-15, all of which are located towards the middle of the former trench.

The compound PCE was detected at a maximum concentration of 175  $\mu\text{g/L}$  at location 109-11, with a lesser concentration of 108  $\mu\text{g/L}$  from location 109-4, both positioned towards the center of the trench. All other detections of PCE were found at concentrations less than 35  $\mu\text{g/L}$ . Carbon

TABLE 2.2.2 IHSS 109 SVS ANALYTICAL DATA SUMMARY

SAMPLE ID	DATE	DEPTH	STATUS	Soil Vapor Analytical Results (ug/L)				
				1,1-DCA	CCl4	TCE	PCE	TOTAL VOC'S
109-1	11/10/93	5	Ba	0	0	0.6	0.7	1.3
109-2	11/10/93	5	Ba	0	0	0	0	0
109-3	11/10/93	5	Ba	6.4	0.4	590	9.1	605.9
109-3FR*	11/10/93	5	Ba	22	0.4	770	12	804.4
109-4	11/11/93	5	Ba	109	0	1,400	108	1,617
109-5	11/11/93	5	Ba	7.2	1	260	26	294.2
109-6	11/12/93	5	Ba	0	0	66	14	80
109-6FR*	11/12/93	5	Ba	0	0	42.5	6.1	48.6
109-7	11/12/93	5	Ba	0	0	9.1	0.9	10
109-8	12/27/93	5	Ba	0	0	0.9	0.4	1.3
109-9	11/12/93	5	Ba	0	0	1	0.4	1.4
109-9LR*	11/12/93	5	Ba	0	0	0.8	0.3	1.1
109-10	11/12/93	5	Ba	0	0	37	9.4	46.4
109-10FR*	11/12/93	5	Ba	0	0	22	5.9	27.9
109-11	11/11/93	5	Ba	0	0	194	175	369
109-12	11/11/93	5	Ba	190	0	26	34	250
109-13	11/11/93	5	Ba	13.2	0.3	60	9.4	82.9
109-14	11/10/93	5	Ba	0	0	0.7	0.5	1.2
109-15	01/03/94	5	De	33	0.3	500	1.2	534.5
109-15LR*	01/03/94	5	De	11	0	68	0.4	79.4
109-15FR*	01/03/94	5	De	11	0	72	0.3	83.3

\*FR\* Denotes Field Replicate Sample

\*FD\* Denotes Field Duplicate Sample

\*LR\* Denotes Laboratory Replicate Sample

\*\* Denotes Sample Value Not Used to Generate SVS Contours

\*Ba\* Denotes Baseline SVS Sample

\*De\* Denotes Detailed SVS Sample

Tetrachloride concentrations were low to not detected. 1,1-Dichloroethane was detected in elevated concentrations at two locations with a maximum concentration of 190  $\mu\text{g}/\text{L}$  occurring at location 109-12, which exceeds the TCE concentration detected at this location. Because of the high concentrations of TCE detected at sample locations within IHSS 109 relative to the other three primary analytes, Total VOC concentration contours generally correspond to TCE contours (see Figures C-10 and C-12). One notable exception to this trend occurs at location 109-12 where detected 1,1-DCA concentrations were found to be an order of magnitude higher than TCE.

The western and eastern margins of Trench T-2 exhibited significantly reduced VOC levels when compared to sample results from the central trench area. VOC concentrations from sample locations at the trench margins ranged from 10  $\mu\text{g}/\text{L}$  as Total VOC's to no detected analytes.

2.2.2.3 T.I.C.'s (IHSS 109) T.I.C.'s detected from soil vapor samples collected at IHSS 109 include the compounds cis- and trans-1,2-Dichloroethene (1,2-DCE), and vinyl chloride. T.I.C.'s in excess of approximately 20  $\mu\text{g}/\text{L}$  were reported at sample locations 109-4, 109-6, and 109-14. The T.I.C.'s cis- and trans-1,2-DCE were detected from sample 109-4, located within the area of the highest detected VOC's. Cis- and trans-1,2-DCE are commonly chemical or biological daughter products which are generated from decomposition of TCE.

Additionally, vinyl chloride was detected at concentrations in excess of 20  $\mu\text{g}/\text{L}$  at locations 109-6 and 109-14, which are positioned at the outer margins of the primary VOC plume. Vinyl chloride is typically found as an end product associated with the microbial degradation of 1,1-DCA, and is often found at VOC plume margins. This results because vinyl chloride is a light gas and its generation requires sufficient reaction time during which it undergoes subsurface vapor transport away from the VOC source area. No other T.I.C.'s were identified from vapor collected from IHSS 109.

## **2.3 Testing Program, Mound Area (IHSS 113)**

### **2.3.1 IHSS 113 Site Background**

IHSS 113, located within the Mound Area, was used to store an estimated 1,405 drums containing primarily depleted uranium- and beryllium-contaminated lathe coolant (a mixture of hydraulic oil and carbon tetrachloride). Some drums were reported to contain PCE. Soil contamination at IHSS 113 is expected to be limited to PCE and Carbon Tetrachloride. Cleanup of IHSS 113 was accomplished in 1970, and the materials removed were packaged and shipped to an off-site DOE facility as radioactive waste. Results of groundwater analyses at wells adjacent to IHSS 113 indicate that PCE comprises the majority of the VOC contamination in the area with lesser amounts of Carbon Tetrachloride present.

### **2.3.2 Investigative Summary and Results (IHSS 113)**

A Baseline SVS investigation was completed at IHSS 113 during June of 1993 which encompassed the collection and analysis of 33 SVS samples at a depth of approximately 5-feet below grade. The sampling approach employed during the Baseline SVS investigation positioned probes in a staggered array spaced at 30-foot to 40-foot intervals. This approach provided for probe coverage within the IHSS boundary to the east and south of the IHSS 113 boundary.

Following completion of the Baseline SVS, an additional seventeen (total of 50) Detailed SVS samples were collected during November and December of 1993. These Detailed SVS samples were located so as to expand the SVS grid, or to provide a tighter grid density at suspected VOC source areas. Four of the Detailed samples were collected from 5-foot depths, while the remaining thirteen SVS samples were collected from a depth of 10-feet below grade. The collection of Detailed SVS at two depths was designed to establish a 5-foot and 10-foot SVS database and permit the evaluation of VOC concentration and distribution as a function of depth.

Nine of the seventeen Detailed SVS samples were located radially away from Baseline sampling location 113-29, which was found to contain elevated Total VOC concentrations. The remaining

eight Detailed samples were positioned at and radially away from Baseline SVS location 113-18, which contained very high PCE concentrations reported in excess of 32,000  $\mu\text{g/L}$ .

Table 2.3.2 presents a summary of SVS analytical results of the Baseline and Detailed SVS samples collected at IHSS 113. Figure C-13 in Appendix C identifies the 50 Baseline and Detailed sampling locations at IHSS 113. Figures C-14 through C-23 present the SVS analytical data and provide interpretive isoconcentration contours for the primary analytes detected at IHSS 113.

Analytical results from the Baseline SVS investigation indicate a bimodal distribution of VOC's within the IHSS 113 boundary. Specifically, the compounds 1,1-DCA and Carbon Tetrachloride were detected principally within the northwestern quadrant of the IHSS 113 boundary, whereas TCE and PCE were detected at elevated concentrations at both the northwestern quadrant, near location 113-38, and at the eastern margin of the IHSS boundary, at locations 113-18 and 113-39.

At a 5-foot depth, detections of elevated 1,1-DCA concentrations were limited to three locations positioned at and west of the dirt road within the northwestern quadrant of the IHSS boundary; 113-29, 113-27, and 113-14 (see Figure C-14). The absence of data west of location 113-14, near the Protected Area fenceline, leaves further interpretations as to westerly 1,1-DCA concentrations inconclusive. At a 10-foot depth, elevated 1,1-DCA concentrations were detected at locations 113-46 and 113-47 positioned approximately 12-feet north of the northern IHSS boundary, near the Protected Area fenceline (see Figure C-19). Comparison of the 5-foot and 10-foot depth data indicates a decrease in 1,1-DCA concentrations with depth. No 1,1-DCA was detected in any of the SVS samples collected in the southern and eastern halves of IHSS 113.

The distribution of Carbon Tetrachloride at IHSS 113 follows a pattern similar to 1,1-DCA. Low to no detected Carbon Tetrachloride characterizes the eastern and southern halves of the IHSS 113 boundary at both 5-foot and 10-foot depths. Within the northeastern quadrant, however, moderate concentrations ranging from 18 to 130  $\mu\text{g/L}$  were detected from location 113-27 to the south, to location 113-46 positioned north of the IHSS border (see Figures C-15 and C-20). Carbon Tetrachloride concentrations indicate a slight increase with depth.

TABLE 2.3.2 IHSS 113 SVS ANALYTICAL DATA SUMMARY

SAMPLE ID	DATE	DEPTH	STATUS	Soil Vapor Analytical Results (ug/L)				
				1,1-DCA	CCI4	TCE	PCE	TOTAL VOC'S
113-1	06/15/93	5	Ba	ND	ND	ND	ND	0
113-2	06/15/93	5	Ba	ND	ND	ND	12	12
113-3*	06/16/93	5	Ba	ND	ND	ND	ND	0
113-3FD	06/16/93	5	Ba	ND	ND	ND	ND	0
113-4	06/15/93	5	Ba	ND	ND	ND	ND	0
113-5	06/15/93	5	Ba	ND	ND	ND	ND	0
113-6	06/15/93	5	Ba	ND	ND	ND	ND	0
113-7	06/15/93	5	Ba	ND	ND	ND	16	16
113-8	06/16/93	5	Ba	ND	ND	ND	12	12
113-9	06/15/93	5	Ba	ND	ND	ND	190	190
113-10	06/16/93	5	Ba	ND	ND	ND	ND	0
113-11	06/16/93	5	Ba	ND	ND	ND	23	23
113-12	06/15/93	5	Ba	ND	ND	ND	ND	0
113-13	06/16/93	5	Ba	ND	ND	ND	ND	0
113-14	06/17/93	5	Ba	470	ND	18	23	511
113-15	06/16/93	5	Ba	ND	ND	ND	ND	0
113-16	06/15/93	5	Ba	ND	ND	ND	ND	0
113-17	06/16/93	5	Ba	ND	ND	ND	ND	0
113-18	06/17/93	5	Ba	ND	ND	740	16,000	16,740
113-19	06/15/93	5	Ba	ND	ND	ND	ND	0
113-20	06/14/93	5	Ba	ND	ND	ND	ND	0
113-21	06/14/93	5	Ba	ND	ND	ND	1.5	1.5
113-22	06/16/93	5	Ba	ND	ND	ND	ND	0
113-23	06/17/93	5	Ba	ND	ND	ND	ND	0
113-24	06/14/93	5	Ba	ND	ND	ND	ND	0
113-25	06/14/93	5	Ba	ND	ND	ND	1.6	1.6
113-26	06/16/93	5	Ba	ND	ND	ND	21	21
113-27*	06/14/93	5	Ba	15	5.2	13	39	72.2
113-27FR	06/17/93	5	Ba	360	18	14	39	431
113-28	06/16/93	5	Ba	ND	ND	ND	ND	0
113-29	06/14/93	5	Ba	5,400	46	370	610	6,426
113-30	06/15/93	5	Ba	ND	ND	ND	48	48
113-31	06/16/93	5	Ba	ND	ND	ND	ND	0
113-32	06/16/93	5	Ba	ND	ND	ND	ND	0
113-33	06/14/93	5	Ba	ND	ND	ND	ND	0
113-33FD	06/14/93	5	Ba	ND	ND	ND	ND	0

"FR" Denotes Field Replicate Sample

"FD" Denotes Field Duplicate Sample

"\*\*" Denotes Sample Value Not Used to Generate SVS Contours

"Ba" Denotes Baseline SVS Sample

"De" Denotes Detailed SVS Sample

TABLE 2.3.2 IHSS 113 SVS ANALYTICAL DATA SUMMARY  
(CONTINUED)

SAMPLE ID	DATE	DEPTH	STATUS	Soil Vapor Analytical Results (ug/L)				
				1,1-DCA	CCl4	TCE	PCE	TOTAL VOC'S
113-34	10/28/93	10	De	ND	ND	ND	30	30
113-35	10/28/93	10	De	ND	ND	ND	2.7	2.7
113-36	10/29/93	10	De	ND	0.4	1.1	25	26.5
113-37	10/29/93	5	De	ND	ND	ND	0.9	0.9
113-37	10/29/93	10	De	ND	ND	ND	4.3	4.3
113-37LR*	10/29/93	10	De	ND	ND	ND	4.3	4.3
113-38	10/28/93	5	De	ND	51	930	2,500	3,481
113-38	10/28/93	10	De	ND	130	2,600	6,300	9,030
113-39	11/02/93	10	De	ND	12	3,300	32,400	35,712
113-40	11/02/93	10	De	ND	0.3	37	3,740	3,777.3
113-41	11/02/93	10	De	ND	ND	1.1	27	28.1
113-42	11/02/93	5	De	ND	ND	ND	19	19
113-43	11/02/93	5	De	ND	ND	ND	0.96	0.96
113-43	11/02/93	10	De	ND	ND	ND	1	1
113-44	11/02/93	10	De	ND	ND	17	415	432
113-45	12/30/93	10	De	ND	ND	ND	0.2	0.2
113-46*	12/30/93	10	De	280	52	2,620	4,880	7,832
113-46FD*	12/30/93	10	De	260	46	2,520	4,510	7,336
113-46LR	12/30/93	10	De	240	55	2,790	5,160	8,245
113-47*	12/30/93	10	De	40	ND	244	115	399
113-47FD*	12/30/93	10	De	40	ND	240	120	400
113-47LR	12/30/93	10	De	43	ND	249	117	409

\*FR\* Denotes Field Replicate Sample

\*FD\* Denotes Field Duplicate Sample

\*\*\* Denotes Sample Value Not Used to Generate SVS Contours

\*Ba\* Denotes Baseline SVS Sample

\*De\* Denotes Detailed SVS Sample

The compounds TCE and PCE were detected at elevated concentrations (e.g., in excess of 250  $\mu\text{g/L}$ ) at nine of the 50 sampling points within IHSS 113, centered around the two primary areas within the IHSS boundary. The first area was at locations 113-29 and 113-38, within the northwestern quadrant, coterminous with the 1,1-DCA and Carbon Tetrachloride source area, and the second was at location 113-18, centered along the eastern quarter of the IHSS boundary. These distribution patterns of TCE and PCE were similar, however, PCE was detected at concentrations typically an order of magnitude higher than TCE, ranging up to a concentration of 32,400  $\mu\text{g/L}$  at a 10-foot depth at location 113-39. In general, TCE and PCE vapor concentrations were greater at a 10-foot depth compared to 5-foot depth data.

Total VOC contamination is generally concentrated within and north of the northwestern IHSS quadrant and along the eastern IHSS boundary centered around locations 113-18 and 113-39. At locations positioned away from these areas of elevated VOC's, vapor concentrations are generally moderate to not detected. The entire southern third of the IHSS is characterized by very low to no detected VOC's.

### 2.3.3 T.I.C.'s (IHSS 113)

T.I.C.'s in excess of 20  $\mu\text{g/L}$  reported by the mobile laboratory were limited to three SVS samples and include the compounds 1,1-DCE, cis-1,2-DCE, and trans-1,2-DCE. 1,1-DCE was reported from the Baseline sample 113-14 located in the northeastern quadrant of IHSS 113 at an approximate concentration of 27  $\mu\text{g/L}$ . The compounds cis- and trans-1,2-DCE were also reported from samples 113-37 and 113-38, located east and west of the dirt road along the northeastern site boundary, respectively, at concentrations of approximately 30  $\mu\text{g/L}$ .

## **2.4 Testing Program, East Trenches Area**

### 2.4.1 Testing Program, Primary IHSS 110

2.4.1.1 IHSS 110 Site Background IHSS 110 (Trench T-3) is one of nine burial trenches within the East Trenches Area. The trenches were used from 1954 to 1968 for disposal of depleted

uranium; flattened, depleted uranium- and plutonium-contaminated drums; and sanitary sewage. The sludge disposed in the trench consisted of concentrated organic matter typically found in sanitary wastewater treatment plant sludge. Disposal operations at Trench T-3 were conducted during the period of July 2, 1955 through August 14, 1968.

2.4.1.2 Investigative Results (IHSS 110) The Baseline SVS investigation conducted at IHSS 110 during June of 1993 encompassed 22 sampling locations collected at a depth of approximately 5-feet below grade. The sampling strategy for the IHSS 110 Baseline SVS employed a triangular grid pattern with probe spacing approximately equidistant at 20-foot intervals. This approach provided for near-complete coverage along the margins of Trench T-3. Following completion of the Baseline SVS data, an additional seven Detailed probe locations were sampled at a depth of 10-feet below grade. The Detailed probe locations were sampled during November and December of 1993. Detailed probes were positioned near areas where Baseline data indicated relatively high VOC concentrations. Additionally, the 10-foot depth of the Detailed probes allowed an evaluation of subsurface conditions as a function of both lateral probe positioning as well as depth.

Table 2.4.1 presents a summary of SVS analytical results of the Baseline and Detailed SVS samples collected at IHSS 110. Figure C-24 in Appendix C identifies the 29 Baseline and Detailed sampling locations at IHSS 110. Figures C-25 through C-34 present the SVS analytical data and provide interpretive isoconcentration contours for each of the primary analytes detected at IHSS 110.

A review of Table 2.4.1 and Figures C-26 through C-30 indicates that the primary VOC's detected from shallow, 5-foot depth soil vapor samples were 1,1-DCA and PCE, which were detected at concentrations ranging from the tens to hundreds of  $\mu\text{g/L}$ . TCE and carbon tetrachloride were detected as well in selected SVS samples, yet with concentrations ranging in the units to tens of  $\mu\text{g/L}$ . Therefore, Total VOC values and corresponding contours at a 5-foot depth generally mimic 1,1-DCA and PCE contours.

At a 5-foot depth, the compound 1,1-DCA was detected at a maximum concentration of 410  $\mu\text{g/L}$  at location 110-3, positioned approximately 35-feet west of the southwest IHSS boundary (see Figure C-25). Elevated 1,1-DCA detections from 5-foot depth samples were confined within the western

TABLE 2.4.1 IHSS 110 SVS ANALYTICAL DATA SUMMARY

SAMPLE ID	DATE	DEPTH	STATUS	Soil Vapor Analytical Results (ug/L)				
				1,1-DCA	CCI4	TCE	PCE	TOTAL VOC'S
110-1	06/11/93	5	Ba	ND	47	ND	ND	47
110-2*	06/11/93	5	Ba	140	ND	ND	1.2	141.2
110-2FR	06/11/93	5	Ba	ND	111	ND	1.1	112.1
110-3	06/11/93	5	Ba	410	110	ND	4.3	524.3
110-4*	06/11/93	5	Ba	200	46	1.2	29	276.2
110-4FD	06/11/93	5	Ba	320	77	1.1	34	432.1
110-5*	06/09/93	5	Ba	1,900	38	18	410	2,366
110-5FR	06/11/93	5	Ba	280	51	5.2	52	388.2
110-6*	06/07/93	5	Ba	510	17	21	400	948
110-6FR	06/09/93	5	Ba	46	7.2	1.2	29	83.4
110-7	06/09/93	5	Ba	300	30	21	310	661
110-8*	06/07/93	5	Ba	140	11	7.2	140	298.2
110-8FD*	06/07/93	5	Ba	140	11	6.6	130	287.6
110-8FR	06/09/93	5	Ba	220	15	12	310	557
110-9*	06/07/93	5	Ba	150	3.3	9.9	270	433.2
110-9FR	06/09/93	5	Ba	96	1.6	6.7	170	274.3
110-10*	06/07/93	5	Ba	40	1.9	2.6	78	122.5
110-10FR	06/09/93	5	Ba	81	3.3	3.6	96	183.9
110-11*	06/07/93	5	Ba	ND	ND	ND	16	16
110-11FR	06/09/93	5	Ba	ND	ND	ND	5.1	5.1
110-12	06/07/93	5	Ba	ND	ND	ND	2.9	2.9
110-12FR*	06/09/93	5	Ba	ND	ND	ND	2.5	2.5
110-13	06/07/93	5	Ba	ND	ND	ND	ND	0
110-13FD*	06/07/93	5	Ba	ND	ND	ND	ND	0
110-14	06/07/93	5	Ba	ND	ND	ND	ND	0
110-15	06/07/93	5	Ba	ND	ND	ND	ND	0
110-16*	05/28/93	5	Ba	ND	0.36	ND	0.11	0.47
110-16FR	06/04/93	5	Ba	ND	ND	ND	ND	0
110-17	06/04/93	5	Ba	ND	ND	ND	ND	0
110-18	06/04/93	5	Ba	ND	ND	ND	ND	0
110-19	06/04/93	5	Ba	ND	ND	ND	ND	0
110-20	06/04/93	5	Ba	ND	ND	ND	ND	0
110-20FD*	06/04/93	5	Ba	ND	ND	ND	ND	0
110-21	05/28/93	5	Ba	ND	ND	ND	ND	0
110-22	06/11/93	5	Ba	ND	1	ND	ND	1
110-23	11/03/93	10	De	ND	410	12	690	1,112
110-24	11/02/93	10	De	ND	1.4	ND	0.74	2.14
110-25	11/01/93	10	De	ND	30	7.2	115	152.2
110-25FR*	11/05/93	10	De	ND	32	5.4	88	125.4
110-26	11/01/93	10	De	ND	3.5	ND	ND	3.5
110-27	12/27/93	10	De	15	66	0.7	9.6	91.3
110-28	12/27/93	10	De	68	70	2.8	100	240.8
110-29	12/27/93	10	De	59	490	16	280	845

\*FR\* Denotes Field Replicate Sample

\*Ba\* Denotes Baseline SVS Sample

\*FD\* Denotes Field Duplicate Sample

\*De\* Denotes Detailed SVS Sample

\*\*\* Denotes Sample Value Not Used to Generate SVS Contours

half of the IHSS, north of the SVE trailer. 1,1-DCA was detected at moderate concentrations at a 10-foot depth from locations 110-27, 110-28, and 110-29 positioned south, east, and north of the SVE trailer, respectively. 1,1-DCA concentrations were highest in the 5-foot depth samples.

Elevated Carbon Tetrachloride detections were reported from 5-foot depth SVS samples at locations 110-3 and 110-2, positioned at the northwestern corner of the IHSS boundary (see Figure C-26). Carbon Tetrachloride levels diminish progressively eastward from this area. At a 10-foot depth, elevated Carbon Tetrachloride concentrations were highest at locations 110-23 and 110-29 located between the trench and the SVE trailer (see Figure C-30).

TCE was detected at low concentrations at both 5-foot and 10-foot sampling depths throughout IHSS 110. Relatively low concentrations ranging from 1.1 to 21  $\mu\text{g}/\text{L}$  were detected at location 110-7 at 5-feet, and southward towards the SVE trailer at locations 110-23 and 110-29 at a 10-foot depth (see Figures C-27 and C-32). Compared to the other three analytes, TCE does not appear to contribute to overall contamination at IHSS 110.

Elevated PCE detections in soil vapor were concentrated within the western third of the IHSS boundary, and resemble the distribution of 1,1-DCA within IHSS 110. The most significant detections of PCE at 5-foot depths occurred at locations 110-7 through 110-10 within the western third of the IHSS, ranging in concentrations from 96 to 310  $\mu\text{g}/\text{L}$ . Elevated PCE concentrations at a 10-foot depth are confined to locations between the SVE trailer and the southern IHSS border, similar to 1,1-DCA, with the exception of location 110-25. The detection of PCE at 10-feet at location 110-25 with a concentration of 115  $\mu\text{g}/\text{L}$  has the effect of drawing PCE contours northward from the SVE trailer. Given the absence of additional 10-foot depth SVS data in areas between the SVE trailer and location 110-25, it is difficult to establish whether the 10-foot depth PCE contours are accurately depicting site conditions. PCE was not detected from any of the SVS locations positioned within the eastern half of the IHSS.

As discussed earlier, Total VOC concentrations and resultant contours closely resemble the distribution of 1,1-DCA and PCE. An exception to this trend is the elevated concentration of Carbon Tetrachloride at a 10-foot depth at SVS locations in the vicinity of the SVE trailer, particularly at

locations 110-23 and 110-29. Clearly, Total VOC values in the area of the SVE trailer are an indication of primarily PCE and carbon tetrachloride (see Table 2.4.1).

2.4.1.3 T.I.C.'s (IHSS 110) T.I.C.'s detected from SVS samples collected from the IHSS 110 site were limited to the compounds cis- and trans-1,2-DCE detected from sample 110-25 located 10 feet north of the IHSS 110 centerline. This sample location was also characterized by elevated levels of carbon tetrachloride. In this instance, the presence of T.I.C.'s in this sample are interpreted to be related to the degradation of PCE. Additionally, vinyl chloride was detected at an approximate concentration of 23  $\mu\text{g/L}$  from location 110-5, positioned north of the SVE trailer.

#### 2.4.2 Testing Program, Alternate IHSS 111.1

2.4.2.1 IHSS 111.1 Site Background The alternate SVS site for the East Trenches Area is IHSS 111.1. IHSS 111.1, also known as Trench T-4, is a burial trench located approximately 100- feet east of IHSS 110. This trench, similar to IHSS 110, was used from 1954 to 1968 for disposal of sanitary sewage sludge contaminated with uranium and plutonium, and contains flattened drums contaminated with depleted uranium and plutonium. The wastes have not been disturbed since their burial.

2.4.2.2 Investigative Results (IHSS 111.1) The Baseline SVS investigation at IHSS 111.1 was completed during November of 1993 which comprised 21 sample locations designated as 111.1-1 through 111.1-21 collected at a 5-foot depth. The Baseline sampling strategy utilized a series of equidistant probes staggered in an offset triangular grid along the outer margins of Trench T-4. Following sample collection and analysis, an additional probe location designated as 111.1-22 was positioned at an area exhibiting high VOC concentrations. This Detailed SVS location was sampled from a 5-foot depth on December 31, 1993.

A summary of the Baseline and Defined SVS analytical results for IHSS 111.1 is presented as Table 2.4.2. Figure C-35 presented in Appendix C identifies the 22 sampling locations within IHSS 111.1. Figures C-36 through C-40 present the SVS analytical data along with interpretive isoconcentration contours for each analyte detected at IHSS 111.1.

Review of the SVS data presented in Table 2.4.2 and Figures C-36 through C-40 indicates that the primary VOC's of concern at IHSS 111.1 are TCE and PCE, which were detected at concentrations in the range of hundreds to thousands of  $\mu\text{g/L}$  at various sample locations along the trench. Owing to the high reported levels of TCE and PCE, the Total VOC values and corresponding isoconcentration contours closely resemble areas of high reported TCE and PCE.

The compounds 1,1-DCA and Carbon Tetrachloride were generally limited to concentrations below 20  $\mu\text{g/L}$ , with exceptions of location 111.1-17 which had a reported level of 93  $\mu\text{g/L}$  of Carbon Tetrachloride, and location 111.1-22 which reported a 1,1-DCA concentration of 557  $\mu\text{g/L}$ . The high detected level of 1,1-DCA occurring at location 111.1-22 was somewhat anomalous when compared to the other 21 sampling locations of which only three locations showed any detectable 1,1-DCA, which ranged from 5.9 to 14  $\mu\text{g/L}$ . This single high detection of 1,1-DCA at location 111.1-22 is represented by isoconcentration contours to indicate a potential source area to the northwest. This computer interpolation likely misrepresents actual VOC distributions since no other SVS data is available north or west of location 111.1-22 to substantiate the contours.

The distribution of Carbon Tetrachloride at IHSS 111.1 is concentrated towards the central portion of Trench T-4 with a high concentration centered around location 111.1-17 (see Figure C-37). Overall Carbon Tetrachloride concentrations are 2-3 orders of magnitude lower than TCE and PCE concentrations, and therefore contribute relatively little to overall site contamination.

The overall highest analyte concentrations detected at IHSS 111.1 are generally weighted towards TCE. Table 2.4.2 and Figure C-38 indicate that TCE concentrations are greatest at location 111.1-18, positioned slightly west of the center of Trench T-4, and are generally confined to the southwest near 111.1-4, and to the northeast at location 111.1-15. TCE concentrations away from the central trench area, towards the western and eastern margins are characterized by low or non detected levels.

The compound PCE was the highest detected principle analyte at IHSS 111.1, with a maximum concentration of 4,000  $\mu\text{g/L}$  detected at location 111.1-19. Overall, the elevated PCE concentrations are limited to an area centered around location 111.1-19, extending west midway between locations 111.1-3 and 111.1-20, and east towards location 111.1-7 (see Figure C-39). The lack of additional

TABLE 2.4.2 IHSS 111.1 SVS ANALYTICAL DATA SUMMARY

SAMPLE ID	DATE	DEPTH	STATUS	Soil Vapor Analytical Results (ug/L)				
				1,1-DCA	CCI4	TCE	PCE	TOTAL VOC'S
111.1-1	11/03/93	5	Ba	0	0	0	0.4	0.4
111.1-1LR*	11/03/93	5	Ba	0	0	0	0.3	0.3
111.1-2	11/04/93	5	Ba	0	0	0	2.9	2.9
111.1-3	11/04/93	5	Ba	0	0	0.6	6.8	7.4
111.1-4	11/04/93	5	Ba	0	0	150	2,300	2,450
111.1-5	11/04/93	5	Ba	0	0.9	416	314	730.9
111.1-6	11/04/93	5	Ba	0	15	1,450	349	1,819
111.1-7	11/08/93	5	Ba	0	19	965	83	1,067
111.1-7FD*	11/08/93	5	Ba	0	23	664	95	782
111.1-8*	11/08/93	5	Ba	0	5.8	430	17.6	453.4
111.1-8LR*	11/08/93	5	Ba	0	5.8	423	17.1	445.9
111.1-8FR	11/08/93	5	Ba	0	12	1,470	9.4	1,491.4
111.1-9	11/08/93	5	Ba	0	1.9	9.5	96	107.4
111.1-10	11/09/93	5	Ba	0	0.2	13	0.8	14
111.1-11	11/09/93	5	Ba	0	0	1.6	2.2	3.8
111.1-11FR*	11/09/93	5	Ba	0	0	1	0.8	1.8
111.1-12	11/09/93	5	Ba	0	0	7.5	0.7	8.2
111.1-13	11/09/93	5	Ba	0	0	1	0.7	1.7
111.1-14	11/09/93	5	Ba	0	0.5	24	1	25.5
111.1-15	11/08/93	5	Ba	0	11	770	21	802
111.1-16	11/08/93	5	Ba	0	19	514	31	564
111.1-17	11/04/94	5	Ba	14	93	1,023	274	1,404
111.1-18	11/04/94	5	Ba	12	3	2,740	1,670	4,425
111.1-19*	11/05/93	5	Ba	5.8	0.5	1,390	3,500	4,896.3
111.1-19FD	11/05/93	5	Ba	5.9	0.5	1,670	4,000	5,676.4
111.1-20	11/05/93	5	Ba	0	0.2	110	896	1,006.2
111.1-20FD*	11/05/93	5	Ba	0	0.2	151	640	791.2
111.1-21	11/05/93	5	Ba	0	0	0.8	4.4	5.2
111.1-21FD*	11/05/93	5	Ba	0	0	0	1.5	1.5
111.1-22*	12/31/93	5	De	468	0	39	93	600
111.1-22LR*	12/31/93	5	De	548	0	86	163	797
111.1-22FR	12/31/93	5	De	557	0	88	170	815

\*FR\* Denotes Field Replicate Sample

\*FD\* Denotes Field Duplicate Sample

\*\* Denotes Sample Value Not Used to Generate SVS Contours

\*Ba\* Denotes Baseline SVS Sample

\*De\* Denotes Detailed SVS Sample

SVS data north and south of Trench T-4 precludes accurate evaluation of PCE distribution in these areas.

The Total VOC distribution is very similar to the distribution of TCE along Trench T-4 (see Figures C-38 and C-40). The subtle difference between the TCE and Total VOC contour maps is the method in which the computer interpreted the contours about sample location 111.1-8. The TCE map presents the 1,000  $\mu\text{g}/\text{L}$  contour about 111.1-8 as a detached source open to the south, whereas the Total VOC map includes the contour as a footprint attached to the principle source area. In either case, the computer interpretation of additional VOC's existing south of the trenchline is considered as broadly interpretive given the existing database. VOC distributions are shown to decrease progressively away from the central trench and approach levels below detection limits along the western and eastern trench margins.

2.4.2.3 T.I.C.'s (IHSS 111.1) T.I.C.'s detected during the IHSS 111.1 SVS investigation include the compounds cis- and trans-1,2-DCE, and vinyl chloride. This suite of three T.I.C.'s were detected at levels in excess of 20  $\mu\text{g}/\text{L}$  at locations 111.1-4, 111.1-5, 111.1-19, and 111.1-21, all positioned along the western third of the trench, and at location 111.1-15 positioned approximately 75 feet west of the eastern trench terminus. No other T.I.C.'s were reported from locations sampled within this IHSS site.

### 3.0 OU2 SVS INVESTIGATIVE CONCLUSIONS AND RECOMMENDATIONS

The results from the Baseline and Detailed SVS investigations conducted during this work indicate the majority of the VOC contamination within the five sites tested at OU2 as being located within five principle contamination areas, and the detected analytes were mostly TCE and PCE. One principle area is interpreted to reside in IHSS 112. Of the 181 points that were sampled, approximately 54 percent resulted in Total VOC values greater than 20  $\mu\text{g/L}$  and 16 of the Total VOC values were above 1,000  $\mu\text{g/L}$ . The highest value recorded was 32,400  $\mu\text{g/L}$  of PCE at a depth of 10-feet (Sample ID No. 113-39) located inside the eastern boundary of IHSS 113. The corresponding Total VOC value was 35,712  $\mu\text{g/L}$ . The greatest percentage of Total VOC sample detections above 1,000  $\mu\text{g/L}$  occurred at IHSS 111.1.

A presentation of the highest contamination sample locations within OU2 is as follows:

- IHSS 110-23: 690  $\mu\text{g/L}$  PCE and 410  $\mu\text{g/L}$   $\text{CCl}_4$ ; Depth 10-feet
- IHSS 109-4: 1,400  $\mu\text{g/L}$  TCE; Depth 5-feet
- IHSS 111.1-19: 4,000  $\mu\text{g/L}$  PCE and 1,670  $\mu\text{g/L}$  TCE; Depth 5-feet
- IHSS 112: 27,000 PCE; Depth 5-feet
- IHSS 113: Two locations
  - 113-38: 6,300  $\mu\text{g/L}$  PCE and 2,600  $\mu\text{g/L}$  TCE; Depth 10-feet
  - 113-39: 32,400  $\mu\text{g/L}$  PCE and 3,300  $\mu\text{g/L}$  TCE; Depth 10-feet

The following sections present the conclusions and recommendations for each of the investigated areas conducted during this activity.

#### 3.1 IHSS 112

Results from the Baseline and Detailed SVS investigations at primary OU2 IHSS 112 indicate the presence of three principle areas of elevated VOC's. The area of highest detected VOC's is located outside the southeastern IHSS boundary centered at location 112-60, with PCE detected at a concentration of 27,000  $\mu\text{g/L}$ . Based on the SVS data collected from locations positioned radially

away from location 112-60, which indicated low to no detected VOC's, the high PCE concentrations previously detected at 112-60 is shown in Figures C-5 and C-6 to be localized in extent, limited to within an approximate 20-foot to 30-foot radial distance.

Based on the very high PCE concentrations detected at location 112-60, with low to no detected VOC's at locations positioned radially away from 112-60, it is recommended that a resample of 112-60 be carried out at both 5-foot and 10-foot depths to verify PCE concentrations, and to establish a vertical distribution of PCE concentrations, if possible. The two additional areas in the vicinity of locations 112-20 and 112-21 are fairly well defined based on the SVS data to date. No additional probe locations are recommended for these two areas.

### 3.2 IHSS 109

A review of the OU2 alternate IHSS 109 SVS data and the contour maps presented in Appendix C indicates the presence of elevated VOC's west of the midpoint and south of Trench T-2, in the area of probe locations 109-4 and 109-15. This area is characterized by moderate to high (100 - 1,000  $\mu\text{g/L}$ ) concentrations of 1,1-DCA, TCE, and PCE. Interpretive contours presented on Figure C-12 are shown to extend approximately 100-feet east of the elevated VOC area at location 109-4. As no actual VOC data have been obtained due east of sample locations 109-4 and 109-15 to provide an anchor point for contouring, the computer-generated contours extending east of location 109-4 may not be indicative of actual site conditions. A second area of elevated VOC's is centered around location 109-11. Sample location 109-11, located approximately 45-feet east-northeast of location 109-4 is characterized by the highest PCE concentration detected at IHSS 109. The lack of additional SVS data north of location 109-11 limits any further conclusions as to VOC distribution north of 109-11.

Based on the lower VOC concentrations detected at IHSS 109 relative to the three primary OU2 IHSS's, it is recommended that a limited (2-3 additional probes) number of additional probe locations be sampled at locations southeast of 109-4, and north of 109-11 in order to provide closure of SVS data in these areas where current data is lacking.

### 3.3 IHSS 113

Elevated VOC concentrations of the target analytes within IHSS 113 are shown on the contour maps to occupy two principle areas of VOC contamination. The first principle area of elevated VOC's is centered around sample locations 113-18 and 113-39 located 30-feet west of the eastern IHSS border. This area is characterized by locally maximum concentrations of PCE and TCE, with low to no detected 1,1-DCA and Carbon Tetrachloride. In general, VOC vapor concentrations are greater in samples collected from a 10-foot depth when compared to nearby 5-foot depth probe locations.

The second principle area of elevated VOC's is located in the northwestern quadrant of the IHSS 113 boundary, centered around sample locations 113-29 and 113-38. This area is characterized by high concentrations of 1,1-DCA, PCE and TCE, with Total VOC concentrations ranging from about 3,400 to 6,400  $\mu\text{g/L}$ . However, soil vapor collected from a 10-foot sample depth indicates elevated concentrations north of the IHSS boundary, whereas, elevated VOC's from 5-foot sample locations are greatest within the IHSS boundary. An absence of additional SVS data north of sample location 113-46 prevents conclusive evidence as to the northern terminus of the subsurface VOC vapor plume. The southern and central portions of the IHSS boundary are characterized by relatively low to no detected VOC's.

Based on these findings, additional SVS samples are recommended to be collected north of the northwestern IHSS boundary at location 113-46 at both 5-foot and 10-foot depths in order to further define the northern terminus of VOC concentrations in this area. Also, it is recommended that additional SVS samples be collected at a tighter grid spacing (eg. 5-foot radius) around sample locations 113-18 and 113-39, located 30-feet west of the eastern IHSS boundary in order to better define the lateral extent of VOC occurrence in this area.

### 3.4 IHSS 110

SVS investigative results from primary IHSS 110 indicate elevated VOC concentrations in the northern vicinity of the existing SVE trailer, detected in the range of 100 - 1,000  $\mu\text{g/L}$ , as Total

VOC's. SVS samples collected from a 10-foot depth indicate elevated VOC's directly north of the current SVE trailer location, however, samples collected from a 5-foot depth indicate elevated VOC concentrations an additional 70-feet north and northwest of the SVE trailer, within the IHSS boundary. Low to no detected VOC's characterize the entire eastern half of IHSS 110.

Based on the moderate VOC detections within IHSS 110 relative to IHSS's 112 and 113, and the existing site coverage of SVS probe sampling locations, no additional sampling locations are recommended at this time.

### **3.5 IHSS 111.1**

SVS data collected from OU2 alternate IHSS 111.1 (Trench T-4) indicates a principle area of elevated VOC's, primarily TCE and PCE, along Trench T-4, centered around locations 111.1-18 and 111.1-19. A review of Figures C-38 through C-40 in Appendix C indicates that the general area of elevated TCE and PCE may extend from location 111.1-20 on the west, towards location 111.1-9 at the east, encompassing an approximate length of 150-feet of Trench T-4. Vapor concentrations at the eastern and western trench margins are low to not detected. Subsurface VOC conditions north and south of the trench are unknown based on the existing data.

Based on the elevated VOC concentrations detected along an approximate 150-foot length of Trench T-4, it is recommended that additional SVS samples be collected at probe locations positioned along an east-west trending line, at a distance of 15-feet to 20-feet both north and south of the trench. It is further recommended that the SVS probe array extend from location 111.1-20 at the western margin to location 111.1-15 at the eastern margin, in order to evaluate soil vapor conditions away from the principle area of elevated VOC's.

### **3.6 Future Activity**

Based on the SVS data collected to date, the discovery of the free phase product, and the installation of the six-phase heating system at IHSS 110, no additional SVS work is recommended.

#### 4.0 TESTING PROGRAM, OU1 IHSS 119.1

Included within the scope of the OU2 Subsurface IM/IRAP/EA Document was an SVS investigation specified for IHSS 119.1 located within OU1 (see Figure 4-1). The objective of the OU1 SVS was to collect and analyze soil vapor samples in order to map the distribution and concentration of potential VOC contamination in shallow (5-feet below grade) soil vapor. The OU1 SVS Work Plan, dated December, 1993, set forth SVS program requirements to be followed throughout the implementation of the OU1 SVS at IHSS 119.1. In general, the Health & Safety program, SVS investigative sampling and analytical methodologies, and QA/QC program elements were identical to those employed during the OU2 SVS investigation program described in Sections 1 and 2 of this document. Specific modifications from the OU2 SVS program that were specified for this OU1 SVS program are outlined and discussed in the following section.

#### 4.1 Data Quality Objectives

Different species of VOC's were expected to be present within the shallow soils at IHSS 119.1 based on Rocky Flats records. The OU1 SVS program, therefore, adopted a modified set of Data Quality Objectives. Specifically, in addition to the minimum analyte list specified for the OU2 SVS which included the compounds 1,1-DCA, carbon tetrachloride, TCE, and PCE; the OU1 analyte list specified the additional analytes 1,1-Dichloroethene (1,1-DCE) and Toluene. Field laboratory minimum instrument detection limits for each of the six OU1 analytes are as follows:

<u>Compound</u>	<u>Detection Limit</u>
1,1-DCA	0.5 µg/L
CCl <sub>4</sub>	0.2 µg/L
TCE	0.5 µg/L
PCE	0.2 µg/L
1,1-DCE	1.0 µg/L
Toluene	1.0 µg/L

The above stated detection limits are based on the results of an Instrument Detection Limit (IDL) exercise performed by the mobile laboratory prior to initiating sampling activities. The IDL was performed according to Method 8000, modified for vapors, as described in USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (USEPA SW 846). Actual reporting limits may be greater than the minimum detection limits listed above. This condition arose when potential dilutions of soil vapor samples were carried out by the mobile laboratory during analysis. Dilutions were performed on selected samples in order to keep resultant concentrations within the linear range of the instrument calibration curves.

#### 4.1.1 Data Quantity

A SVS sampling grid was established within the investigation area at IHSS 119.1 which included a total of 24 initial SVS samples collected at a 5-foot depth. The initial grid was constructed as a series of sampling points positioned along a set of five northeast-southwest trending lines parallel to the dirt road at the southern margin of the IHSS boundary. The resultant probe spacing interval was 10-feet to 20-feet. The type and quantity of SVS samples are summarized below.

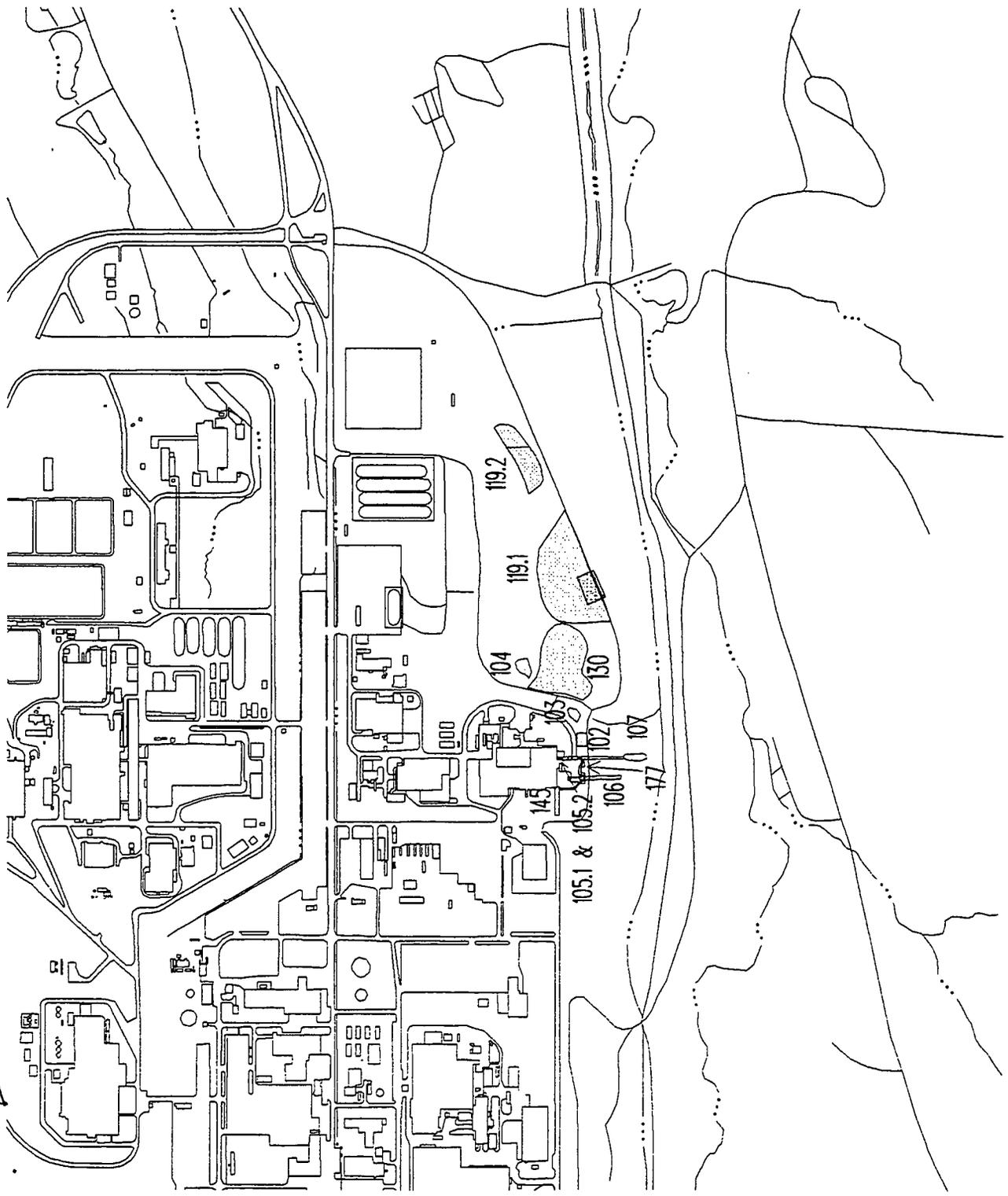
- 24 initial SVS sample (5-foot depth)
- 6 additional SVS samples at 5-foot or 10-foot depths to expand grid or increase grid density at IHSS 119.1.

## **4.2 Testing Program, IHSS 119.1 (OU1)**

### 4.2.1 IHSS 119.1 Site Background

The 881 Hillside Area of Rocky Flats Plant, designated as OU1, is located on the south side of the Rocky Flats Plant security area. Several sites are included within this area because of their physical proximity to each other. Figure 4-1 shows the location of the 881 Hillside Area and highlights the Individual Hazardous Substance Site designated as IHSS 119.1.

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== Roads

... - Streams and Ponds

□ Buildings

□ IHSSs Within OU1

▨ Primary Soil Vapor Survey Site (IHSS 119.1)

250 0 250 500 FEET

PREPARED FOR  
U.S. DEPARTMENT OF ENERGY  
ROCKY FLATS PLANT  
GOLDEN, COLORADO

FIGURE 4-1  
IHSS LOCATIONS AND  
PRIMARY SOIL VAPOR  
SURVEY SITE  
OPERABLE UNIT NO.1

Sites at the 881 Hillside were selected as High Priority Sites as a result of Plant-wide characterization activities which showed elevated concentrations of VOC's in ground water upgradient from Woman Creek. The most pronounced organic contamination is in the east portion of the 881 Hillside Area, in the general area of IHSS 119.1, with concentrations of PCE, TCE, 1,1-DCE, 1,1-DCA, 1,1,1-TCA, 1,2,2-TCA, and CCl<sub>4</sub> reaching several thousand  $\mu\text{g/L}$  in many samples. In addition, Toluene was detected in soil samples during the French Drain Geotechnical Investigation, and within surface water at many sampling stations (DOE, 1993).

Beginning in 1967, the area east of Building 881 designated as IHSS 119.1 located along the southern perimeter road was used as a barrel storage area. The barrels contained unknown quantities and types of solvents and wastes. Barrel storage in this area was discontinued, and all barrels were removed by 1972.

#### 4.2.2 Investigative Summary and Results (IHSS 119.1)

The SVS investigations at IHSS 119.1 were completed during December 23 through December 31, 1993, encompassing the collection and analysis of an initial 24 SVS samples and an additional 6 SVS samples. The SVS sample location strategy employed an offset triangular grid approach with northeast-southwest oriented rows of sampling locations positioned parallel to the dirt road in order to provide effective site coverage (see Figure C-41). Four of the initial SVS samples were positioned along the dirt road located outside of the southern IHSS boundary. These probe locations were designed to evaluate whether or not the dirt road served as a historic VOC source.

Based on the analytical results of the 24 initial samples, an additional 4 samples were collected from a 5-foot depth, and 2 additional samples were collected from a 10-foot depth (see Figure C-41). The 5-foot additional samples were designed to collect SVS data along the eastern margin of the initial probe array, while the 10-foot depth samples were positioned at areas of elevated VOC detections, in order to evaluate elevated VOC's as a function of depth. The resultant grid spacing at IHSS 119.1 was 10-feet to 20-feet.

The SVS analytical data for the OU1 IHSS 119.1 SVS investigations are presented in Table 4.2.2. The OU-1 IHSS 119.1 contour maps which present the four above mentioned analytes in addition to the compounds Toluene and 1,1-Dichloroethene (1,1-DCE) are presented in Appendix C as Figures C-42 through C-48.

Review of Table 4.2.2 data indicate that overall soil vapor concentrations detected from samples collected at IHSS 119.1 were relatively low, ranging from not detected to a maximum of 198  $\mu\text{g/L}$  for Total VOC's at sample location 119.1-20. TCE was the most frequently detected compound, where the locations exhibiting the greatest TCE concentrations were typically accompanied by moderate levels of 1,1-DCA and PCE. Detections of 1,1-DCA and  $\text{CCl}_4$  ranged in the units to tens of  $\mu\text{g/L}$ . 1,1-DCE was not detected from any SVS samples, while Toluene was detected at a concentration of 17  $\mu\text{g/L}$  at a single location (119.1-66).

1,1-DCA was detected at a total of eight sample locations within the IHSS 119.1 investigation area. The occurrence and distribution of elevated 1,1-DCA concentrations was limited to three locations within the investigated area, specifically at 119.1-5, 119.1-20 and 119.1-22, all positioned within 24-feet north of the dirt road (see Figure C-42). Both north and south of these locations, 1,1-DCA concentrations were minimal to not detected.

$\text{CCl}_4$  was detected at a total of four sample locations, at low concentrations. The highest detected levels of  $\text{CCl}_4$  were confined to two locations, 119.1-7 and 119.1-23, at concentrations of 17 and 29  $\mu\text{g/L}$ , respectively, which are located at the western margin of the investigative grid, 20-feet to 30-feet north of the dirt road. Owing to the lack of additional SVS data to the west in the area of borehole 1074, no conclusion can be drawn as to the potential of  $\text{CCl}_4$  concentrations in this area (see Figure C-43).

TCE concentrations detected at IHSS 119.1 remained moderate to not detected, ranging from a maximum of 132  $\mu\text{g/L}$  at location 119.1-20 to below detection limits. The occurrence and distribution of moderately elevated TCE concentrations in shallow soil vapor at IHSS 119.1 resembles that of 1,1-DCA, where sample locations 119.1-5 and 119.1-20 positioned north of the dirt road identify the highest TCE areas. SVS data collected at a 10-foot depth from sample

TABLE 4.2.2 IHSS 119.1 SVS ANALYTICAL DATA SUMMARY

SAMPLE ID	DATE	DEPTH	Soil Vapor Analytical Results (ug/L)						
			1,1-DCA	1,1-DCE	CCI4	TCE	PCE	Toluene	TOTAL VOC'S
119.1-1	12/28/93	5	10	0	0	0.6	1.6	0	12.2
119.1-3	12/28/93	5	0	0	0	0	0	0	0
119.1-4	12/28/93	5	0	0	0	2	0	0	2
119.1-5	12/28/93	5	59	0	0	56	19	0	134
119.1-5LR*	12/28/93	5	58	0	0	54	18	0	130
119.1-6	12/28/93	5	5.8	0	0	1.5	0	0	7.3
119.1-7	12/23/93	5	0	0	17	18	0.2	0	35.2
119.1-8	12/23/93	5	0	0	0	6.7	1.1	0	7.8
119.1-9	12/27/93	5	0	0	0	1.5	0.9	0	2.4
119.1-9FD*	12/27/93	5	0	0	0	3.2	0.9	0	4.1
119.1-9LR*	12/27/93	5	0	0	0	3.2	0.9	0	4.1
119.1-10	12/27/93	5	0.9	0	0	3.9	28	0	32.8
119.1-11	12/29/93	5	1.6	0	0.2	0.7	8.1	0	10.6
119.1-13	12/29/93	5	0	0	0	0	0.2	0	0.2
119.1-14	12/23/93	5	1.1	0	2.2	9	0.4	0	12.7
119.1-14FR*	12/23/93	5	2	0	2.3	9.3	0.4	0	14
119.1-14LR*	12/23/93	5	1.4	0	2.3	9.1	0.3	0	13.1
119.1-15	12/23/93	5	0	0	0	1	0.3	0	1.3
119.1-16	12/27/93	5	0	0	0	1.8	0.5	0	2.3
119.1-16FR*	12/27/93	5	0	0	0	2	0.6	0	2.6
119.1-17	12/29/93	5	0	0	0	0.6	4	0	4.6
119.1-19	12/28/93	5	0	0	0	0	0	0	0
119.1-20	12/28/93	5	66	0	0	132	0	0	198
119.1-21	12/28/93	5	0	0	0	0	0	0	0
119.1-22	12/28/93	5	22	0	0	9.7	0	0	31.7
119.1-23	12/29/93	5	0	0	29	10	0.2	0	39.2
119.1-50	12/29/93	5	0	0	0	0	0	0	0
119.1-51	12/29/93	5	0	0	0	3.2	1.4	0	4.6
119.1-52	12/29/93	5	0	0	0	0	0	0	0
119.1-53	12/29/93	5	0	0	0	0	0	0	0
119.1-61	12/31/93	5	0	0	0	0	0	0	0
119.1-62	12/31/93	5	3	0	0	0.6	0	0	3.6
119.1-63	12/31/93	5	0	0	0	0	0	0	0
119.1-64	12/31/93	5	0	0	0	2.8	0	0	2.8
119.1-65	12/31/93	10	0	0	0	16	0	0	16
119.1-66	12/31/93	10	58	0	0	64	20	17	159

\*FR\* Denotes Field Replicate Sample  
 \*FD\* Denotes Field Duplicate Sample

\*\*\* Denotes Sample Value Not Used to Generate SVS Contours  
 \*LR\* Denotes Laboratory Replicate Sample

locations 119.1-66 and 119.1-65, coincident with locations 119.1-5 and 119.1-20, respectively, indicate reduced TCE concentrations with depth.

The highest detected PCE occurred at location 119.1-10 at a concentration of 28  $\mu\text{g/L}$ , which is positioned north of borehole 4387. PCE was also detected at sample location 119.1-5 (depth 5-feet) at a concentration of 19  $\mu\text{g/L}$ , and 10-foot depth at coincident location 119.1-66 at a concentration of 20  $\mu\text{g/L}$ . At sample locations positioned radially away from these areas, PCE is shown to diminish to low or no detected levels.

A single detection of Toluene was noted from sample location 119.1-66 at a 10-foot depth, with a corresponding concentration of 17  $\mu\text{g/L}$ . No other Toluene was detected in soil vapor samples collected during this SVS investigation. The absence of any other detections of Toluene at this site limits any further discussion of subsurface distribution.

In general, areas of elevated Total VOC levels are closely related to locations exhibiting elevated TCE and 1,1-DCA concentrations, which together, constitute the majority of VOC's detected at the site. The exception to this trend is the area along the western margin of the investigation area at locations 119.1-7 and 119.1-23, where  $\text{CCl}_4$  and TCE levels comprise the primary VOC's.

#### 4.2.3 T.I.C.'s

No tentatively identified compounds other than the primary six analytes were detected above 20  $\mu\text{g/L}$  in soil vapor collected from sample locations within IHSS 119.1.

#### 4.2.4 Conclusions and Recommendations

The overall magnitude of VOC's detected in soil vapor at IHSS 119.1 indicate low level contamination of shallow soils in localized areas. VOC concentrations are shown to decrease with depth from 5-feet to 10-feet. Of the thirty locations tested, approximately 23 percent resulted in Total VOC values greater than 20  $\mu\text{g/L}$ , and three of the Total VOC values were reported above 100  $\mu\text{g/L}$ . Sample 119.1-20 reported 132  $\mu\text{g/L}$  of TCE and 66  $\mu\text{g/L}$  of 1,1-DCA and represents the

location of the highest contamination recorder during this investigation. Based on the low levels of VOC's detected from the shallow soils at IHSS 119.1, no further probe locations are recommended at this site.

## 5.0 REFERENCES

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**APPENDIX A**  
**PARCC ANALYSIS**

## APPENDIX A - PARCC ANALYSIS

### INTRODUCTION

The six primary elements comprising the OU2 SVS Subsurface IM/IRA Program DQO's were summarized and described in Section 1.2.2 of this document, and are listed below:

- Data Uses/Users
- Data Types
- Data Quality
- Data Quantity
- Sampling and Analytical Approach
- PARCC Parameters

A discussion of the six elements relative to the SVS program implementation follows.

**Data Uses/Users:** Soil vapor samples were collected and analyzed in an on-site mobile laboratory to provide qualitative data on VOC's in the unsaturated zone at each of the five IHSS's within OU2. Data was used to locate areas of elevated VOC's and to locate pilot unit vapor extraction wells.

**Data Types:** Baseline grab samples of soil vapor were collected along established and approved initial sampling grids. Detailed soil vapor samples were collected at pre-approved locations which were designed to expand the Baseline grid or increase the grid density at areas exhibiting elevated VOC concentrations.

**Data Quality:**

- a) Prioritized data uses:
  - Location of areas of elevated VOC's
  - Location of pilot unit vapor extraction wells
- b) Appropriate analytical level
  - Level II- mobile laboratory GC
- c) Minimum Analyte List
  - OU2: Carbon tetrachloride (CCl<sub>4</sub>), tetrachloroethene (PCE), trichloroethene (TCE), and 1,1-Dichloroethane (1,1-DCA).
  - OU1: (CCl<sub>4</sub>), (PCE), (TCE), (1,1-DCA), 1,1-Dichloroethene (1,1-DCE), and Toluene.

d) Detection Limits

Minimum instrument detection limits for the initial SVS ranged from 1.0  $\mu\text{g/L}$  to 20  $\mu\text{g/L}$  depending on the analyte screened for during the analysis. Minimum instrument detection limits for the follow-up SVS were as follows:

<u>Compound</u>	<u>Detection Limit</u>
1,1-DCA:	1.0 $\mu\text{g/L}$
TCE:	0.1 $\mu\text{g/L}$
PCE:	0.1 $\mu\text{g/L}$
$\text{CCl}_4$ :	0.05 $\mu\text{g/L}$
1,1-DCE:	0.5 $\mu\text{g/L}$
Toluene:	1.0 $\mu\text{g/L}$

The above stated detection limits are based on the results of an Instrument Detection Limit (IDL) exercise performed by the mobile laboratory prior to initiating sampling activities. The IDL was performed according to Method 8000, modified for vapors, as described in USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (USEPA SW 846). Some reporting limits were greater than the minimum detection limits listed above. This condition arose when potential dilutions of soil vapor samples were carried out by the mobile laboratory during analysis. Dilutions were performed on selected samples in order to keep resultant concentrations within the linear range of the instrument calibration curves.

**Data Quantity:**

- Baseline sampling grid for primary sites (119 samples)
  - IHSS 112 - 64 samples (5-foot depth)
  - IHSS 113 - 33 samples (5-foot depth)
  - IHSS 110 - 22 samples (5-foot depth)
- Baseline sampling grid for alternate sites (36 samples)
  - IHSS 109 - 14 samples (5-foot depth)
  - IHSS 111.1 - 22 samples (5-foot depth)
- Total of 34 additional Detailed samples at the five OU2 IHSS's to expand grid or increase grid density on-site, depending on results from Baseline samples.
  - IHSS 112 - 8 samples
    - 7 samples (5-foot depth)
    - 1 sample (10-foot depth)
  - IHSS 113 - 17 samples
    - 4 samples (5-foot depth)
    - 13 samples (10-foot depth)
  - IHSS 110 - 7 samples (10-foot depth)
  - IHSS 111.1 - 1 sample (5-foot depth)
  - IHSS 109 - 1 sample (5-foot depth)

### Sampling and Analysis Approach:

Shallow soil vapor samples were collected by inserting a soil vapor probe to depth of either 5-feet or 10-feet below grade (see Section 2.1.1.1). Each sample was collected and analyzed for the minimum analyte list presented above, within two hours from sample collection.

### PARCC Parameters:

- a) Precision
  - Field Duplicate  $\pm 20\%$  RPD
  - Laboratory Replicate analysis  $\pm 20\%$  RPD
- b) Accuracy
  - Calibration standards  $\pm 20\%$  RPD
  - Analysis once daily of independently prepared gas standard  $\pm 30\%$  RPD
- c) Representativeness
  - Adherence to 3-dimensional sampling locations and procedures specified in Final Work Plan.
- d) Completeness
  - Laboratory completeness 95%
  - Field completeness 90%
- e) Comparability
  - Adhere to analytical protocol specified in Final Work Plan.

The following sections present the analysis of the PARCC parameters associated with the OU2 SVS Final Work Plan requirements.

- Precision
- Accuracy
- Representativeness
- Comparability
- Completeness

#### Precision

Precision is a measure of agreement amongst individual measurements of the same property under similar conditions. Precision is expressed in terms of Relative Percent Difference (RPD) between duplicates. As a means of evaluating the precision DQO index, a series of tables have been prepared which are presented in this appendix. Each set of tables presents analytical results for selected SVS sampling locations and the corresponding Field Duplicate and Laboratory Replicate analytical results for specific sample locations that underwent QA/QC sampling. The Relative Percent Difference

(RPD) expressed as a percentage of deviation was calculated for each data set using the following relationship:

$$\text{RPD (\%)} = (\text{Sample} - \text{QA/QC}) / [1/2 * (\text{Samp} + \text{QA/QC})]$$

where:

- Sample refers to the sample analytical value ( $\mu\text{g/L}$ )
- QA/QC refers to the Duplicate or Laboratory Replicate analytical value ( $\mu\text{g/L}$ )

The resultant RPD value was compared against the DQO's targeted for the OU2 SVS Program which are as follows:

- Field Duplicate  $\pm 20\%$  RPD
- Laboratory Replicate  $\pm 10\%$  RPD

A total of 19 Field Duplicate samples were analyzed during the SVS investigative activities. Tables A-1 through A-10 present a summary of the RPD calculations associated with Field Duplicates and Laboratory Replicate analyses. A Field Duplicate was collected in the field by filling two sampling containers connected in series from a single sample location. This QA/QC sample type is designed to identify precision in the field sample collection procedures. As can be seen from the attached tables, 10 of the 19 Field Duplicate samples fell within the  $\pm 20\%$  precision criteria. The remaining 9 samples exceeded this criteria by varying amounts.

A Laboratory Replicate sample refers to two consecutive analyses of a single, specific sample. This QA/QC sample type is designed to identify precision within the mobile laboratory. A total of 11 Laboratory Replicate analyses were completed during the follow-up SVS activities. 6 of the 10 Laboratory Replicate samples were within the  $\pm 10\%$  criteria. The remaining 4 samples slightly exceeded the  $\pm 10\%$  criteria. In each of the cases where the  $\pm 10\%$  criterion was exceeded, the calculation was based on relatively small values. The relative percent difference (RPD) between 0.3 and 0.4  $\mu\text{g/L}$  is much greater than the difference between 9.3 and 9.4  $\mu\text{g/L}$ , even though both are reported to the same number of significant figures. Moreover, 0.3 and 0.4  $\mu\text{g/L}$ , as analytical concentrations, are, in fact, the same value statistically. The  $\pm 10\%$  RPD criterion is only meaningful at concentration values greater than 1  $\mu\text{g/L}$ .

Applying this argument to the existing Laboratory Replicate results, it is evident that three of the instances where the  $\pm 10\%$  RPD criterion was exceeded were confined to sample values that were detected at concentrations at or below 1  $\mu\text{g/L}$  (see Tables A-3 and A-8), and the fourth instance (Table A-10) occurred at a sample concentration of 2  $\mu\text{g/L}$ . Applying this same rationale to Field Duplicate samples, it is evident in Tables A-1, A-4, and A-9 that three cases of  $\pm 20\%$  RPD exceedence were attributed to sample values at or less than 4.3  $\mu\text{g/L}$ .

### Accuracy

Accuracy is defined as the degree of agreement of a measurement (or measurement average) with an accepted reference or true value. It is a measure of system bias and is usually expressed as a

percentage of the true value. Accuracy criteria are stated in the Final Work Plan and are listed as follows:

- Calibration Standards  $\pm 20\%$  RPD
- Analysis once daily of independently prepared gas standard  $\pm 30\%$  RPD.

The mobile laboratory analyzed calibration standards containing each of the primary analytes, as a minimum, prior to initial sample analysis and at the beginning of each days work following initial instrument calibration. Instrument calibration involved the generation of a four point calibration curve with a corresponding correlation coefficient of at least 0.99. Following initial instrument calibration to each of the minimum list of chemical analytes, ongoing calibration checks were run at the beginning and at the end of each day of analysis, as a minimum. If these criterion were not met by the mobile laboratory in all cases, the instrument calibration was repeated. This step ensured that the accuracy criteria were met for the SVS Program at all times.

In addition to instrument calibration procedures, Field Equipment Blanks and sampling container blanks were collected at regular intervals in order to quantify potential background contamination within the sampling system. A quantity of 58 Field Equipment Blanks were collected throughout the SVS Program in order to routinely evaluate potential contamination during SVS sampling activities. Of the 58 Field Equipment Blanks collected and analyzed, the vast majority indicated no detected contamination, while a total of 3 indicated contamination in excess of  $1.0 \mu\text{g/L}$ . Blanks designated as B-19 and B-20, collected during Baseline sampling in IHSS 110, on June 9, 1993, indicated detections of PCE at  $2.5$  and  $2.0 \mu\text{g/L}$ , respectively. Corrective action included thorough decontamination procedures prior to additional sample collection. The third case occurred on November 8, 1993, during Baseline sampling in IHSS 111.1, where PCE was detected at  $12 \mu\text{g/L}$ , and TCE was detected at  $2.3 \mu\text{g/L}$ . Following collection and analysis of an ambient air blank at IHSS 111.1, it was determined that PCE was present in the air space, likely related to off-gassing from the site soils.

Sampling container blanks were analyzed routinely in order to evaluate potential contamination that the sample container may pose to the analytical system. No sample container blanks showed contamination above detection limits.

#### **Representativeness:**

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a data population, process condition, sampling point, or an environment. Representativeness is a qualitative parameter of the SVS Program which is evaluated through adherence to the sampling program. No deviations from the SVS program were noted during the investigative efforts. Therefore, the SVS data is qualitatively designated as representative with respect to the sampling activities.

**Comparability:**

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. To achieve comparability for the SVS Program, similar reporting units, analytical protocol, sampling depths, and DQO's were utilized.

**Completeness:**

Completeness is a measure of the amount of valid data obtained compared to the amount to be expected under normal, correct conditions. As a measure of completeness for the SVS Program, all of the scheduled Baseline and Detailed SVS sample locations were sampled and analyzed, which translates to 100% completeness. The frequency of Field Duplicate collection was 19 Duplicates per 218 SVS samples collected, which translates to 87% completeness, compared to a targeted criterion of 90%. Laboratory Replicate analyses were specified as 10% of the total sample quantity. During the follow-up SVS activities, 11 Laboratory Replicates were analyzed amongst 99 sample collections, exceeding the 10% criterion. Therefore, Laboratory completeness for the follow-up SVS activities is expressed as 100%.

TABLE A-1 IHSS 112 FIELD PARCC ANALYSIS

SAMPLE ID	DATE	RPD %	1,1-DCA (ug/L)	CCI4 (ug/L)	TCE (ug/L)	PCE (ug/L)	TOTAL VOC's (ug/L)
112-5	6/23/93		0	100	0	0	100
112-5FD	6/23/93		0	76	0	0	76
		RPD %	0.00	27.27	0.00	0.00	27.27
112-21	6/29/93		150	50	0	0	200
112-21FD	6/29/93		420	58	0	0	478
		RPD %	94.74	14.81	0.00	0.00	82.01
112-40	7/1/93		74	0	0	0	74
112-40FD	7/1/93		67	0	0	0	67
		RPD %	9.93	0.00	0.00	0.00	9.93
112-50	7/2/93		0	0	0	0	0
112-50FD	7/2/93		0	0	0	0	0
		RPD %	0.00	0.00	0.00	0.00	0.00
112-54	7/6/93		0	0	0	0	0
112-54FD	7/6/93		0	0	0	0	0
		RPD %	0.00	0.00	0.00	0.00	0.00
112-67	11/10/93		0	0	0.97	1.25	2.22
112-67FD	11/10/93		0	0	1.2	1.4	2.6
		RPD %	0.00	0.00	21.20	11.32	15.77

FD Denotes a Field Duplicate

TABLE A-2 IHSS 112 LABORATORY PARCC ANALYSIS

SAMPLE ID	DATE	RPD %	1,1-DCA (ug/L)	CCI4 (ug/L)	TCE (ug/L)	PCE (ug/L)	TOTAL VOC's (ug/L)
112-67FD	11/10/93		0	0	1.2	1.4	2.6
112-67LR	11/10/93		0	0	1.3	1.5	2.8
		RPD %	0.00	0.00	8.00	6.90	7.41
112-68	11/15/93		0	156	1.4	6.8	164.2
112-68LR	11/15/93		0	151	1.4	6.6	159
		RPD %	0.00	3.26	0.00	2.99	3.22

LR Denotes Laboratory Replicate

TABLE A-3 IHSS 109 LABORATORY PARCC ANALYSIS

SAMPLE ID	DATE	RPD %	1,1-DCA (ug/L)	CCI4 (ug/L)	TCE (ug/L)	PCE (ug/L)	TOTAL VOC's (ug/L)
109-9	11/12/93		0	0	1	0.4	1.4
109-9LR	11/12/93		0	0	0.8	0.3	1.1
		RPD %	0.00	0.00	22.22	28.57	24.00
109-15FR	1/3/94		11	0	72	0.3	83.3
109-15LR	1/3/94		11	0	68	0.4	79.4
		RPD %	0.00	0.00	5.71	28.57	4.79

FR Denotes Field Replicate

LR Denotes Laboratory Replicate

TABLE A-4 IHSS 113 FIELD PARCC ANALYSIS

SAMPLE ID	DATE	RPD %	1,1-DCA (ug/L)	CCI4 (ug/L)	TCE (ug/L)	PCE (ug/L)	TOTAL VOC's (ug/L)
113-3	6/16/93		0	0	0	0	0
113-3FD	6/16/93		0	0	0	0	0
		RPD %	0.00	0.00	0.00	0.00	0.00
113-33	6/14/93		0	0	0	0	0
113-33FD	6/14/93		0	0	0	0	0
		RPD %	0.00	0.00	0.00	0.00	0.00
113-46	12/30/93		260	46	2520	4510	7336
113-46FD	12/30/93		240	55	2790	5160	8245
		RPD %	8.00	17.82	10.17	13.44	11.67
113-47	12/30/93		40	0	244	115	399
113-47FD	12/30/93		40	0	240	120	400
		RPD %	0.00	0.00	1.65	4.26	0.25

FD Denotes Field Duplicate

TABLE A-5 IHSS 113 LABORATORY PARCC ANALYSIS

SAMPLE ID	DATE	RPD %	1,1-DCA (ug/L)	CCI4 (ug/L)	TCE (ug/L)	PCE (ug/L)	TOTAL VOC's (ug/L)
113-37	10/29/93		0	0	0	4.3	4.3
113-37LR	10/29/93		0	0	0	4.3	4.3
		RPD %	0.00	0.00	0.00	0.00	0.00
113-46FD	12/30/93		280	52	2620	4880	7832
113-46LR	12/30/93		240	55	2790	5160	8245
		RPD %	15.38	5.61	6.28	5.58	5.14
113-47	12/30/93		40	0	244	115	399
113-47LR	12/30/93		43	0	249	117	409
		RPD %	7.23	0.00	2.03	1.72	2.48

LR Denotes Laboratory Replicate

TABLE A-6 IHSS 110 FIELD PARCC ANALYSIS

SAMPLE ID	DATE	RPD %	1,1-DCA (ug/L)	CCI4 (ug/L)	TCE (ug/L)	PCE (ug/L)	TOTAL VOC's (ug/L)
110-4	6/11/93		200	46	1.2	29	276.2
110-4FD	6/11/93		320	77	1.1	34	432.1
		RPD %	46.15	50.41	8.70	15.87	44.02
110-8	6/7/93		140	11	7.2	140	298.2
110-8FD	6/7/93		140	11	6.6	130	287.6
		RPD %	0.00	0.00	8.70	7.41	3.62
110-13	6/7/93		0	0	0	0	0
110-13FD	6/7/93		0	0	0	0	0
		RPD %	0.00	0.00	0.00	0.00	0.00
110-20	6/4/93		0	0	0	0	0
110-20FD	6/4/93		0	0	0	0	0
		RPD %	0.00	0.00	0.00	0.00	0.00

FD Denotes Field Duplicate

TABLE A-7 IHSS 111.1 FIELD PARCC ANALYSIS

SAMPLE ID	DATE	RPD %	1,1-DCA (ug/L)	CCI4 (ug/L)	TCE (ug/L)	PCE (ug/L)	TOTAL VOC's (ug/L)
111.1-7	11/8/93		0	19	965	83	1067
111.1-7FD	11/8/93		0	23	664	95	782
		RPD %	0.00	19.05	36.96	13.48	30.83
111.1-19	11/5/93		5.8	0.5	1390	3500	4896.3
111.1-19FD	11/5/93		5.9	0.5	1670	4000	5676.4
		RPD %	1.71	0.00	18.30	13.33	14.76
111.1-20	11/5/93		0	0.2	110	896	1006.2
111.1-20FD	11/5/93		0	0.2	151	640	791.2
		RPD %	0.00	0.00	31.42	33.33	23.92
111.1-21	11/5/93		0	0	0.8	4.4	5.2
111.1-21FD	11/5/93		0	0	0	1.5	1.5
		RPD %	0.00	0.00	200.00	98.31	110.45

FD Denotes Field Duplicate

TABLE A-8 IHSS 111.1 LABORATORY PARCC ANALYSIS

SAMPLE ID	DATE	RPD %	1,1-DCA (ug/L)	CCI4 (ug/L)	TCE (ug/L)	PCE (ug/L)	TOTAL VOC's (ug/L)
111.1-1	11/3/93		0	0	0	0.4	0.4
111.1-1LR	11/3/93		0	0	0	0.3	0.3
		RPD %	0.00	0.00	0.00	28.57	28.57
111.1-8	11/8/93		0	5.8	430	17.6	453.4
111.1-8LR	11/8/93		0	5.8	423	17.1	445.9
		RPD %	0.00	0.00	1.64	2.88	1.67
111.1-22FR	12/31/93		548	0	86	163	797
111.1-22LR	12/31/93		557	0	88	170	815
		RPD %	1.63	0.00	2.30	4.20	2.23

FR Denotes Field Replicate

LR Denotes Laboratory Replicate

TABLE A-9 IHSS 119.1 FIELD PARCC ANALYSIS

SAMPLE ID	DATE	RPD %	1,1-DCA (ug/L)	1,1-DCE (ug/L)	CCI4 (ug/L)	TCE (ug/L)	PCE (ug/L)	TOLUENE (ug/L)	TOTAL VOC's (ug/L)
119.1-9	12/27/93		0	0	0	1.5	0.9	0	2.4
119.1-9FD	12/27/93		0	0	0	3.2	0.9	0	4.1
		RPD %	0.00	0.00	0.00	72.34	0.00	0.00	52.31

FD Denotes Field Duplicate

TABLE A-10 IHSS 119.1 LABORATORY PARCC ANALYSIS

SAMPLE ID	DATE	RPD %	1,1-DCA (ug/L)	1,1-DCE (ug/L)	CCI4 (ug/L)	TCE (ug/L)	PCE (ug/L)	TOLUENE (ug/L)	TOTAL VOC's (ug/L)
119.1-5	12/28/93		59	0	0	56	19	0	134
119.1-5LR	12/28/93		58	0	0	54	18	0	130
		RPD %	1.71	0.00	0.00	3.64	5.41	0.00	3.03
119.1-9FD	12/27/93		0	0	0	3.2	0.9	0	4.1
119.1-9LR	12/27/93		0	0	0	3.2	0.9	0	4.1
		RPD %	0.00	0.00	0.00	0.00	0.00	0.00	0.00
119.1-14FR	12/23/93		2	0	2.3	9.3	0.4	0	14
119.1-14LR	12/23/93		1.4	0	2.3	9.1	0.3	0	13.1
		RPD %	35.29	0.00	0.00	2.17	28.57	0.00	6.64

FR Denotes Field Replicate

LR Denotes Laboratory Replicate

A-12

**APPENDIX B**

**SVS PROGRAM HEALTH AND SAFETY**

## **APPENDIX B - SVS PROGRAM HEALTH AND SAFETY**

A comprehensive Project Specific Health & Safety Plan (PSHSP) document was prepared and circulated for review and approval prior to initiating field activities. The PSHSP provided detailed health and safety guidance for the implementation of soil vapor investigations of subsurface VOC's at the 903 Pad, Mound, and East Trenches Areas at the RFP. Specific sections within the PSHSP included discussions of the following elements:

### **B.1 Hazard Assessment**

The PSHSP included a detailed description of the potential physical, chemical, biological, and radiological hazards expected during the field work. No unexpected hazards occurred or were encountered during the field work.

### **B.2 Site Control Requirement and Radiological Control Area (RCA)**

Each SVS site was divided into three basic zones: 1) Exclusion zone; 2) Contamination Reduction Zone, and 3) Support Zone. The exclusion zone included areas of high physical, chemical or radiological hazards. Only authorized personnel were permitted within the exclusion zone.

Areas that were determined to be potentially contaminated by radiation were called Radiologically Controlled Areas (RCA). Unless the boundaries of the RCA were already posted, the RCA was considered the same as the exclusion zone. A Radiation Work Permit (RWP) was issued for all activities conducted in known or suspected areas of radiological contamination. A RWP is required as part of the EG&G Health & Safety Practices Manual, Section 6.7.

A step-off pad was established within the Contamination Reduction Zone immediately adjacent to the boundary between the Contamination Reduction Zone and the Support Zone. It is at this pad that each worker was thoroughly screened for the presence of radiological contamination prior to "*stepping off*" into the Support Zone.

### **B.3 Preliminary FIDLER Survey**

FIDLER surveys were performed by EG&G Radiological Engineering approved Health & Safety Specialist (HSS's) in accordance with EMRG 6.6. All FIDLER readings were recorded on Form 6.6A as specified in EMRG 6.6. The purpose of these surveys was to identify any potential radiological anomalies, i.e., locate hot spots. An anomaly in this context is specified in EMRG 6.6 and OPS FO-16 as twice the background value as determined by the FIDLER instrument. FIDLER determined background values collected during implementation of the FIDLER surveys ranged from 960-1115 counts per minute. This range of values translates to trigger points of 1920-2230 counts per minute. The range of FIDLER values measured at SVS sampling points was 752-1845 counts per minute as recorded in the OU2 SVS field logbook. No FIDLER readings were noted to exceed the trigger points established by the RFP Radiological Engineering Department.

#### **B.4 Personal Protective Equipment**

The level of protection worn by field personnel as required by the Project Specific Health & Safety Plan and the Radiological Work Permit was enforced by the HSS. Levels of protection consisted of only Level D and modified Level D (during RCA field work) since real-time monitoring did not require upgrading to Level C or B. All personnel participating in the SVS operated under the contractor's Respiratory Protection Plan. The program is written in accordance with the minimum requirements of OSHA Standard 29 CFR 1910.134 and has been approved by Industrial Hygiene at EG&G. A quantitative fit test was required by EG&G and given to all personnel who performed work in a RCA. The quantitative fit test was conducted by EG&G in their respiratory fit test chamber.

#### **B.5 Decontamination Procedures**

All potentially exposed surfaces of equipment were either wiped off with a cloth dampened with soap and water, or steam cleaned, in accordance with SOP's OPS FO.03 and OPS FO.04. The effectiveness of decontamination was determined by frisking or wipe testing each piece of equipment. All equipment was monitored in accordance to the Rocky Flats Health & Safety Practices Manual, Section 18.10 and Department of Energy Order 5480.11 before leaving plant site. Free release certification of equipment to leave RFP was conducted by EG&G Radiological Protection Technicians (RPTs) at RFP.

#### **B.6 Project Personnel Training**

All field personnel were current in the training required by EG&G and OSHA. The basic training required included the following:

- OSHA 40-hour Hazardous Waste Site Worker Training
- OSHA 8-hour Annual Refresher Training
- OSHA 8-hour Supervisory Training
- 24-hour On The Job Training
- RFP Level II Radiation Worker Training (or equivalent for personnel requiring entry to RCA)
- RFP General Employee Training (GET)
- Site Specific Hazard Communication
- Site Specific Health & Safety Plan Training
- RFP QA/QC Training
- RFP RCRA Training
- Respiratory Protection Training (for personnel requiring entry to RCA)
- First Aid/CPR

#### **B.7 Medical Surveillance**

All personnel who worked in the field during the SVS were participants in a medical monitoring program which fulfills the requirements of 29 CFR 1910.120.

### **B.8 Field Monitoring**

Field monitoring was conducted by the Health & Safety Specialist (HSS) approved by Radiological Engineering. All monitoring activities were conducted in accordance with the Environmental Management Radiological Guidelines Manual. All personnel, material, and equipment were monitored prior to leaving known or suspected areas of radiological contamination.

### **B.9 Health and Safety Audit**

The subcontractor performed work in full compliance as per the health and safety audit conducted by Radiological Engineering, Industrial Hygiene, and Occupational Safety on November 4th, and 8th, 1993. The audit included a review of required records and a field inspection. The audit was conducted in accordance with the Health & Safety Practices Manual (HSP) 21.03, Hazardous Waste Operations Program, which requires quarterly audits of all Environmental Restoration Management (ERM) field projects.

**APPENDIX C**

**ISOCONCENTRATION CONTOUR FIGURES**

REVISION NO: 2

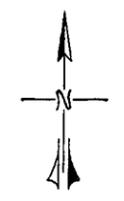
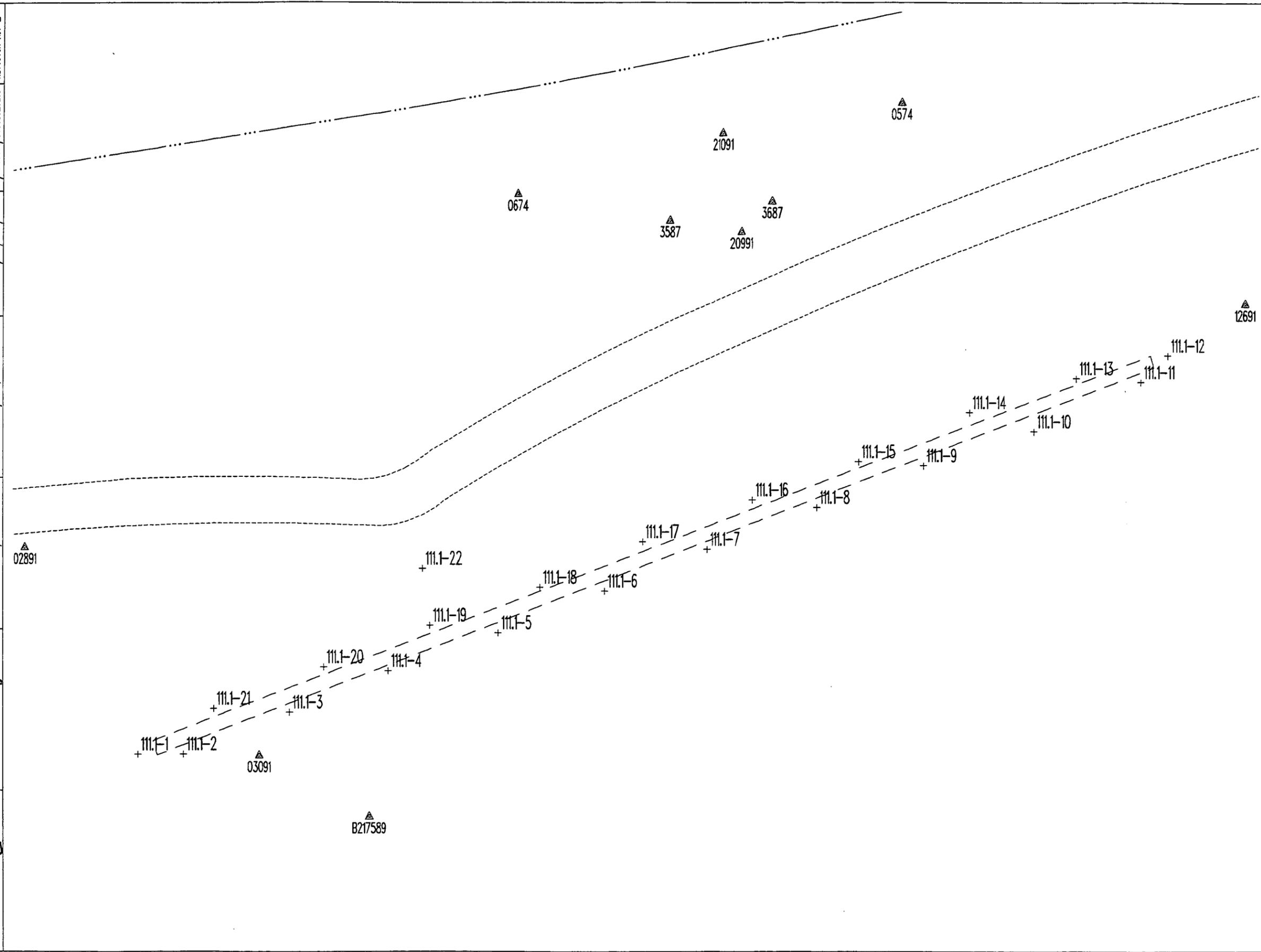
FILENAME: /arc/data/soi/vapor/ihss111/svs1802.cml

DATE: February 10, 1994

DRAWN BY: DDJ/KJS

APPROVED BY:

CHECKED BY:



**Soil Vapor Survey  
Sampling Locations**

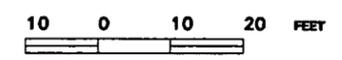
+ 111.1-1 5 Foot Sample Depth

▲ 03091 Boreholes

--- Soil Vapor Survey  
Work Plan  
IHSS 111.1 Border

... Drainage

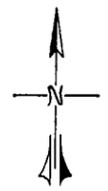
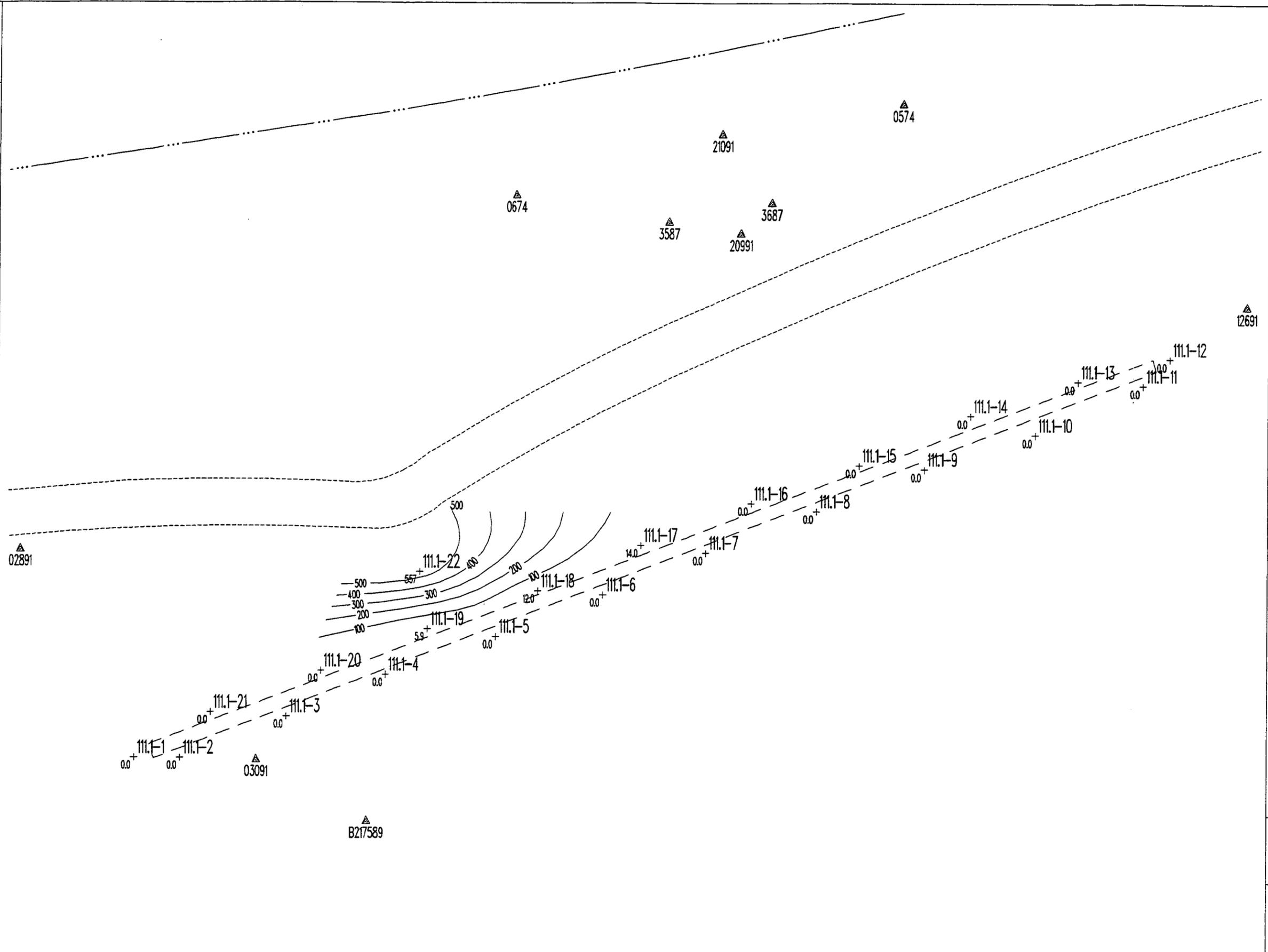
- - - Edge Of Road



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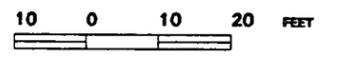
FIGURE C-35  
IHSS 111.1  
SAMPLE LOCATION MAP

CHECKED BY:   
 APPROVED BY:   
 DRAWN BY: DDJ/KJS   
 DATE: February 10, 1994   
 FILENAME: /arc/data/soilvapor/ihss111/svs812.aml   
 REVISION NO: 2



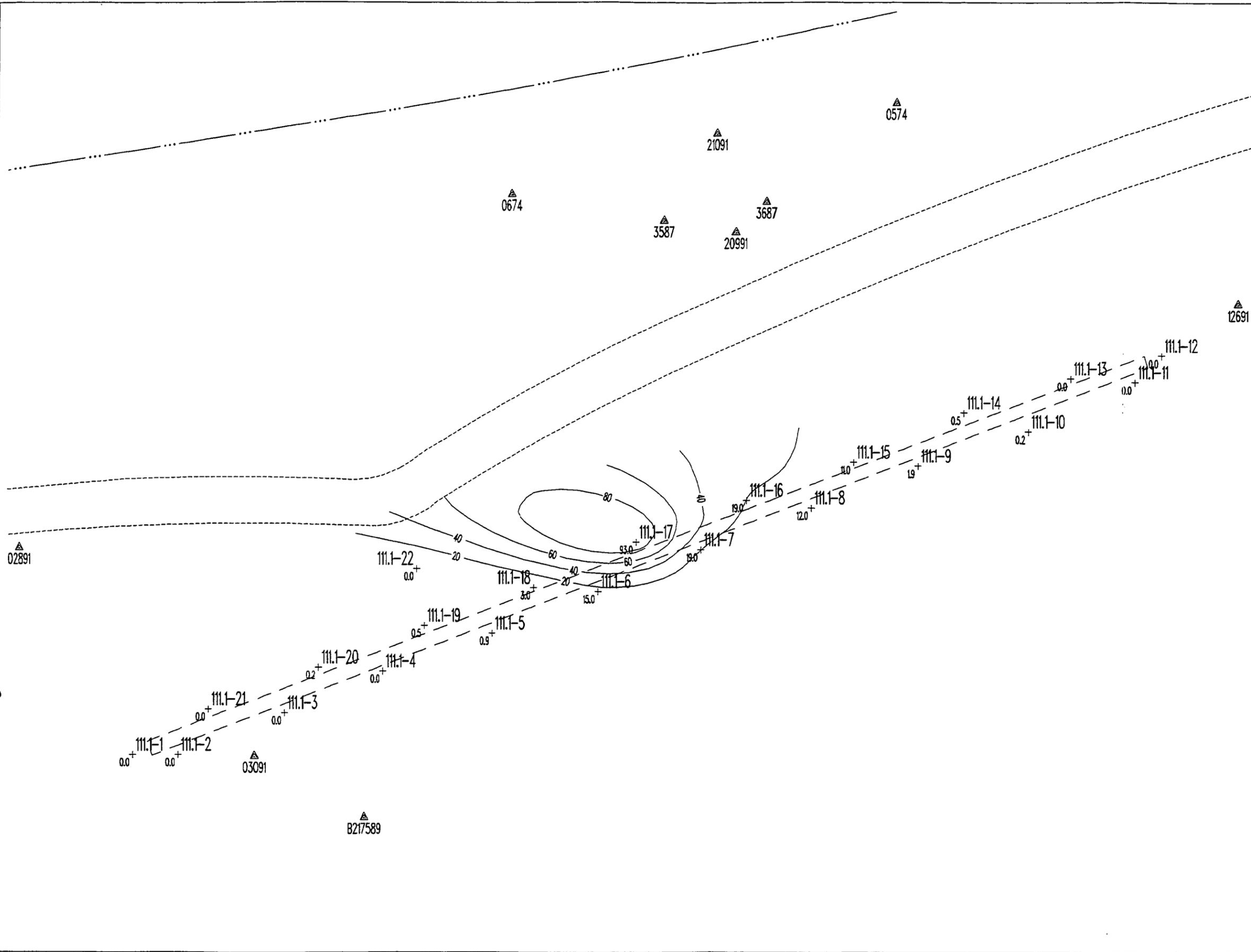
Soil Vapor Survey  
 Sampling Locations  
 1,1-DCA, (ug/L)  
 5 FOOT SAMPLE DEPTH  
 Boreholes  
 Soil Vapor Survey  
 Work Plan  
 IHSS 111.1 Border  
 Drainage  
 Edge of Road  
 Contour Interval = 100 ug/L

NOTE: THE CONTOURS HAVE  
 BEEN COMPUTER GENERATED  
 FROM A LIMITED NUMBER  
 OF POINTS AND MAY NOT  
 REPRESENT ACTUAL FIELD  
 CONCENTRATIONS.



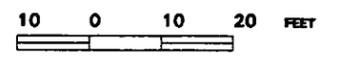
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FIGURE C-36 IHSS 111.1  
 1,1-Dichloroethane (1,1-DCA)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH



- North
- Soil Vapor Survey Sampling Locations CCl<sub>4</sub> (ug/L)
- 5 FOOT SAMPLE DEPTH**
- Boreholes
- Soil Vapor Survey Work Plan IHSS 111.1 Border
- Drainage
- Edge of Road
- Contour Interval = 20 ug/L

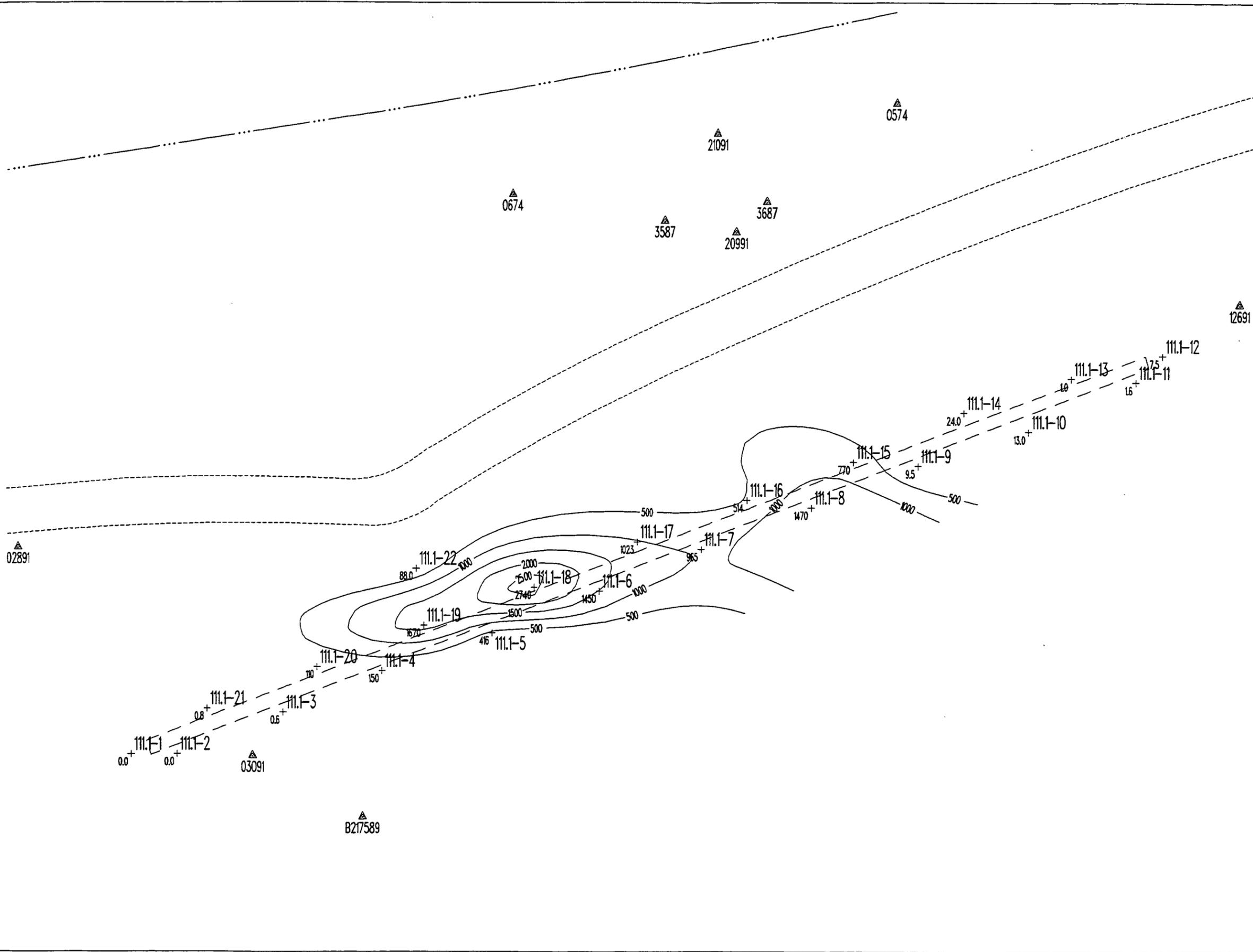
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-37 IHSS 111.1  
 Carbon Tetrachloride (CCl<sub>4</sub>)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH

REVISION NO: 2  
 FILENAME: /arc/data/soi/vapor/ihs111/svs1832.ard  
 DATE: February 10, 1994  
 DRAWN BY: DDJ/KJS  
 APPROVED BY: [Signature]  
 CHECKED BY: [Signature]



N

Soil Vapor Survey Sampling Locations TCE, (ug/L)

5 FOOT SAMPLE DEPTH

Boreholes

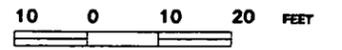
Soil Vapor Survey Work Plan IHSS 111.1 Border

Drainage

Edge of Road

Contour Interval = 500 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-38 IHSS 111.1 Trichloroethene (TCE) ISOCONCENTRATION CONTOUR MAP AT 5 FOOT DEPTH

REVISION NO. 2

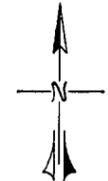
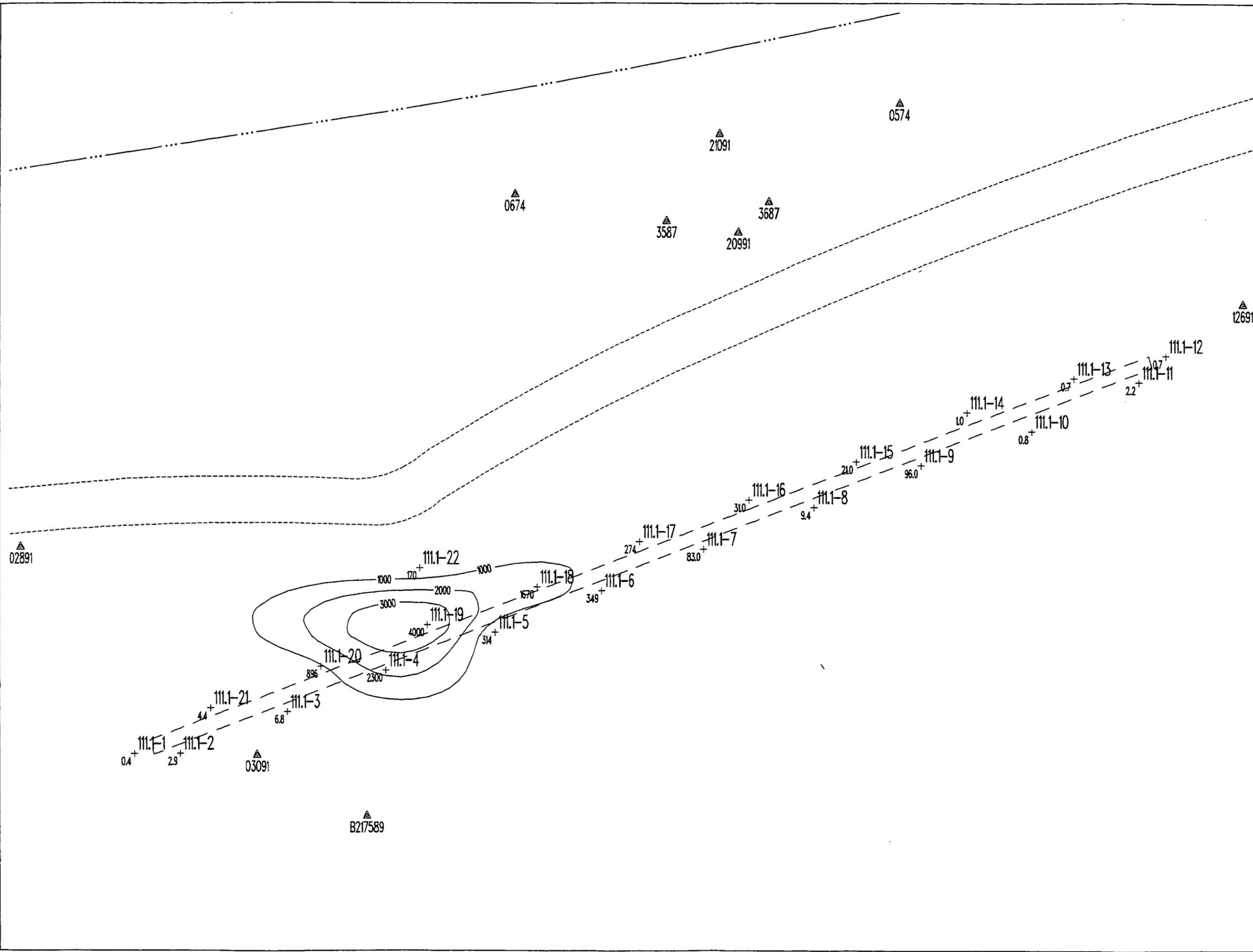
FILENAME: /arc/data/soil/vapor/hss111/svs1842.dwg

DATE: February 10, 1994

DRAWN BY: DDJ/KJS

APPROVED BY: [Signature]

CHECKED BY: [Signature]



111.1  
Soil Vapor Survey  
Sampling Locations  
PCE, (ug/L)  
5 FOOT SAMPLE DEPTH

03091 Boreholes

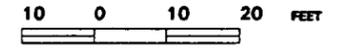
Soil Vapor Survey  
Work Plan  
IHSS 111.1 Border

Drainage

Edge of Road

Contour Interval = 1000 ug/L

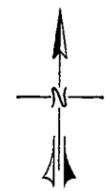
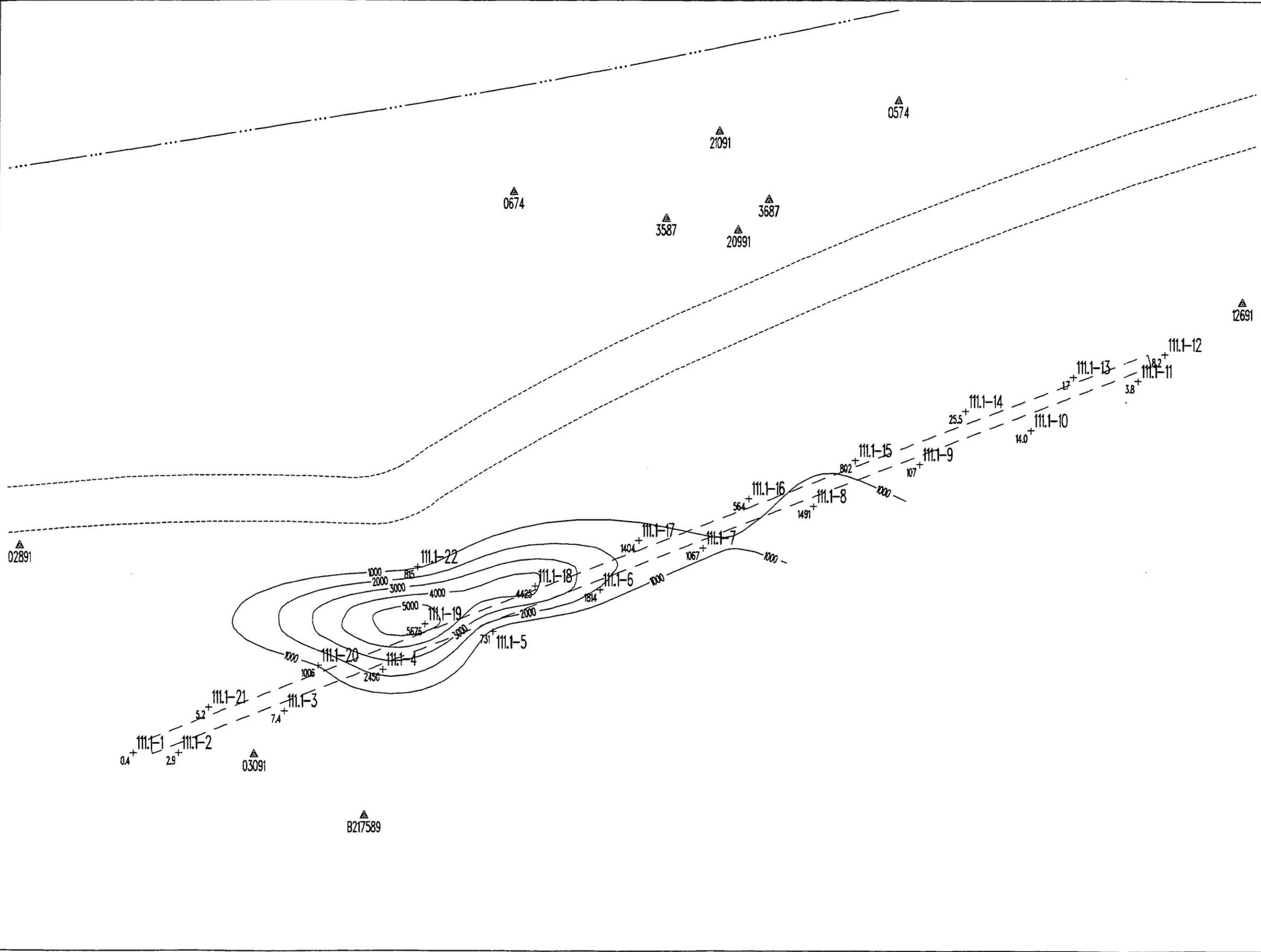
NOTE: THE CONTOURS HAVE  
BEEN COMPUTER GENERATED  
FROM A LIMITED NUMBER  
OF POINTS AND MAY NOT  
REPRESENT ACTUAL FIELD  
CONCENTRATIONS.



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FIGURE C-39 IHSS 111.1  
Perchloroethene (PCE)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH

REVISION NO: 2  
 FILENAME: /arc/cato/soil/vapor/ihs111/sys1852.atl  
 DATE: February 10, 1994  
 DRAWN BY: DDJ/KJS  
 APPROVED BY: [Signature]  
 CHECKED BY: [Signature]



Soil Vapor Survey  
 Sampling Locations  
 Total VOCs, (ug/L)  
 5 FOOT SAMPLE DEPTH

▲ 03091 Boreholes

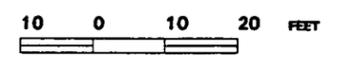
--- Soil Vapor Survey  
 Work Plan  
 IHSS 111.1 Border

... Drainage

- - - Edge of Road

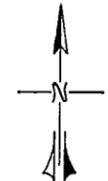
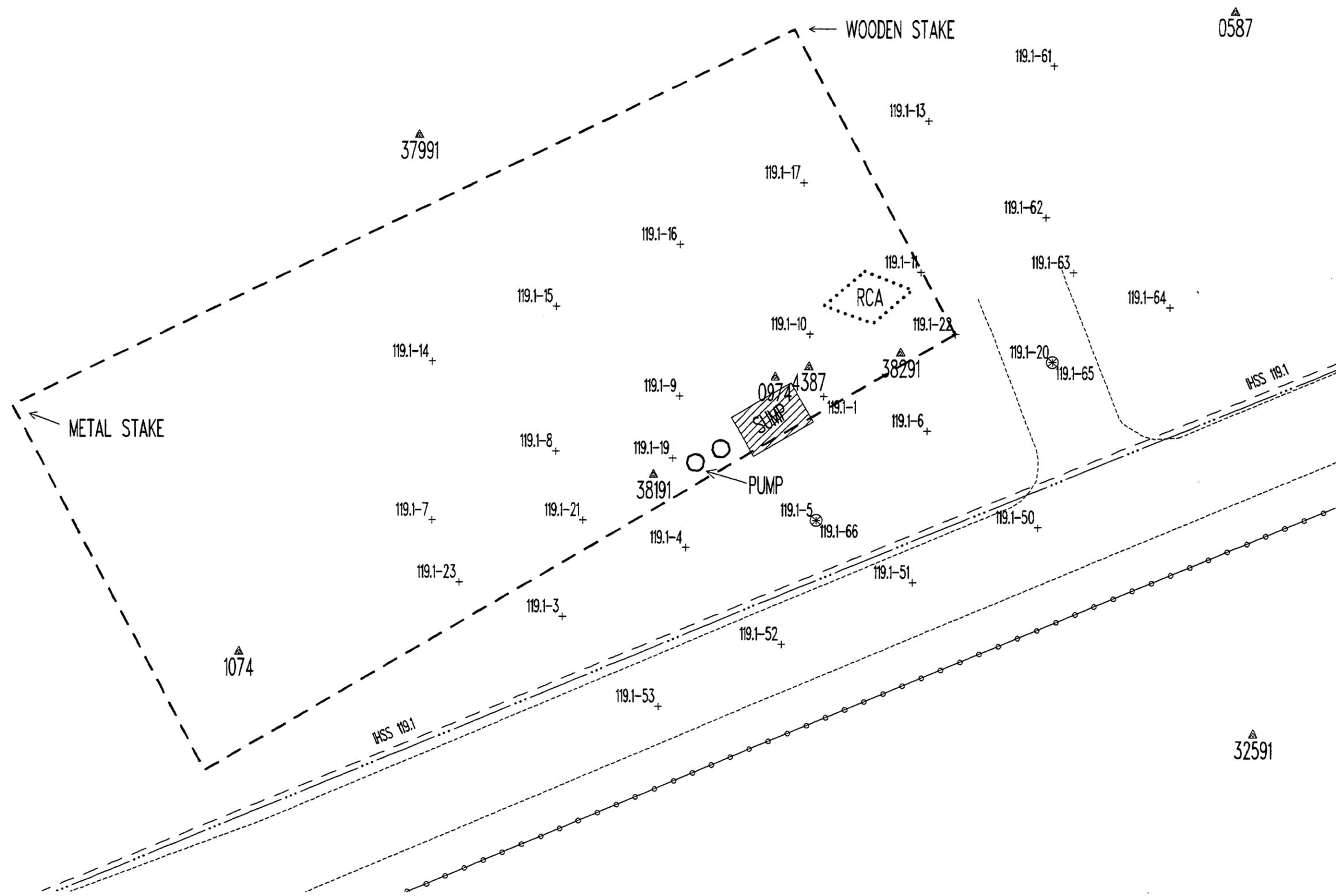
Contour Interval = 1000 ug/L

NOTE: THE CONTOURS HAVE  
 BEEN COMPUTER GENERATED  
 FROM A LIMITED NUMBER  
 OF POINTS AND MAY NOT  
 REPRESENT ACTUAL FIELD  
 CONCENTRATIONS.

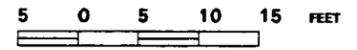


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FIGURE C-40 IHSS 111.1  
 Total VOCs  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH

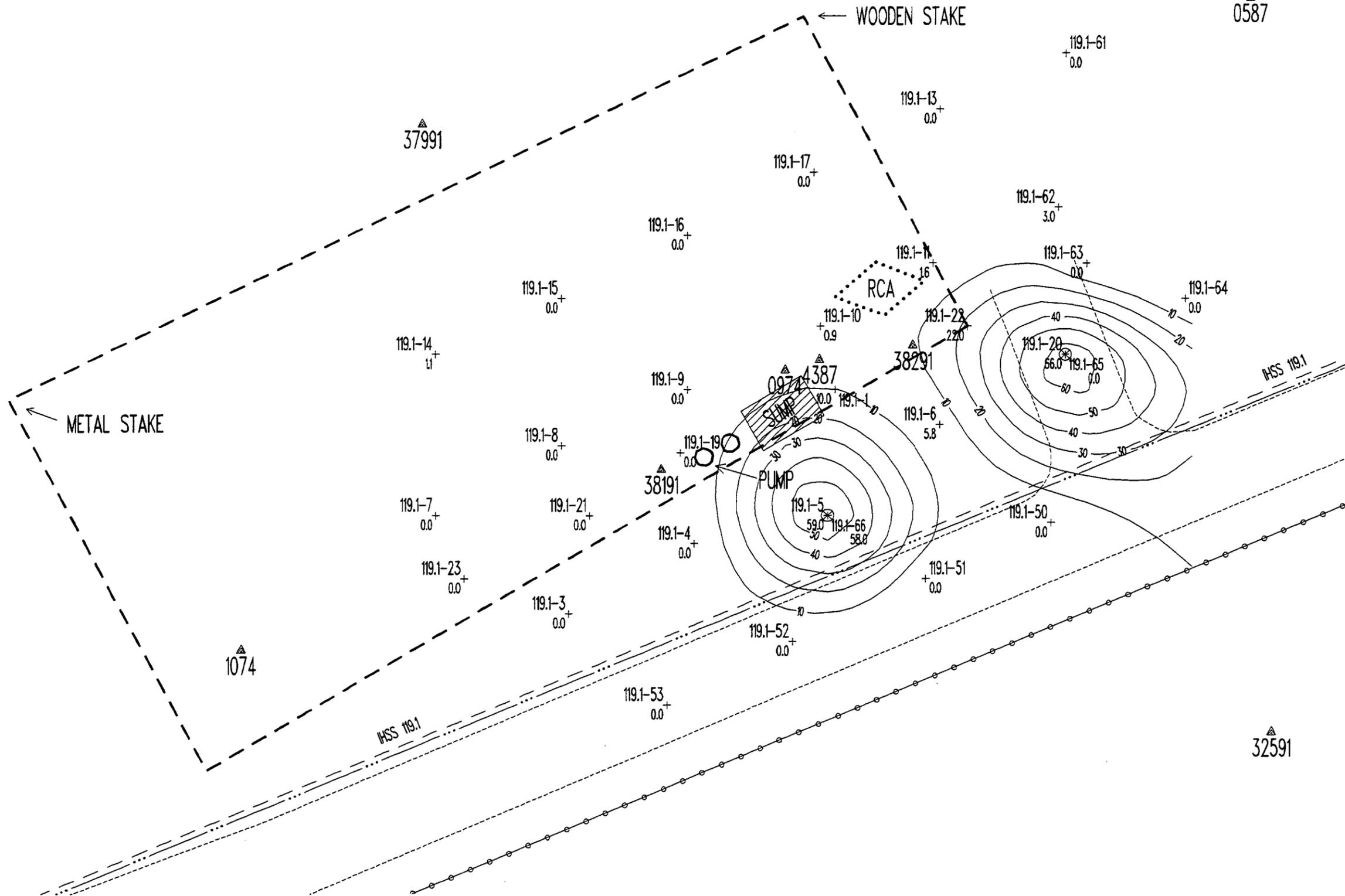
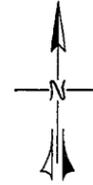


- Soil Vapor Survey Sampling Locations**
- 119.1-1 + 5 Foot Sample Depth
  - ⊗ 119.1-65 10 Foot Sample Depth
  - ▲ 0587 Boreholes
  - Soil Vapor Survey Work Plan IHSS 119.1 Border
  - Fence
  - - - Edge of Road
  - ... Drainage
  - - - Initial Survey Area Boundary
  - ..... Radiologically Controlled Area (RCA)



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FIGURE C-41  
 IHSS 119.1  
 SAMPLE LOCATION MAP

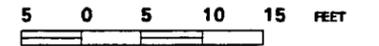


- Soil Vapor Survey Sampling Locations 1,1-DCA, (ug/L)**
- 119.1-1 0.0+ 5 Foot Sample Depth
  - ⊗ 119.1-65 0.0 10 Foot Sample Depth
  - ▲ 0587 Boreholes
  - Soil Vapor Survey Work Plan IHSS 119.1 Border
  - Fence
  - - - Edge of Road
  - ... Drainage
  - Initial Survey Area Boundary
  - ..... Radiologically Controlled Area (RCA)

Contour Interval = 10 ug/L

NOTE: Analyte values from the 10 foot depths were not used in the generation of the contours.

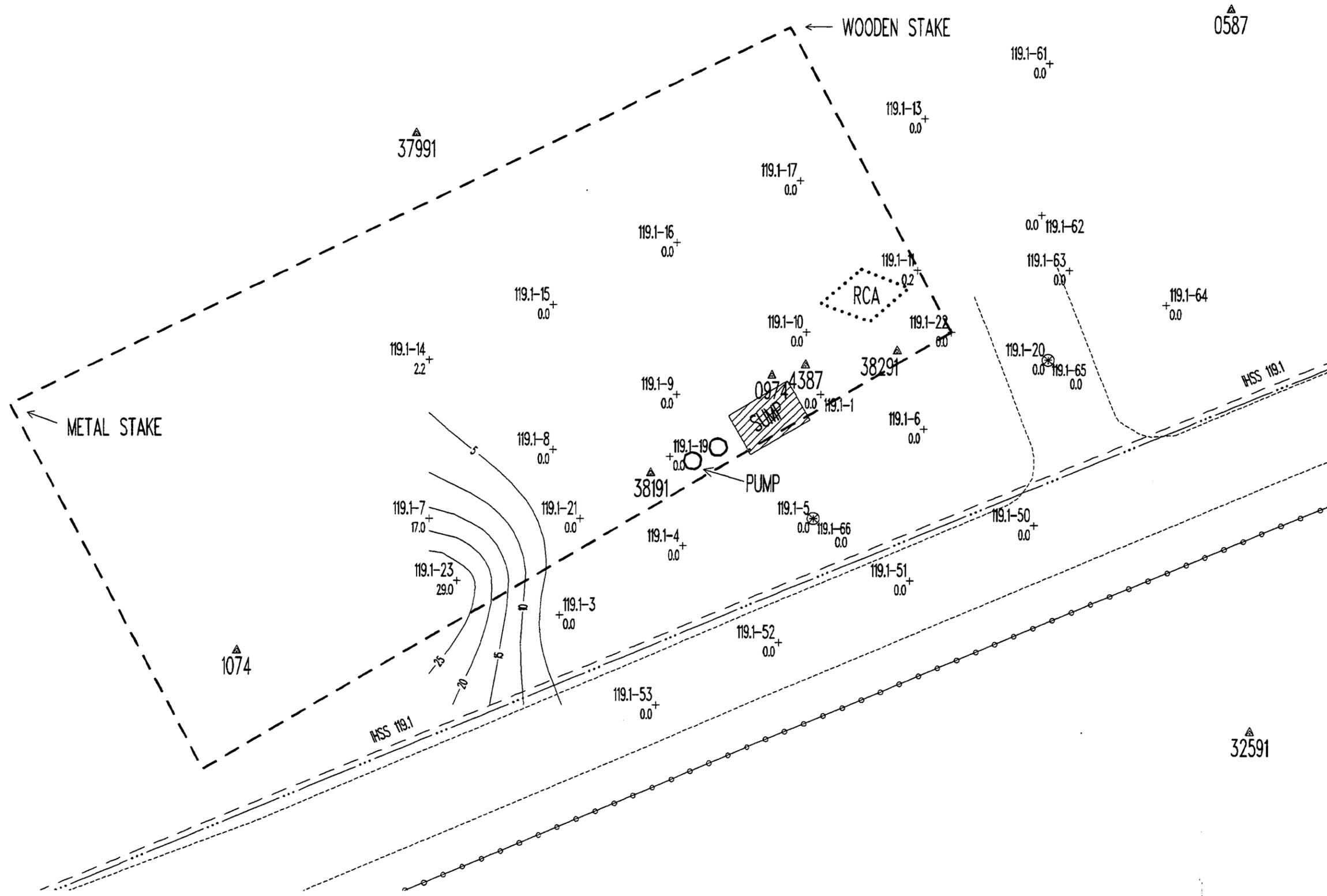
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-42 IHSS 119.1  
1,1-Dichloroethane (1,1-DCA)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH

FILENAME: /arc/dato/soil/vapor/hss19/svs372.cnt  
 REVISION NO: 2  
 DATE: February 14, 1994  
 DRAWN BY: DDJ/KJS  
 APPROVED BY:   
 CHECKED BY: 

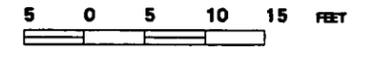


- Soil Vapor Survey Sampling Locations CCl<sub>4</sub> (ug/L)**
- 119.1-1 0.0+ 5 Foot Sample Depth
  - ⊗ 119.1-65 0.0 10 Foot Sample Depth
  - ▲ 0587 Boreholes
  - Soil Vapor Survey Work Plan IHSS 119.1 Border
  - ○ ○ ○ ○ Fence
  - Edge of Road
  - ... Drainage
  - Initial Survey Area Boundary
  - ..... Radiologically Controlled Area (RCA)

Contour Interval = 5 ug/L

NOTE: Analyte values from the 10 foot depths were not used in the generation of the contours.

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.

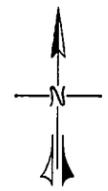
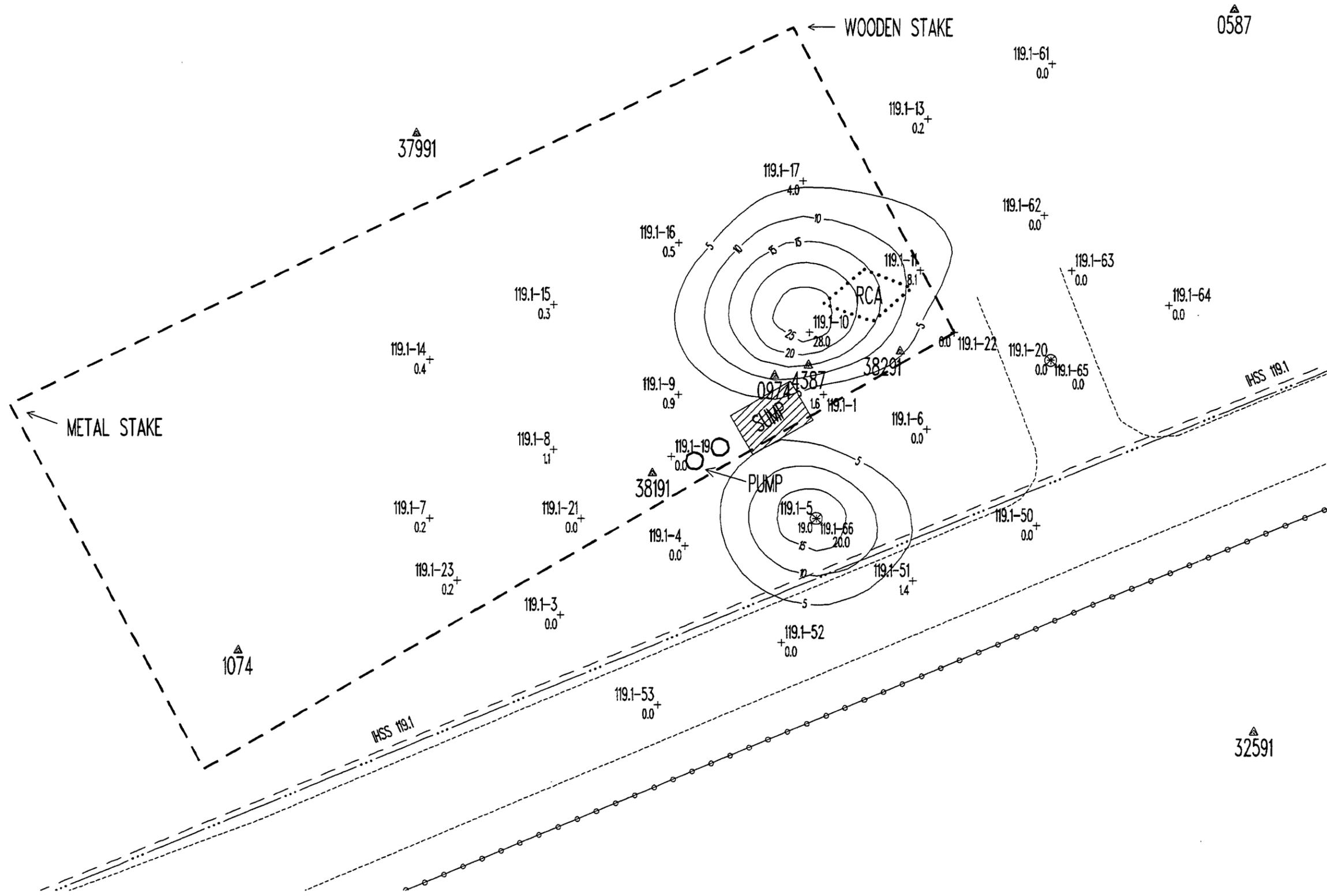


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FIGURE C-43 IHSS 119.1  
 Carbon Tetrachloride (CCl<sub>4</sub>)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH



FILENAME: /arc/dotq/soil/vapor/hss19/svs3142.cnt  
 DATE: February 14, 1994  
 DRAWN BY: DDJ/KJS  
 APPROVED BY: [Signature]  
 CHECKED BY: [Signature]  
 REVISION NO: 2



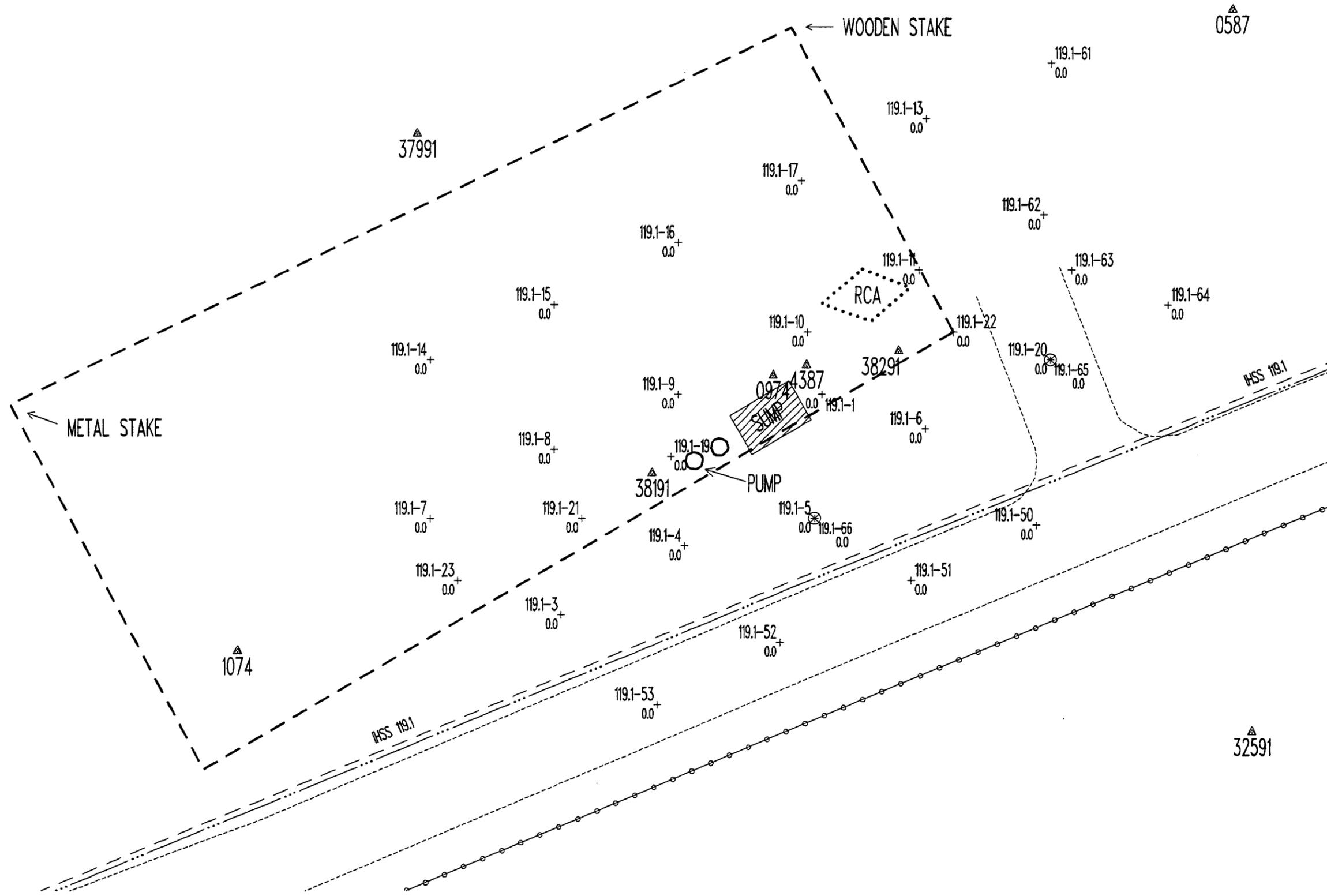
- Soil Vapor Survey Sampling Locations PCE, (ug/L)**
- 119.1-1 0.0 **5 Foot Sample Depth**
  - ⊗ 119.1-65 0.0 **10 Foot Sample Depth**
  - ▲ 0587 **Boreholes**
  - — — **Soil Vapor Survey Work Plan IHSS 119.1 Border**
  - ○ ○ **Fence**
  - - - **Edge of Road**
  - ... **Drainage**
  - — — **Initial Survey Area Boundary**
  - ..... **Radiologically Controlled Area (RCA)**

Contour Interval = 5 ug/L  
 NOTE: Analyte values from the 10 foot depths were not used in the generation of the contours.  
 NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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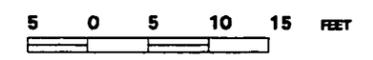
**FIGURE C-45 IHSS 119.1  
 Perchloroethene (PCE)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH**



- Soil Vapor Survey Sampling Locations 1,1-DCE, (ug/L)**
- 119.1-1 0.0+ **5 Foot Sample Depth**
  - ⊗ 119.1-65 0.0 **10 Foot Sample Depth**
  - ▲ 0587 **Boreholes**
  - **Soil Vapor Survey Work Plan IHSS 119.1 Border**
  - ○ ○ **Fence**
  - - - **Edge of Road**
  - ... **Drainage**
  - — — **Initial Survey Area Boundary**
  - ..... **Radiologically Controlled Area (RCA)**

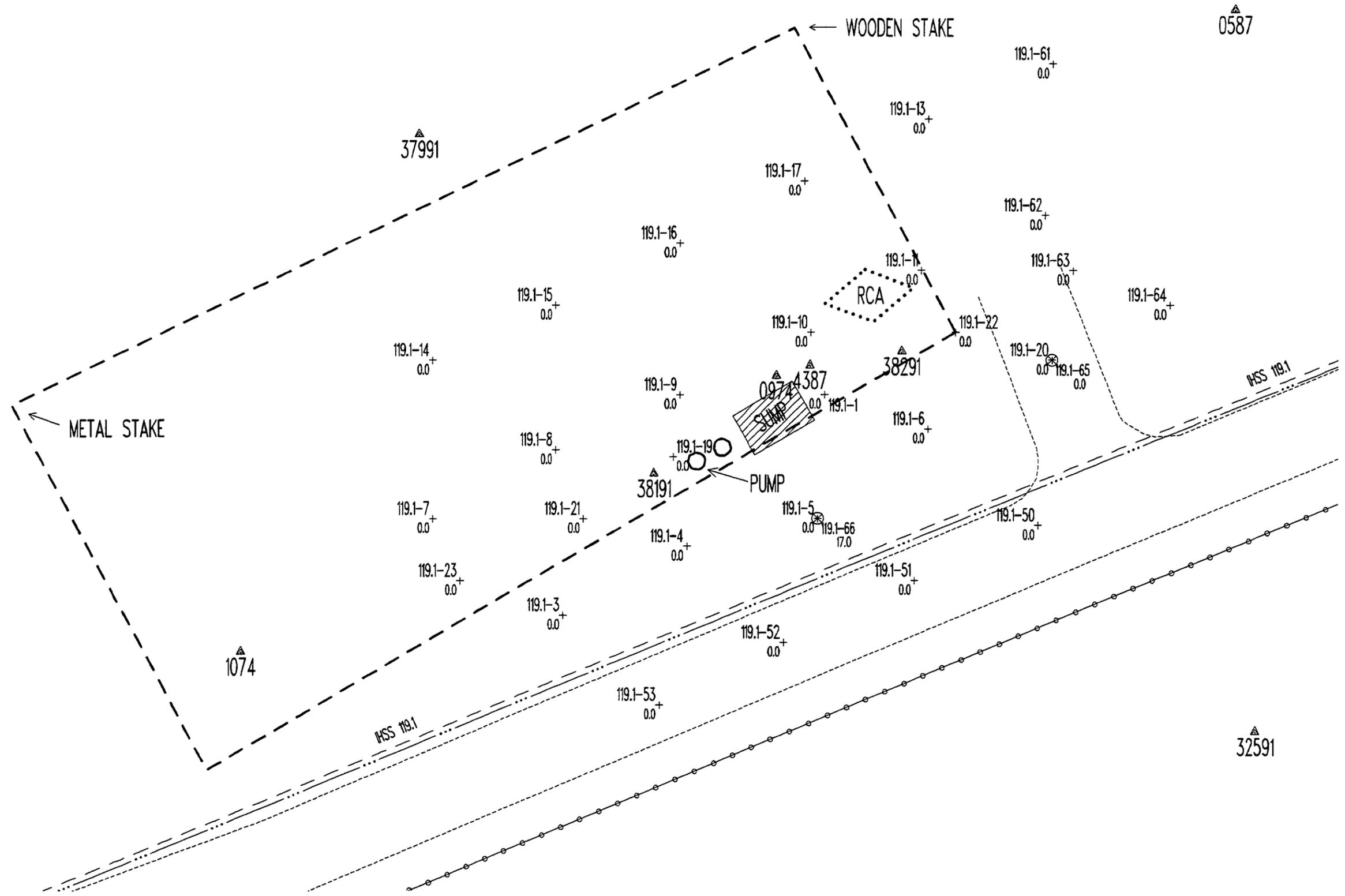
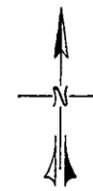
**NOTE: No contours generated because all values are zero.**

**NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.**



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**FIGURE C-46**  
 IHSS 119.1  
 1,1-Dichloroethene (1,1-DCE)  
 CONCENTRATION MAP  
 AT 5 FOOT DEPTH



- Soil Vapor Survey Sampling Locations TOLUENE, (ug/L)**
- 119.1-1 + 0.0 5 Foot Sample Depth
  - ⊗ 119.1-65 0.0 10 Foot Sample Depth
  - ▲ 0587 Boreholes
  - Soil Vapor Survey Work Plan IHSS 119.1 Border
  - ⊕ Fence
  - - - Edge of Road
  - ... Drainage
  - Initial Survey Area Boundary
  - ..... Radiologically Controlled Area (RCA)

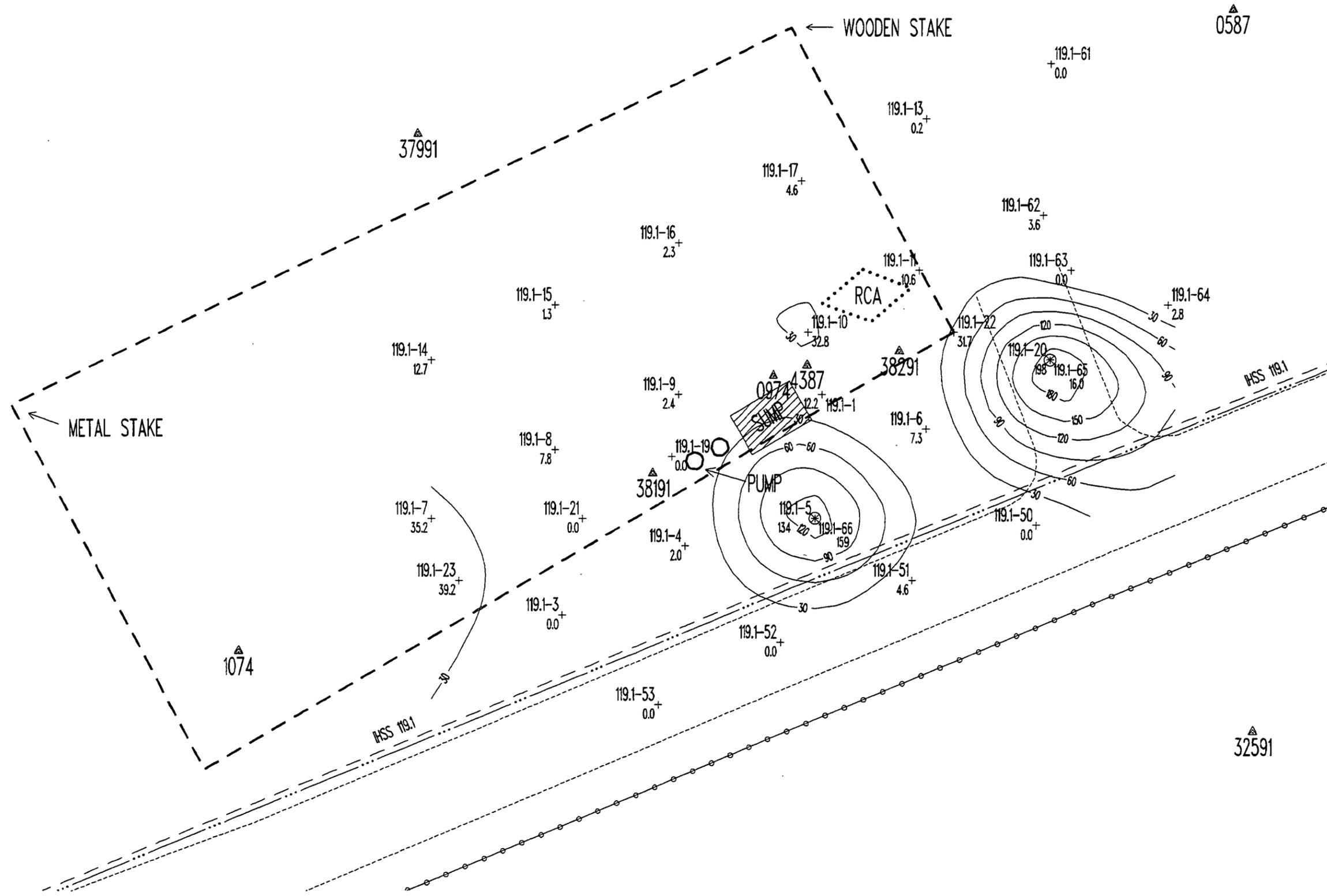
**NOTE: No contours generated because all values are zero.**

**NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.**



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**FIGURE C-47**  
 IHSS 119.1  
 TOLUENE  
 CONCENTRATION MAP  
 AT 5 FOOT DEPTH

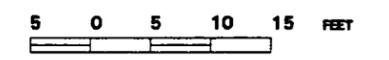


- Soil Vapor Survey Sampling Locations**  
Total VOCs, (ug/L)
- 119.1-1 0.0 **5 Foot Sample Depth**
  - ⊗ 119.1-65 0.0 **10 Foot Sample Depth**
  - ▲ 0587 **Boreholes**
  - — — **Soil Vapor Survey Work Plan IHSS 119.1 Border**
  - ○ ○ **Fence**
  - - - - **Edge of Road**
  - ... .. **Drainage**
  - — — **Initial Survey Area Boundary**
  - ..... **Radiologically Controlled Area (RCA)**

Contour Interval = 30 ug/L

NOTE: Analyte values from the 10 foot depths were not used in the generation of the contours.

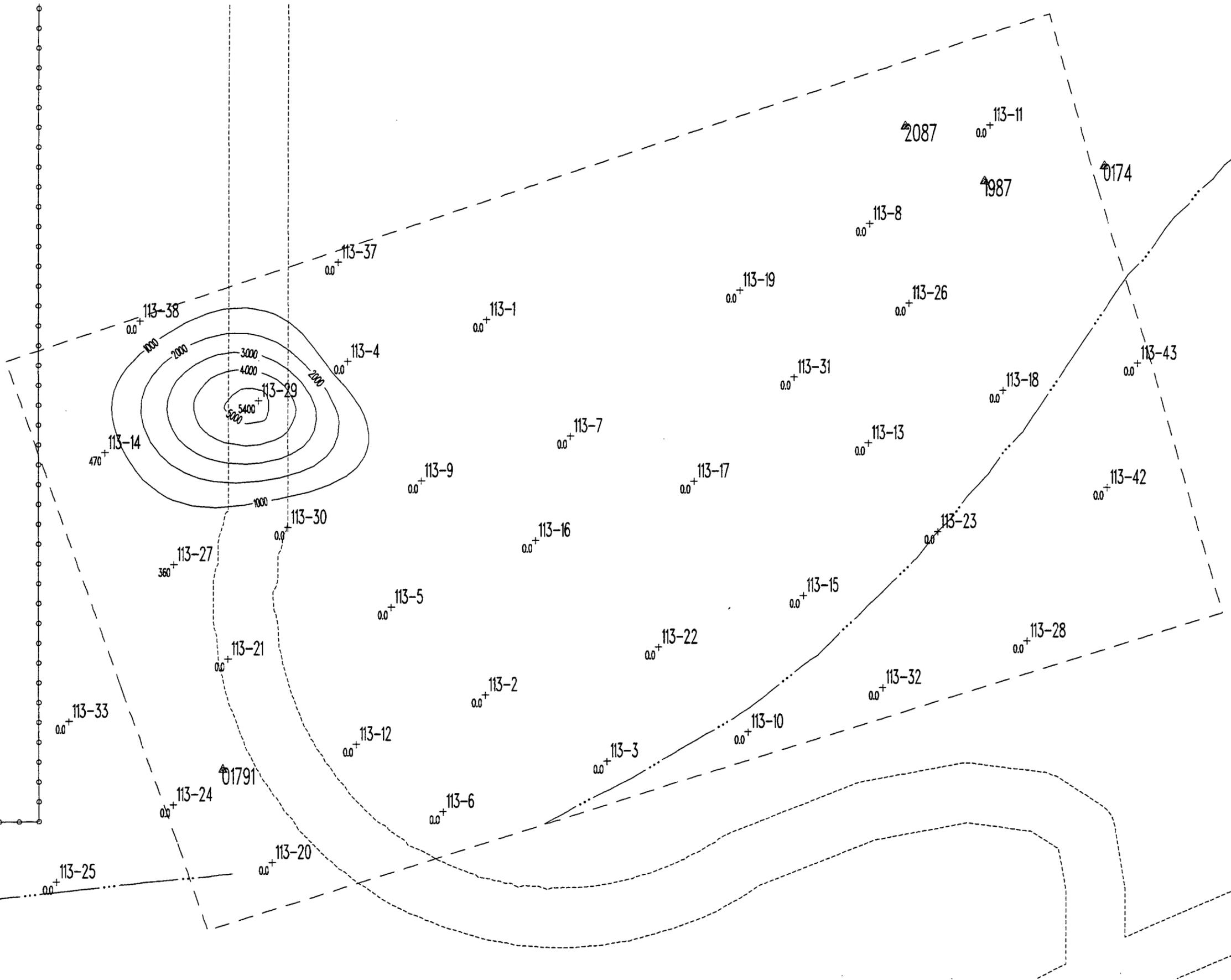
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-48 IHSS 119.1  
Total VOCs  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH

PROTECTED AREA



N

0.0+ 113-1 Soil Vapor Survey Sampling Locations 1-1,DCA, (ug/L)

5 FOOT SAMPLE DEPTH

▲ 1987 Boreholes

— Soil Vapor Survey Work plan IHSS 113 Border

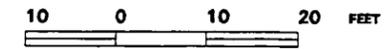
○ Fence

... Drainage

- - - Edge of Road

Contour Interval = 1000 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.

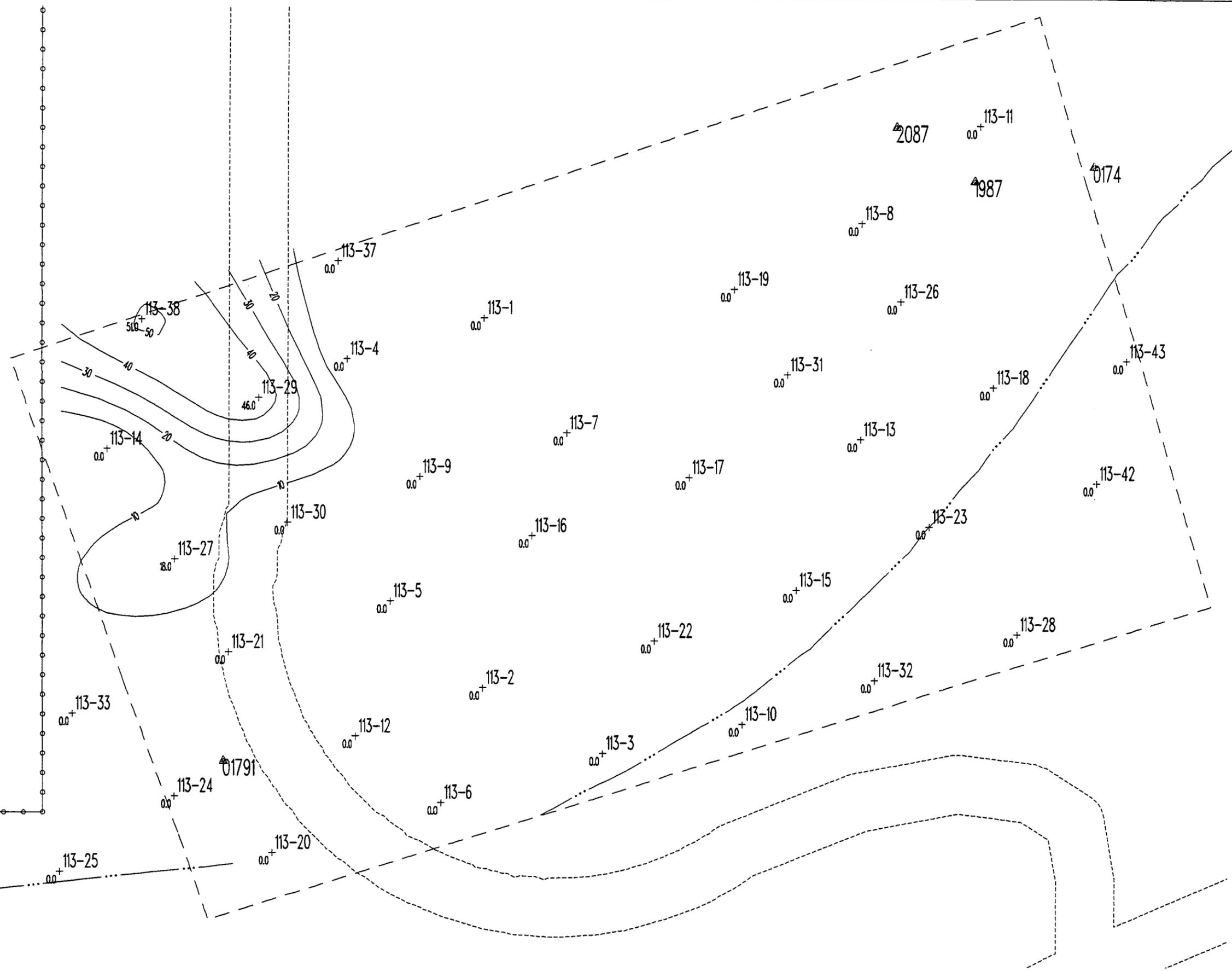


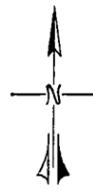
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GOLDEN, COLORADO

FIGURE C-14 IHSS 113  
1,1-Dichloroethane (1-1,DCA)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH

CHECKED BY:   
 APPROVED BY:   
 DRAWN BY: DDJ/KJS   
 DATE: February 10, 1994   
 FILENAME: /arc/data/soi/vapor/ihs113/svs772.cml   
 REVISION NO: 2

PROTECTED AREA





113-1 Soil Vapor Survey Sampling Locations QCI, (ug/L)

**5 FOOT SAMPLE DEPTH**

 1987 Boreholes

 Soil Vapor Survey Work plan IHSS 113 Border

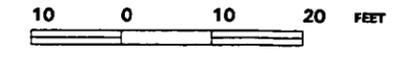
 Fence

 Drainage

 Edge of Road

Contour Interval = 10 ug/L

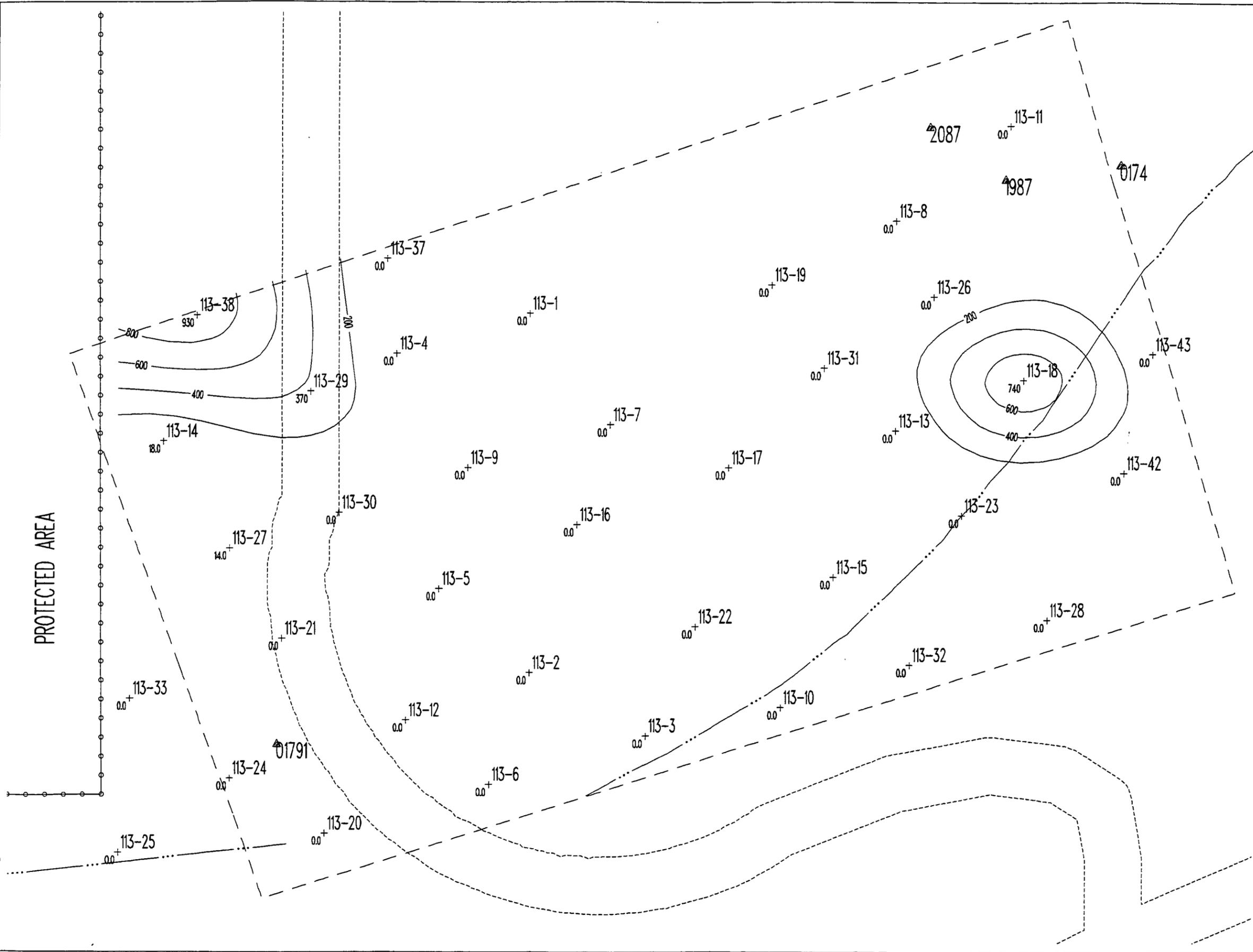
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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**FIGURE C-15 IHSS 113 Carbon Tetrachloride (CCl<sub>4</sub>) ISOCONCENTRATION CONTOUR MAP AT 5 FOOT DEPTH**

PROTECTED AREA

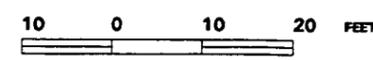


- North
- 113-1 Soil Vapor Survey Sampling Locations TCE, (ug/L)
- 1987 Boreholes
- Soil Vapor Survey Work plan IHSS 113 Border
- Fence
- Drainage
- Edge of Road

5 FOOT SAMPLE DEPTH

Contour Interval = 200 ug/L

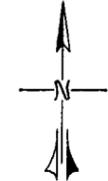
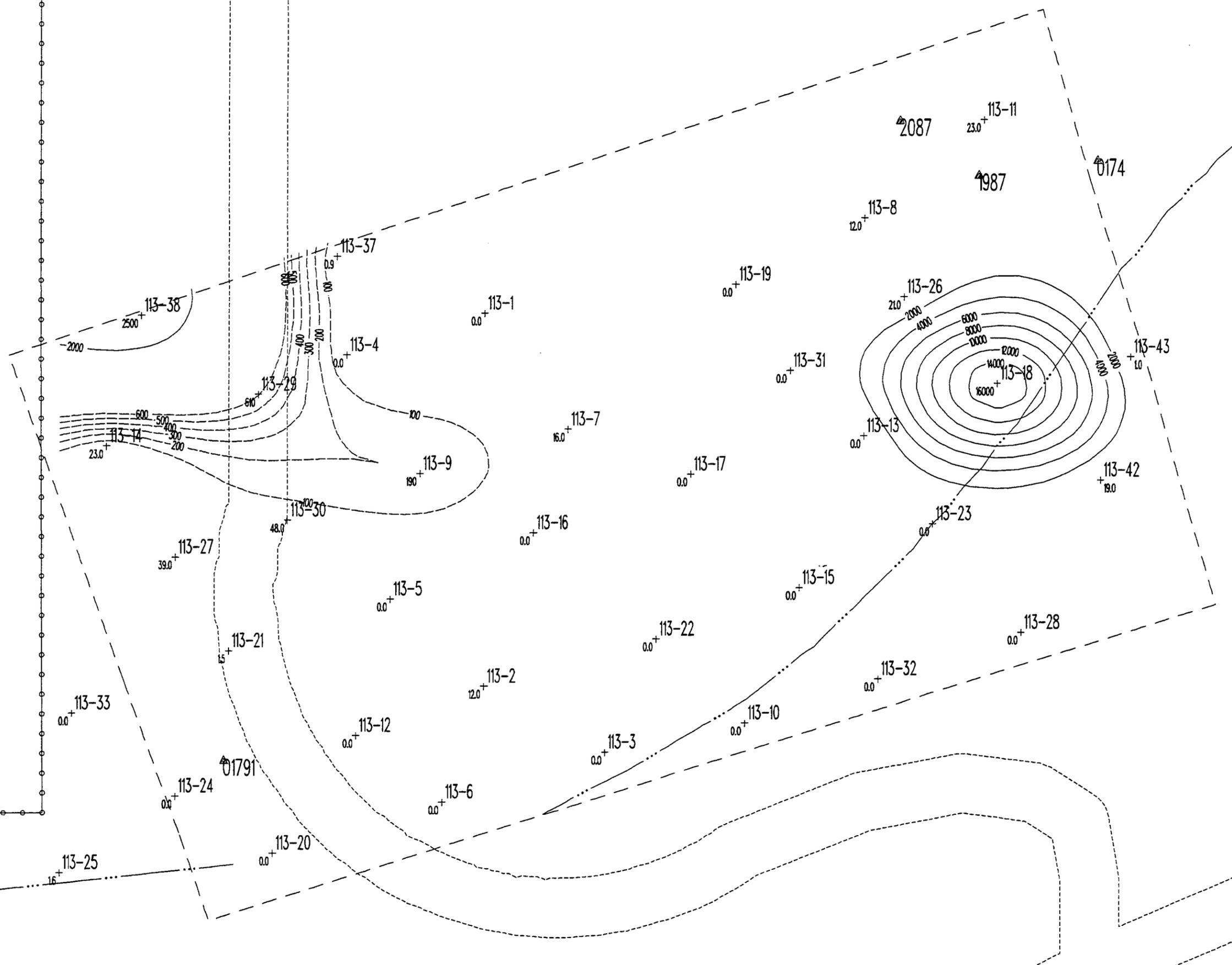
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-16 IHSS 113  
 Trichloroethene (TCE)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH

PROTECTED AREA



Soil Vapor Survey  
Sampling Locations  
PCE, (ug/L)

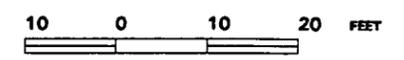
5 FOOT SAMPLE DEPTH

- ▲ 1987 Boreholes
- Soil Vapor Survey Work plan IHSS 113 Border
- Fence
- ... Drainage
- - - Edge of Road

CONTOUR INTERVAL

- 2000 ug/L
- - - 100 ug/L

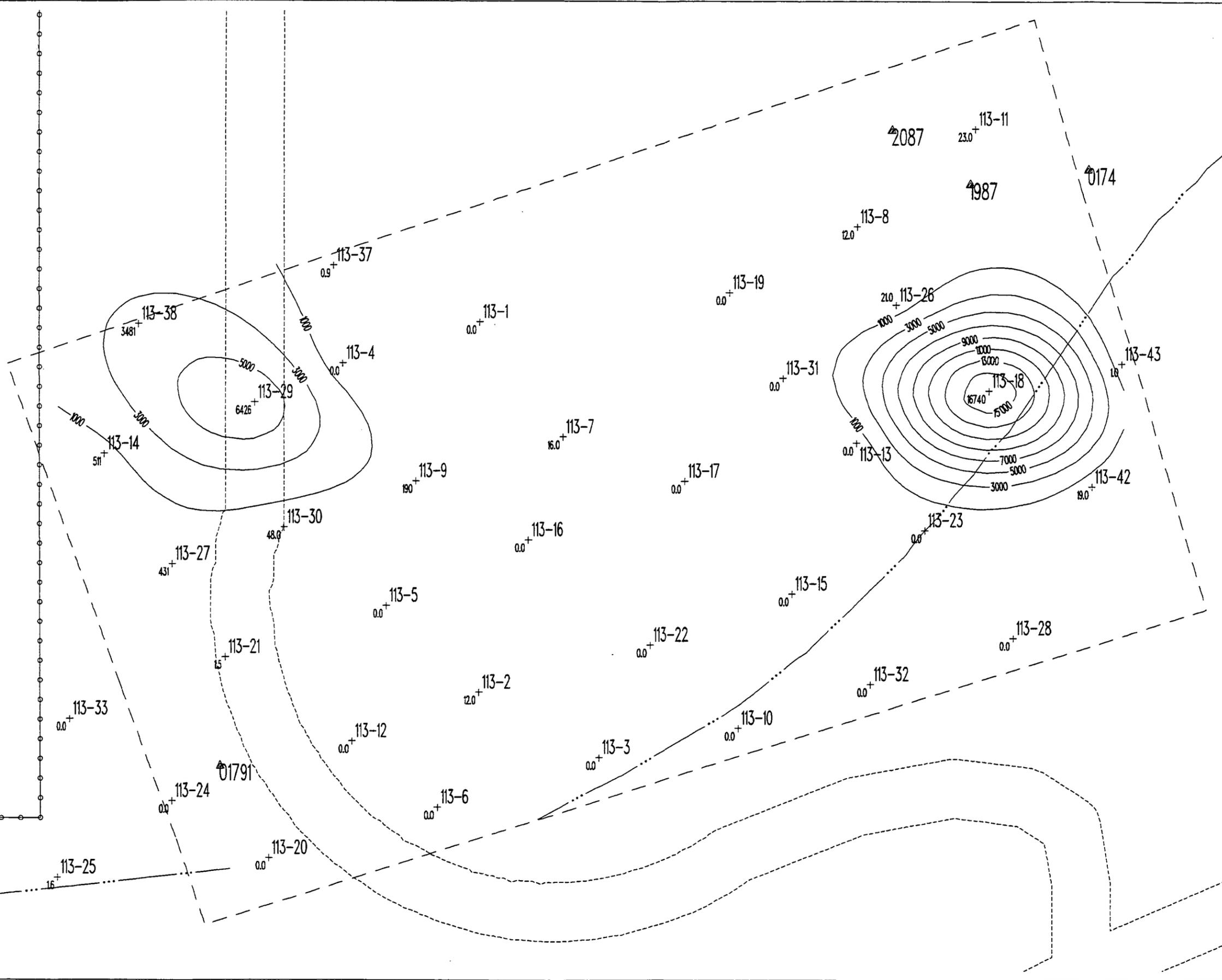
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-17 IHSS 113  
Perchloroethene (PCE)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH

PROTECTED AREA

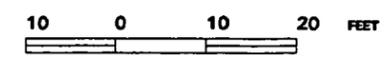


- North
- 113-1 Soil Vapor Survey Sampling Locations TOTAL VOCs, (ug/L)
- 1987 Boreholes
- Soil Vapor Survey Work plan IHSS 113 Border
- Fence
- Drainage
- Edge of Road

5 FOOT SAMPLE DEPTH

CONTOUR INTERVAL  
2000 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.

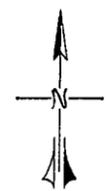
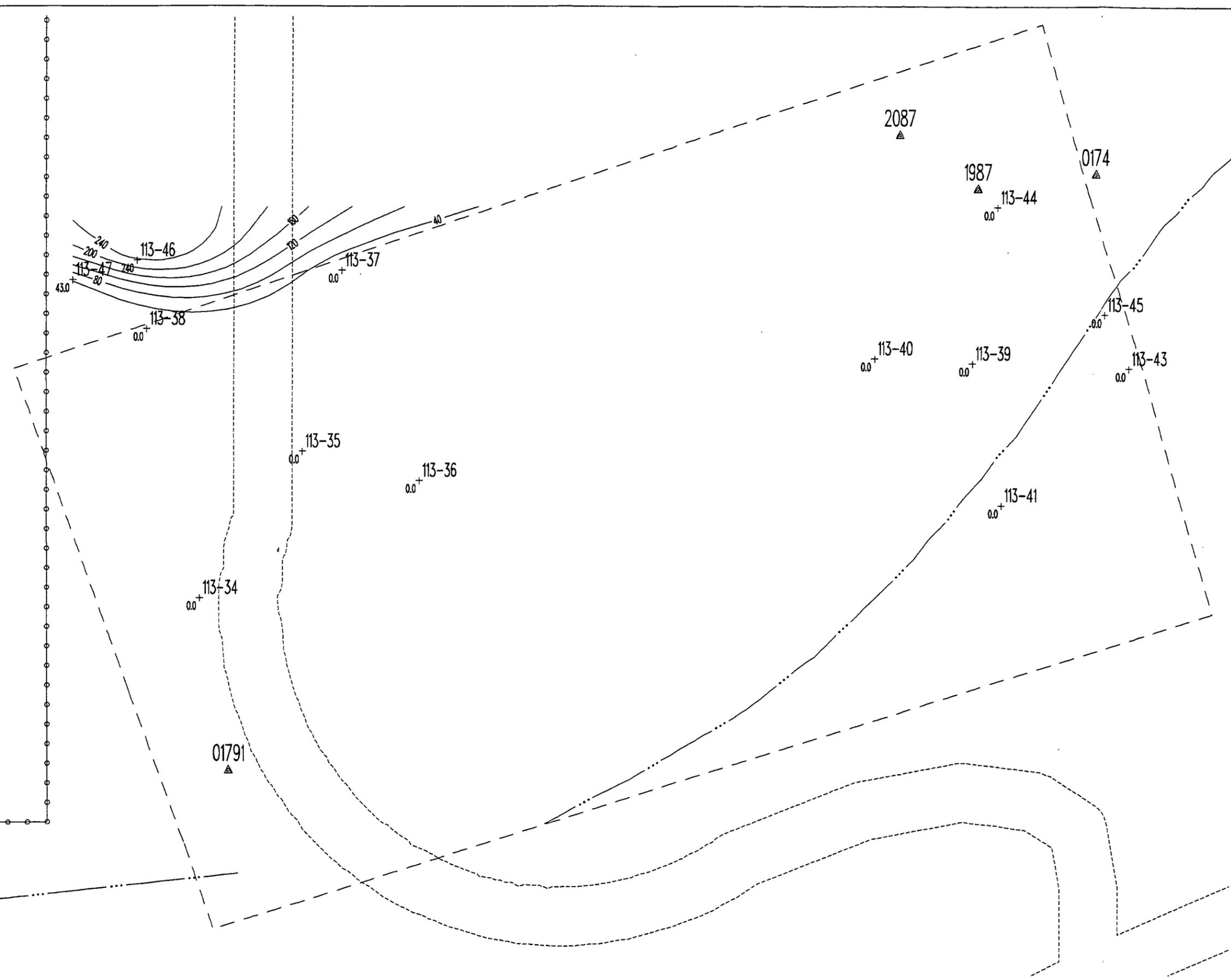


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FIGURE C-18 IHSS 113  
Total VOCs  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH

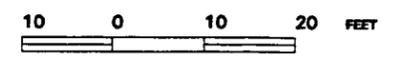
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 DATE: February 10, 1994  
 DRAWN BY: DDJ/KJS  
 APPROVED BY: *[Signature]*  
 CHECKED BY: *[Signature]*

PROTECTED AREA



- 0.0+ 113-1 Soil Vapor Survey Sampling Locations 1-1,DCA, (ug/L)
- 10 FOOT SAMPLE DEPTH
- 03091 Boreholes
- Soil Vapor Survey Work Plan IHSS 113 Border
- Fence
- Edge of Road
- Drainage
- Contour Interval = 40 ug/L

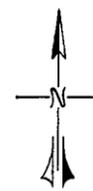
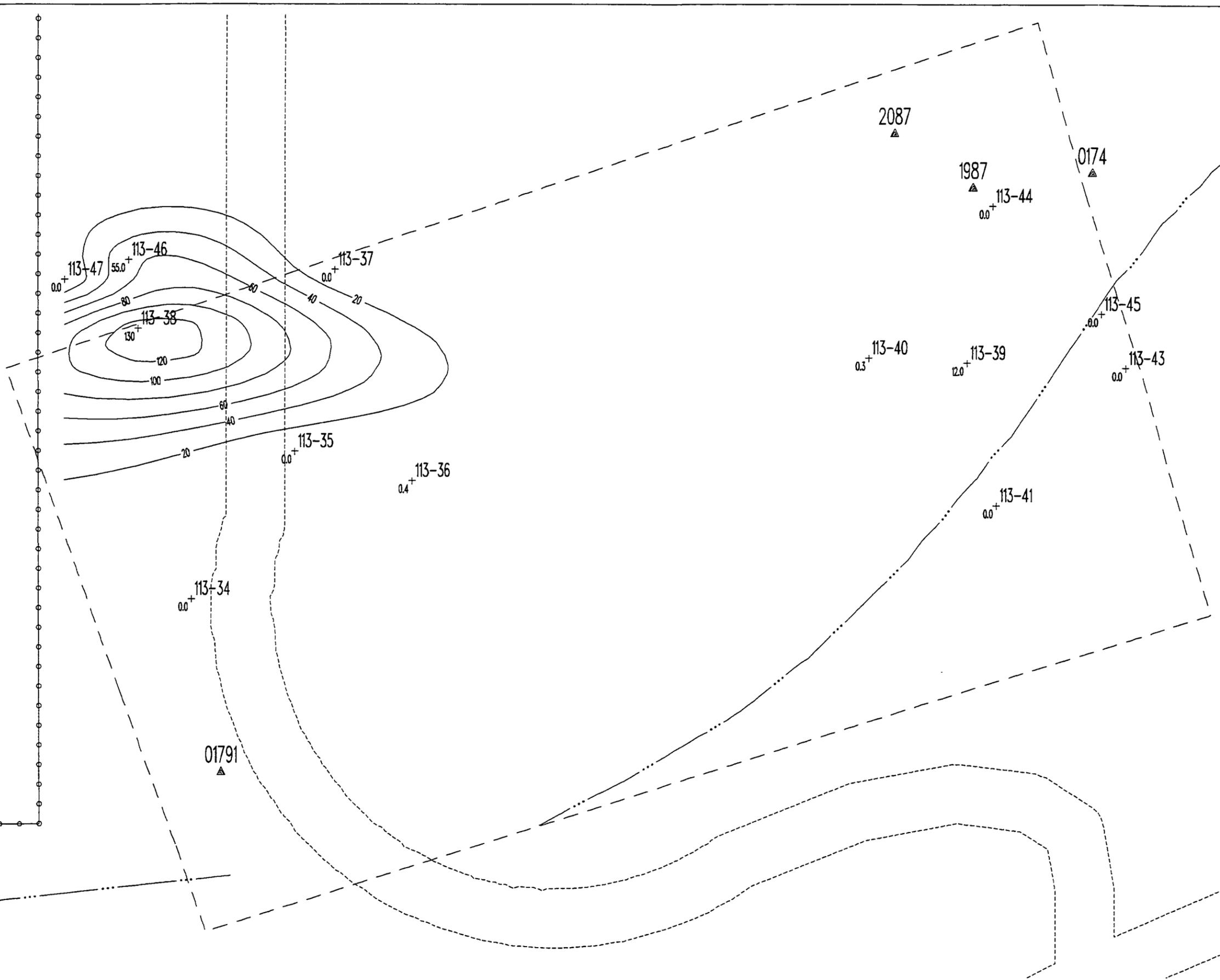
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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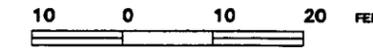
FIGURE C-19 IHSS 113  
 1,1-Dichloroethane (1,1-DCA)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 10 FOOT DEPTH

PROTECTED AREA



- 113-1 Soil Vapor Survey Sampling Locations CCl<sub>4</sub>, (ug/L)
- 10 FOOT SAMPLE DEPTH
- 03091 Boreholes
- Soil Vapor Survey Work Plan IHSS 113 Border
- Fence
- Edge of Road
- Drainage
- Contour Interval = 20 ug/L

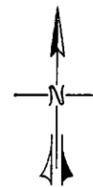
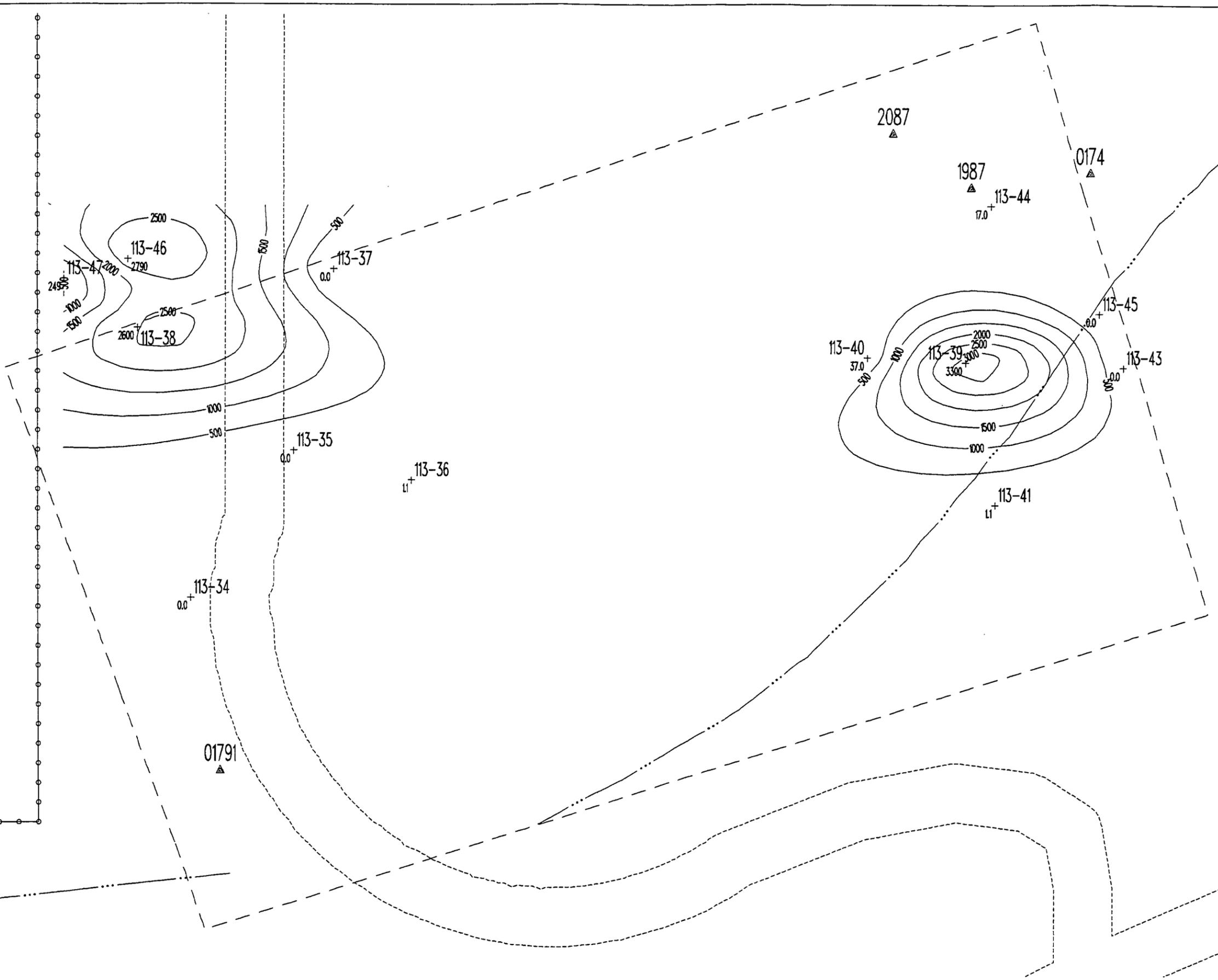
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-20 IHSS 113  
Carbon Tetrachloride (CCl<sub>4</sub>)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 10 FOOT DEPTH

PROTECTED AREA



113-1  
+ Soil Vapor Survey  
Sampling Locations  
TCE, (ug/L)

10 FOOT SAMPLE DEPTH

03091  
▲ Boreholes

--- Soil Vapor Survey  
Work Plan  
IHSS 113 Border

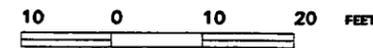
○ Fence

- - - Edge of Road

... Drainage

Contour Interval = 500 ug/L

NOTE: THE CONTOURS HAVE  
BEEN COMPUTER GENERATED  
FROM A LIMITED NUMBER  
OF POINTS AND MAY NOT  
REPRESENT ACTUAL FIELD  
CONCENTRATIONS.

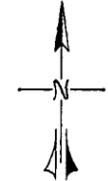
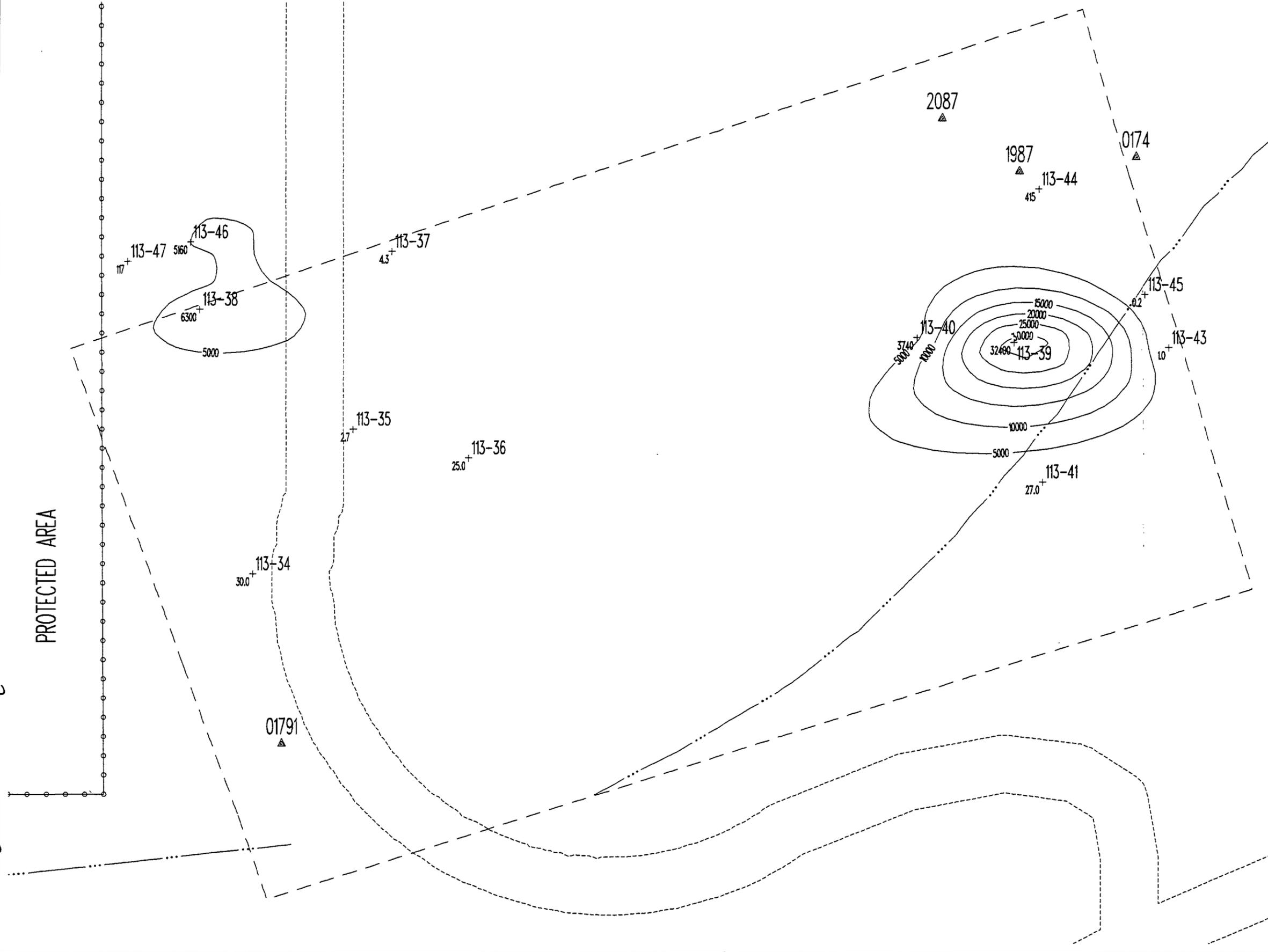


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FIGURE C-21 IHSS 113  
Trichloroethene (TCE)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 10 FOOT DEPTH

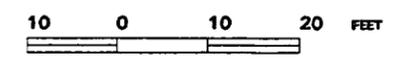
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 DATE: February 10, 1994  
 DRAWN BY: D.D.J./K.J.S.  
 APPROVED BY: [Signature]  
 CHECKED BY: [Signature]

PROTECTED AREA



- 0.0+ 113-1 Soil Vapor Survey Sampling Locations PCE, (ug/L)
- 10 FOOT SAMPLE DEPTH
- 03091 Boreholes
- Soil Vapor Survey Work Plan IHSS 113 Border
- Fence
- Edge of Road
- Drainage
- Contour Interval = 5000 ug/L

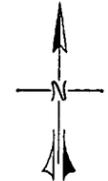
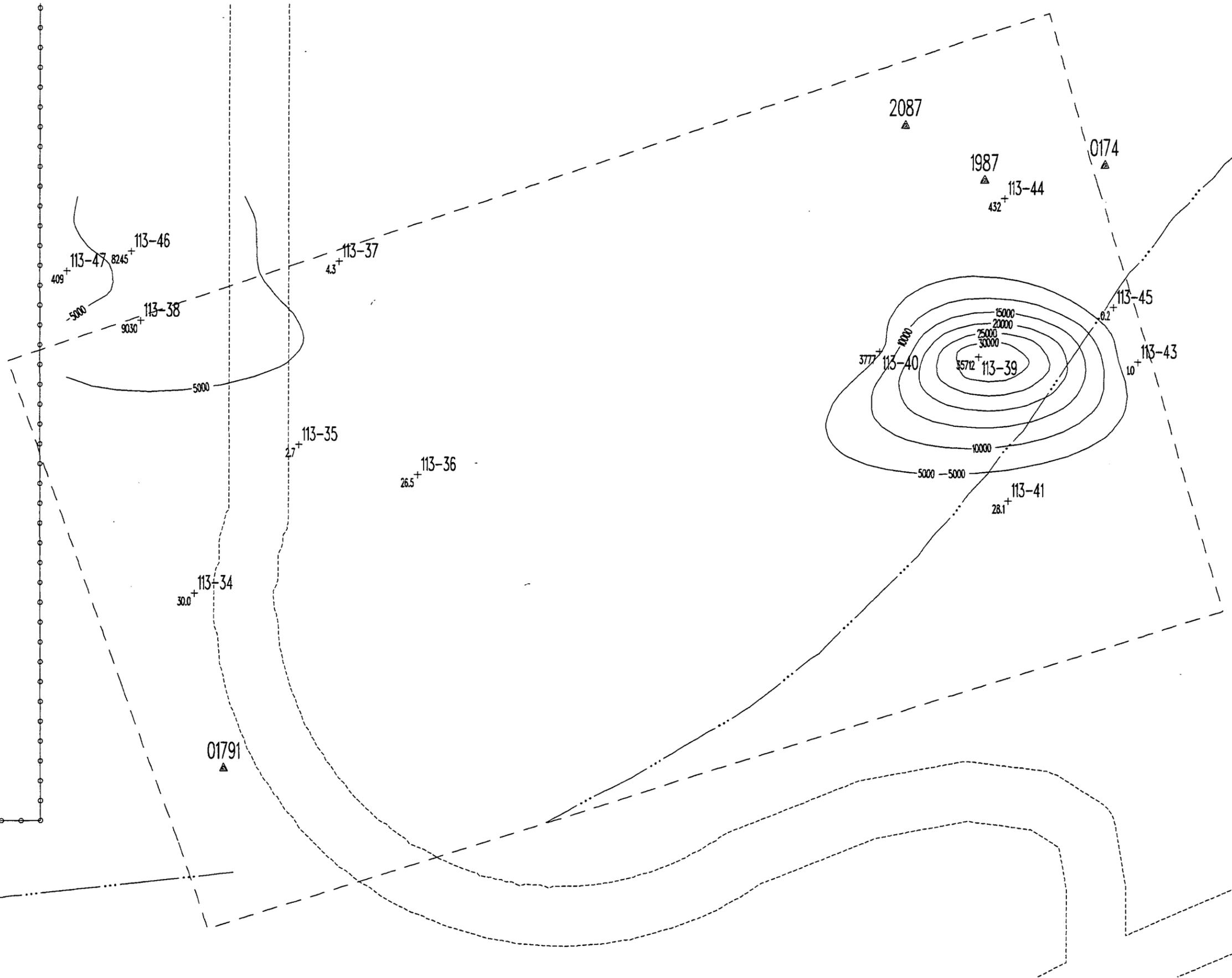
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-22 IHSS 113  
 Perchloroethene (PCE)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 10 FOOT DEPTH

PROTECTED AREA



113-1  
 0.0+ Soil Vapor Survey Sampling Locations Total VOCs, (ug/L)

10 FOOT SAMPLE DEPTH

03091  
 ▲ Boreholes

— Soil Vapor Survey Work Plan  
 - - - IHSS 113 Border

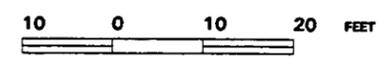
○ Fence

- - - Edge of Road

... Drainage

Contour Interval = 5000 ug/L

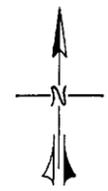
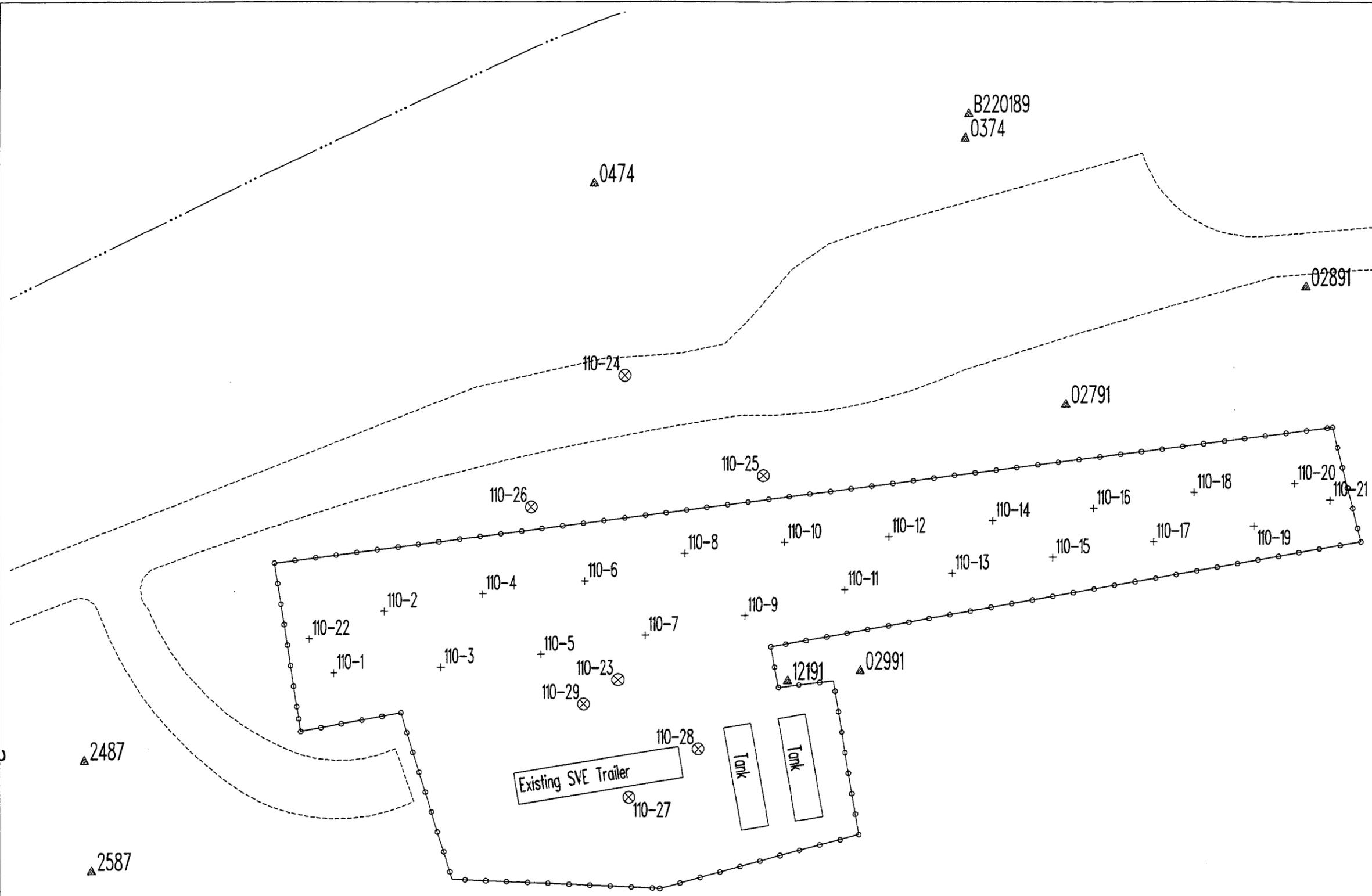
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



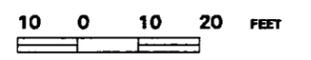
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FIGURE C-23 IHSS 113  
 Total VOCs  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 10 FOOT DEPTH

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 APPROVED BY: *[Signature]*  
 DRAWN BY: D.D.J./K.J.S.  
 DATE: February 10, 1994  
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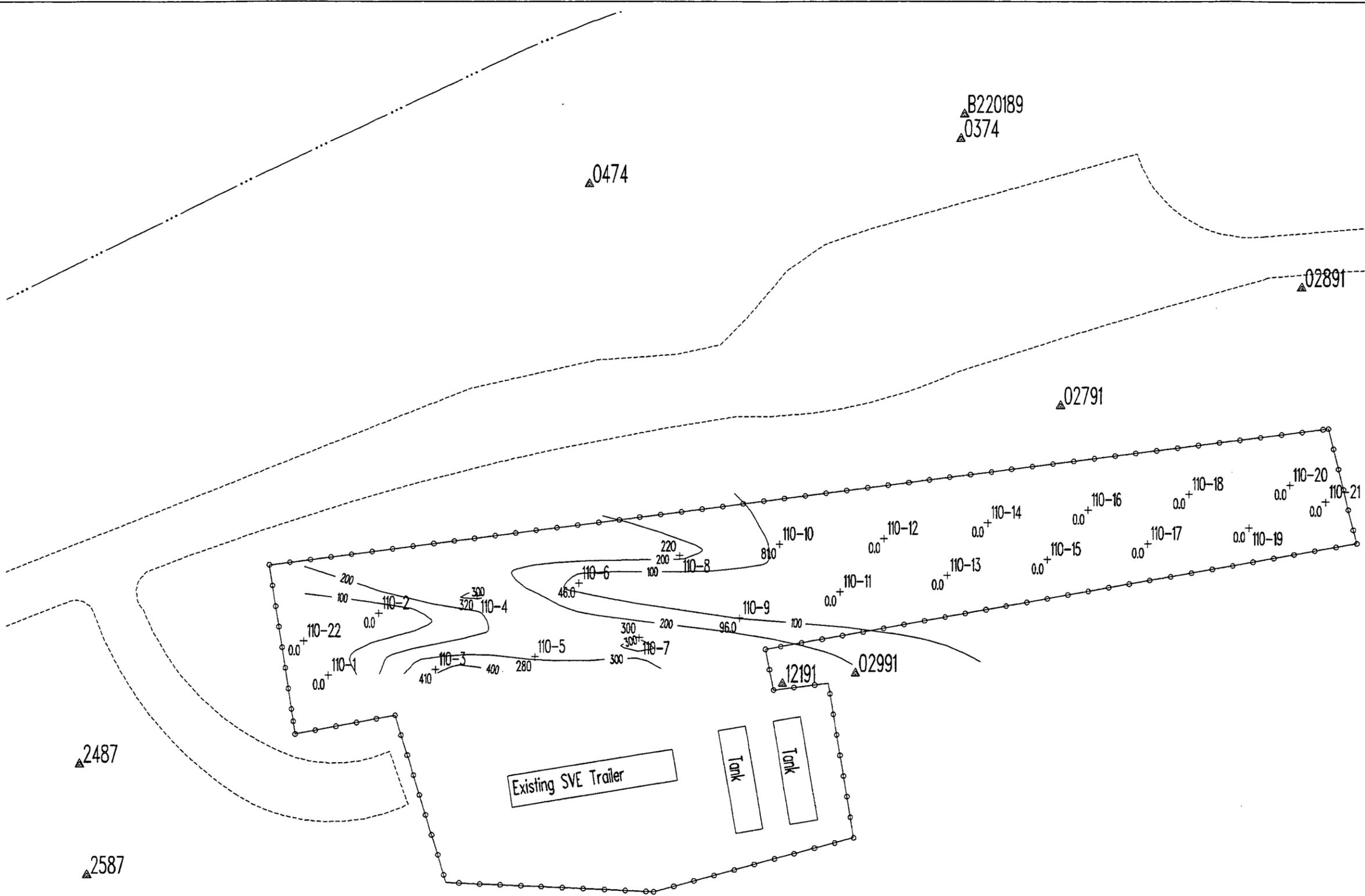


- Soil Vapor Survey Sampling Locations**
- + 110-1 5 Foot Sample Depth
  - ⊗ 110-23 10 Foot Sample Depth
  - ▲ 0374 Boreholes
  - - - Edge of Road
  - ○ ○ Fence
  - ... Drainage



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FIGURE C-24  
 IHSS 110  
 SAMPLE LOCATION MAP



110-1  
+  
Soil Vapor Survey  
Sampling Locations  
1,1-DCA, (ug/L)

5 FOOT SAMPLE DEPTH

0374  
Boreholes

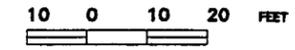
Edge of Road

Fence

Drainage

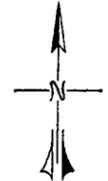
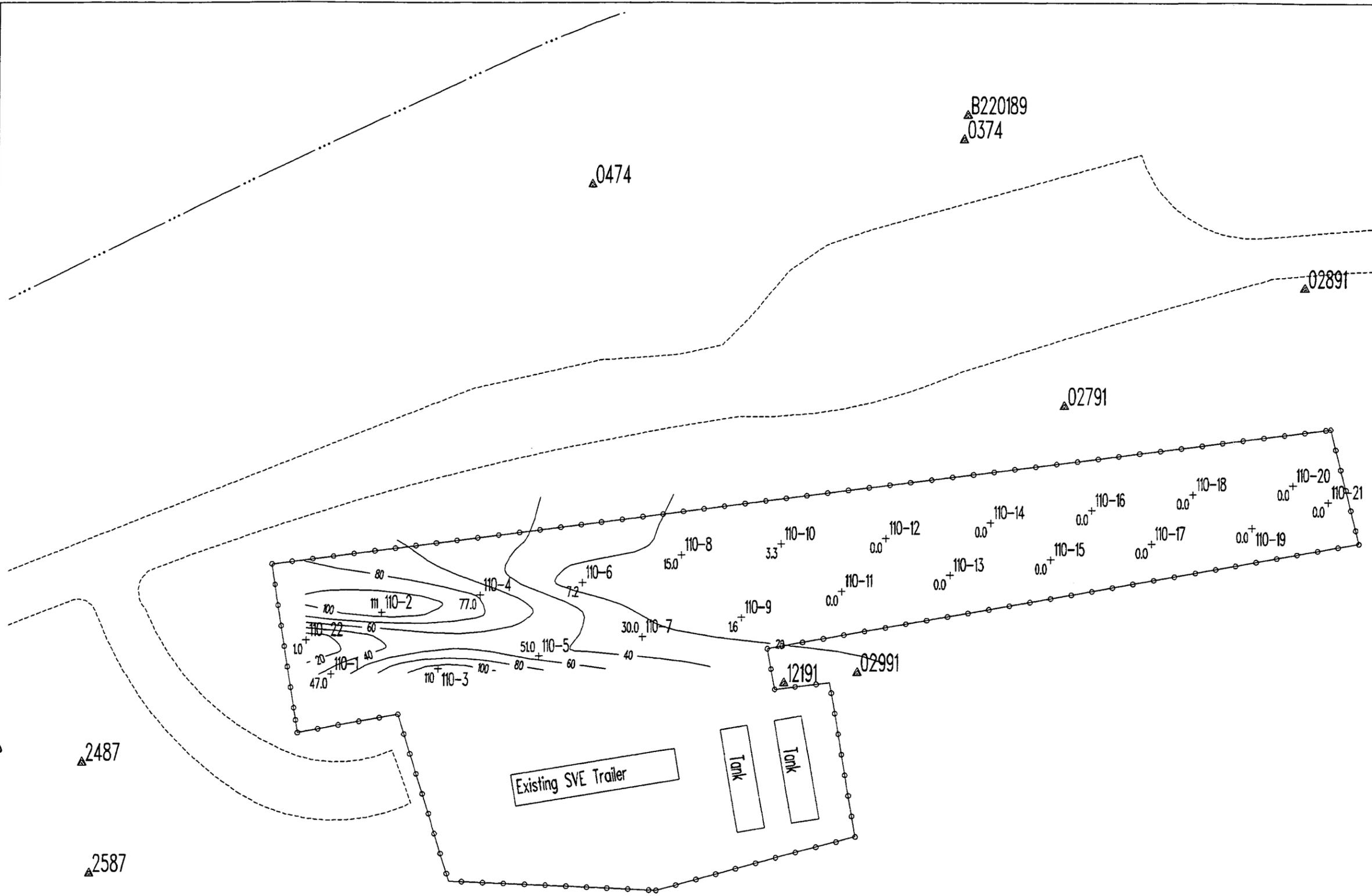
Contour Interval = 100 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



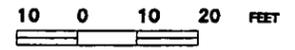
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FIGURE C-25 IHSS 110  
1,1-Dichloroethane (1,1-DCA)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH



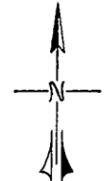
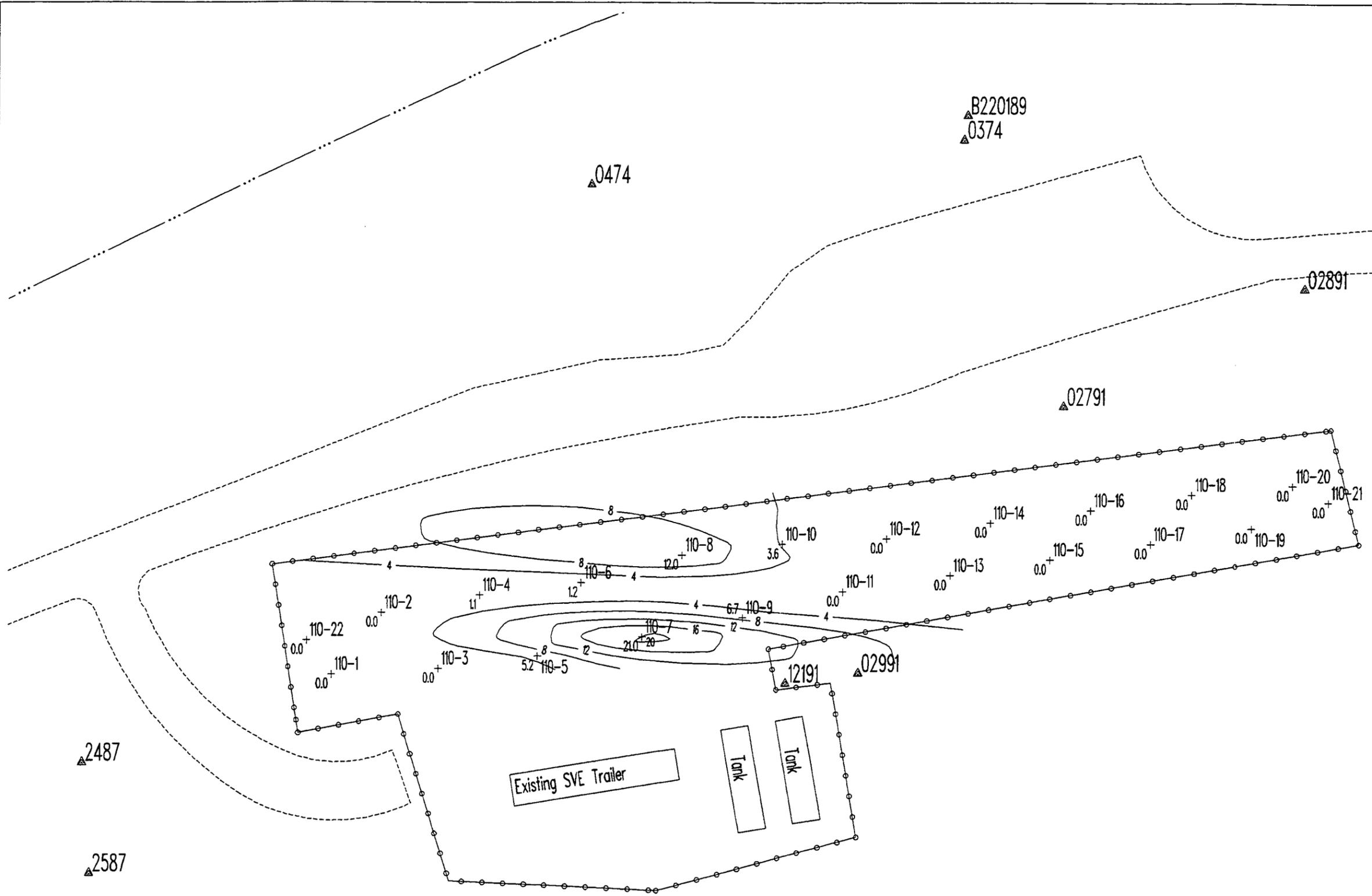
- 110-1 Soil Vapor Survey Sampling Locations CCl<sub>4</sub> (ug/L)
- 5 FOOT SAMPLE DEPTH
- 0374 Boreholes
- Edge of Road
- Fence
- Drainage
- Contour Interval = 20 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



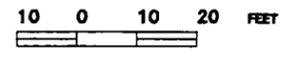
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FIGURE C-26 IHSS 110  
Carbon Tetrachloride (CCl<sub>4</sub>)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH



- 110-1 Soil Vapor Survey Sampling Locations TCE, (ug/L)
- 5 FOOT SAMPLE DEPTH
- 0374 Boreholes
- Edge of Road
- Fence
- Drainage
- Contour Interval = 4 ug/L

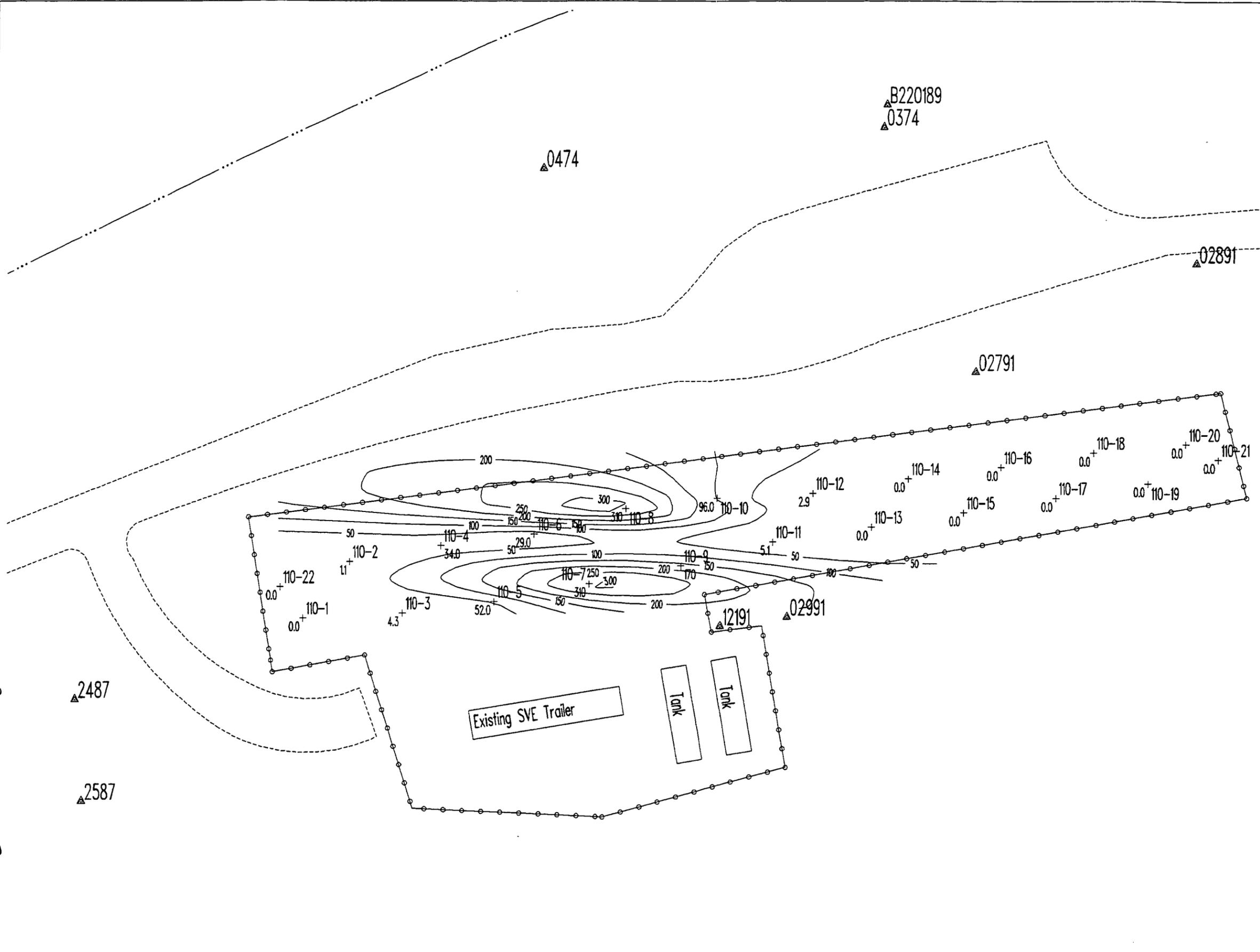
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.

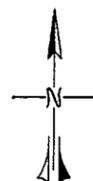


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FIGURE C-27 IHSS 110  
 Trichloroethene (TCE)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH

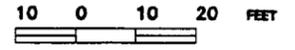
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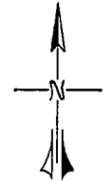
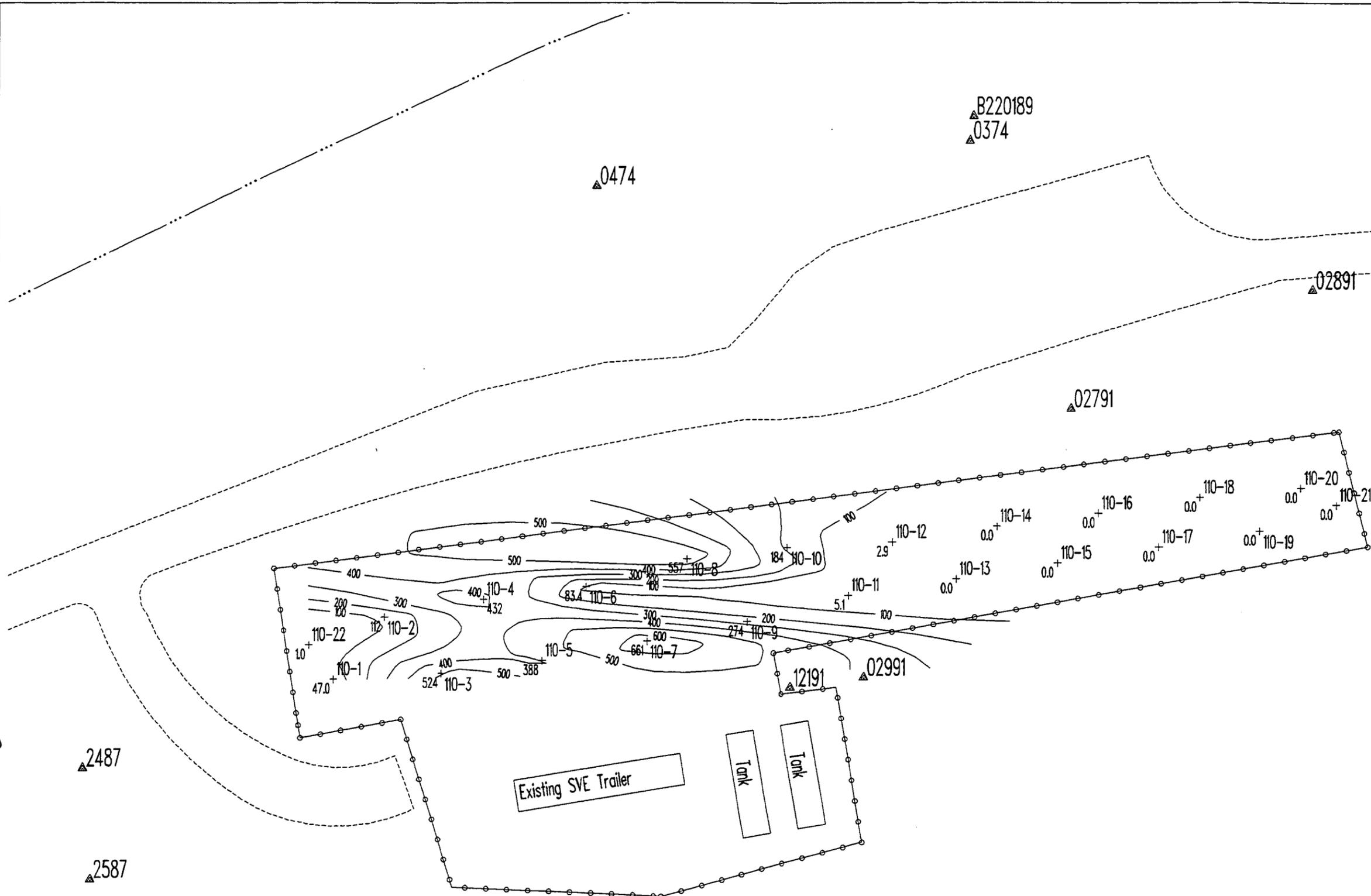
 110-1 Soil Vapor Survey Sampling Locations PCE, (ug/L)  
 5 FOOT SAMPLE DEPTH  
 0374 Boreholes  
 --- Edge of Road  
 Fence  
 ... Drainage  
 Contour Interval = 50 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-28 IHSS 110  
 Perchloroethene (PCE)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH



110-1  
+  
0.0 Soil Vapor Survey  
Sampling Locations  
Total VOCs, (ug/L)

5 FOOT SAMPLE DEPTH

0374  
▲ Boreholes

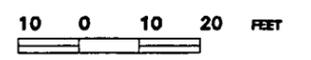
----- Edge of Road

○ ○ Fence

... Drainage

Contour Interval = 100 ug/L

NOTE: THE CONTOURS HAVE  
BEEN COMPUTER GENERATED  
FROM A LIMITED NUMBER  
OF POINTS AND MAY NOT  
REPRESENT ACTUAL FIELD  
CONCENTRATIONS.

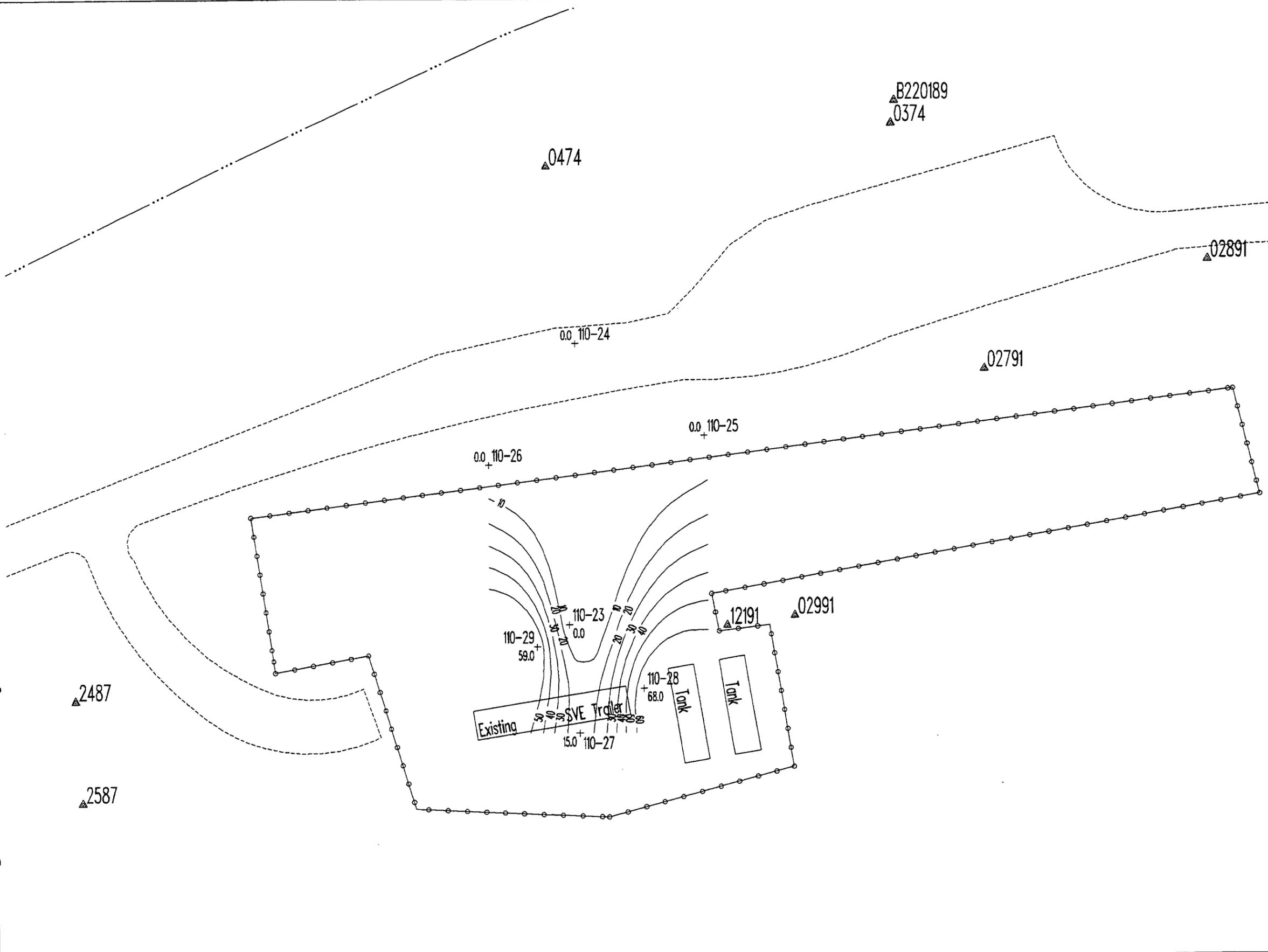


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FIGURE C-29 IHSS 110  
Total VOCs  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH

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 DRAWN BY: DDJ/KJS  
 APPROVED BY: [Signature]  
 CHECKED BY: [Signature]

REVISION NO: 2



N

0.0 + 110-23 Soil Vapor Survey Sampling Locations 1,1-DCA, (ug/L)

10 FOOT SAMPLE DEPTH

▲ 0374 Boreholes

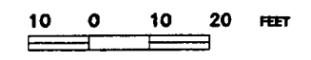
--- Edge of Road

○ Fence

... Drainage

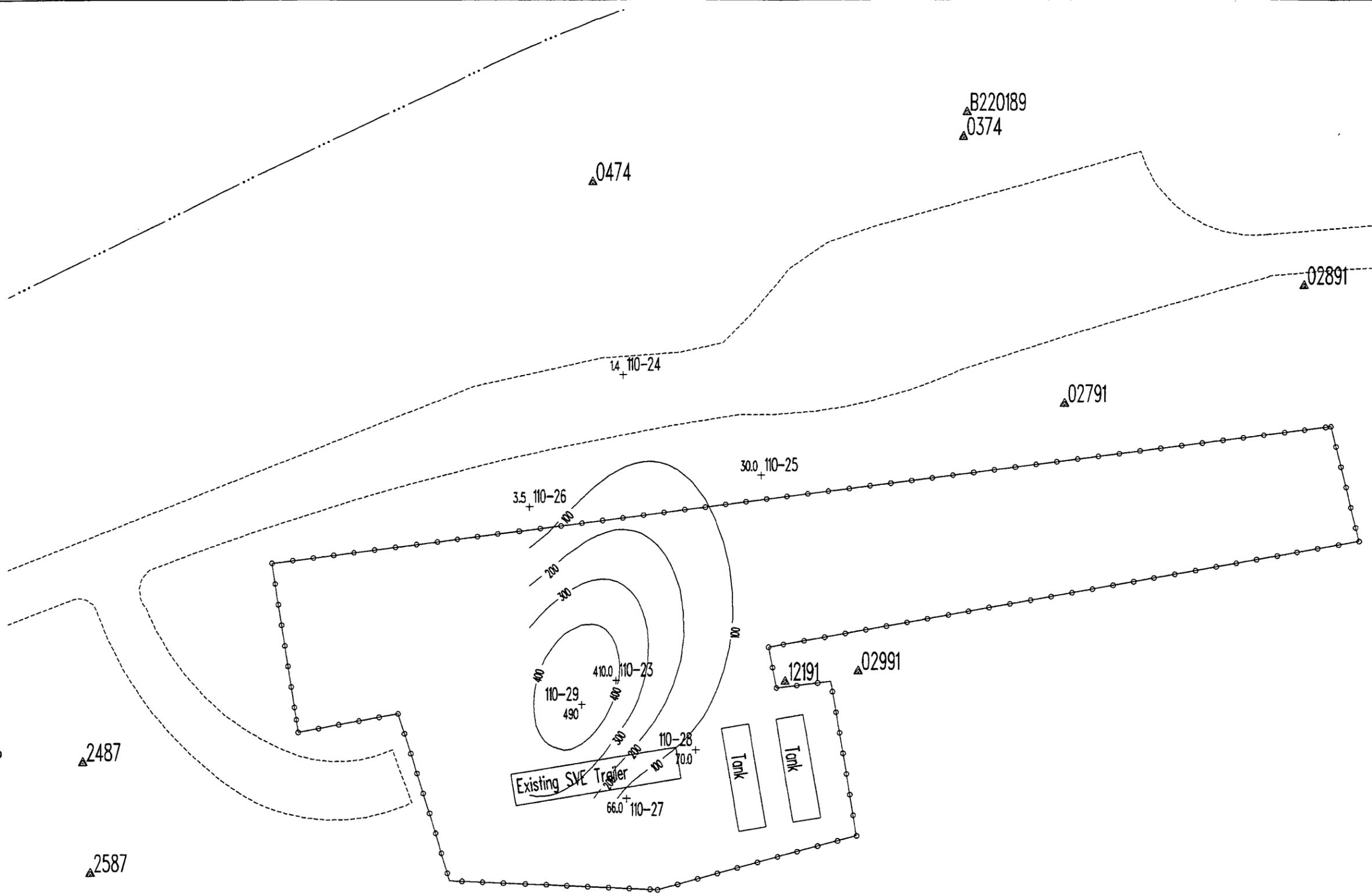
Contour Interval = 10 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-30 IHSS 110  
 1,1-Dichloroethane (1,1-DCA)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 10 FOOT DEPTH



↑  
N  
↓

0.0 110-23  
+ Soil Vapor Survey  
Sampling Locations  
CCl<sub>4</sub>, (ug/L)

10 FOOT SAMPLE DEPTH

▲ 0374  
Boreholes

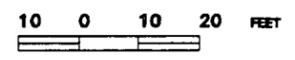
--- Edge of Road

○—○ Fence

... Drainage

Contour Interval = 100 ug/L

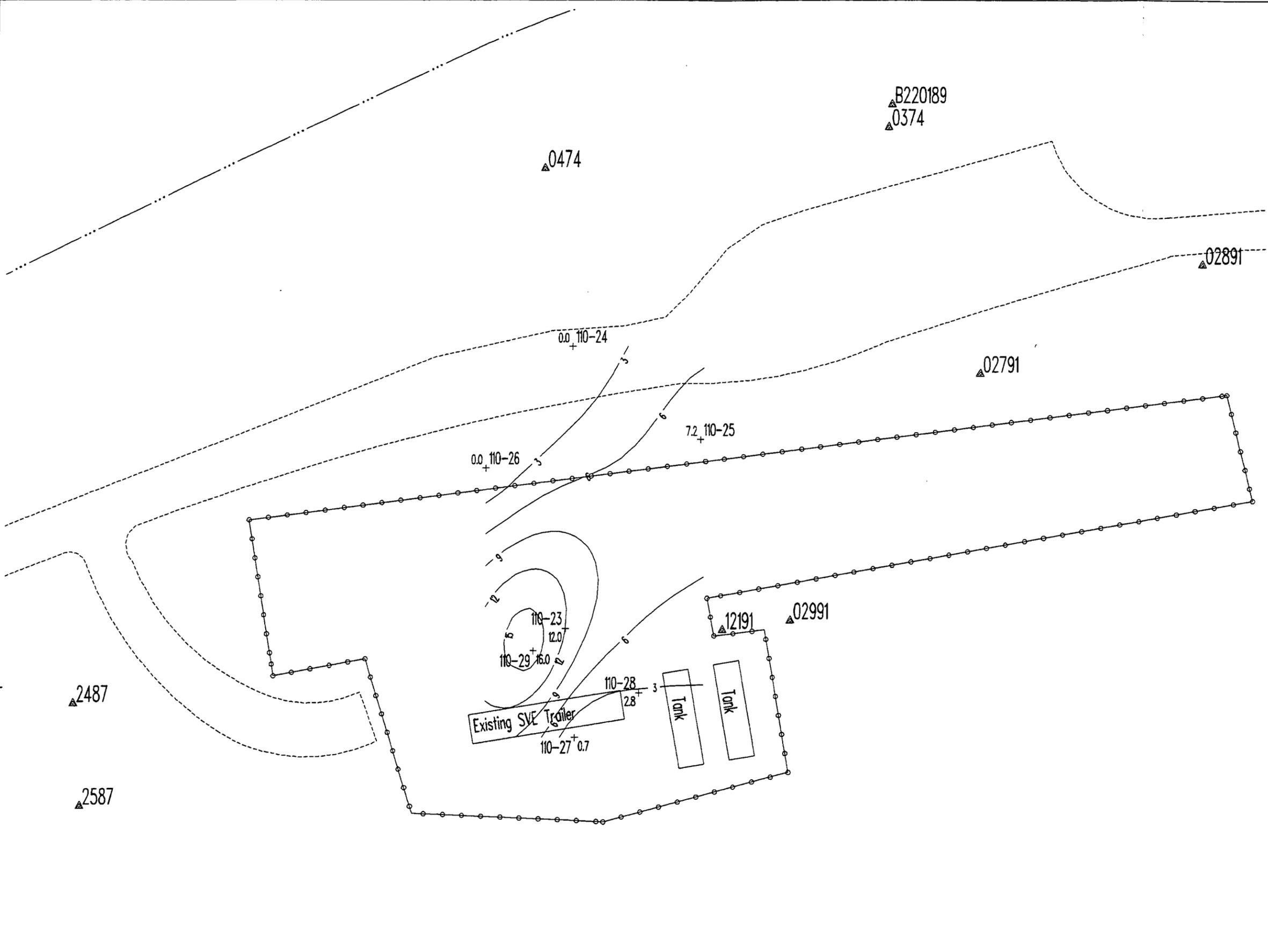
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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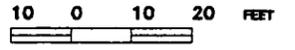
FIGURE C-31 IHSS 110  
Carbon Tetrachloride (CCl<sub>4</sub>)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 10 FOOT DEPTH

FILENAME: /arc/data/soil/vapor/ihss1010/svs1732.cml REVISION NO: 2  
 DATE: February 10, 1994  
 DRAWN BY: DDJ/KJS  
 APPROVED BY: [Signature]  
 CHECKED BY: [Signature]



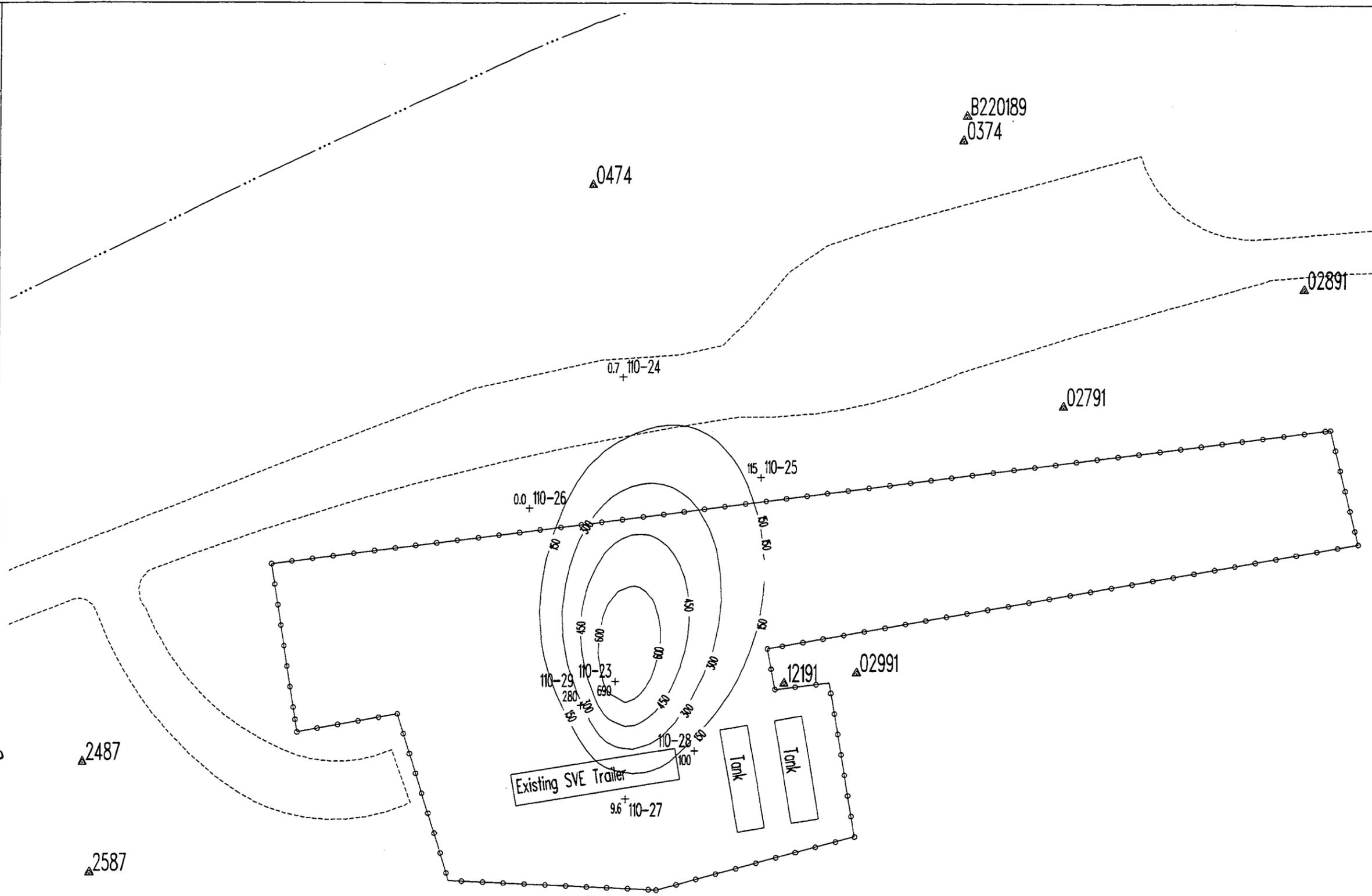
0.0 110-23 Soil Vapor Survey Sampling Locations TCE, (ug/L)  
 10 FOOT SAMPLE DEPTH  
 0374 Boreholes  
 --- Edge of Road  
 ○-○-○ Fence  
 ... Drainage  
 Contour Interval = 3 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-32 IHSS 110  
 Trichloroethene (TCE)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 10 FOOT DEPTH



N

0.0 110-23  
+ Soil Vapor Survey  
Sampling Locations  
PCE, (ug/L)

10 FOOT SAMPLE DEPTH

0374  
▲ Boreholes

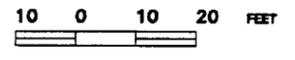
----- Edge of Road

○-○-○ Fence

... Drainage

Contour Interval = 150 ug/L

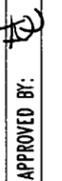
NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



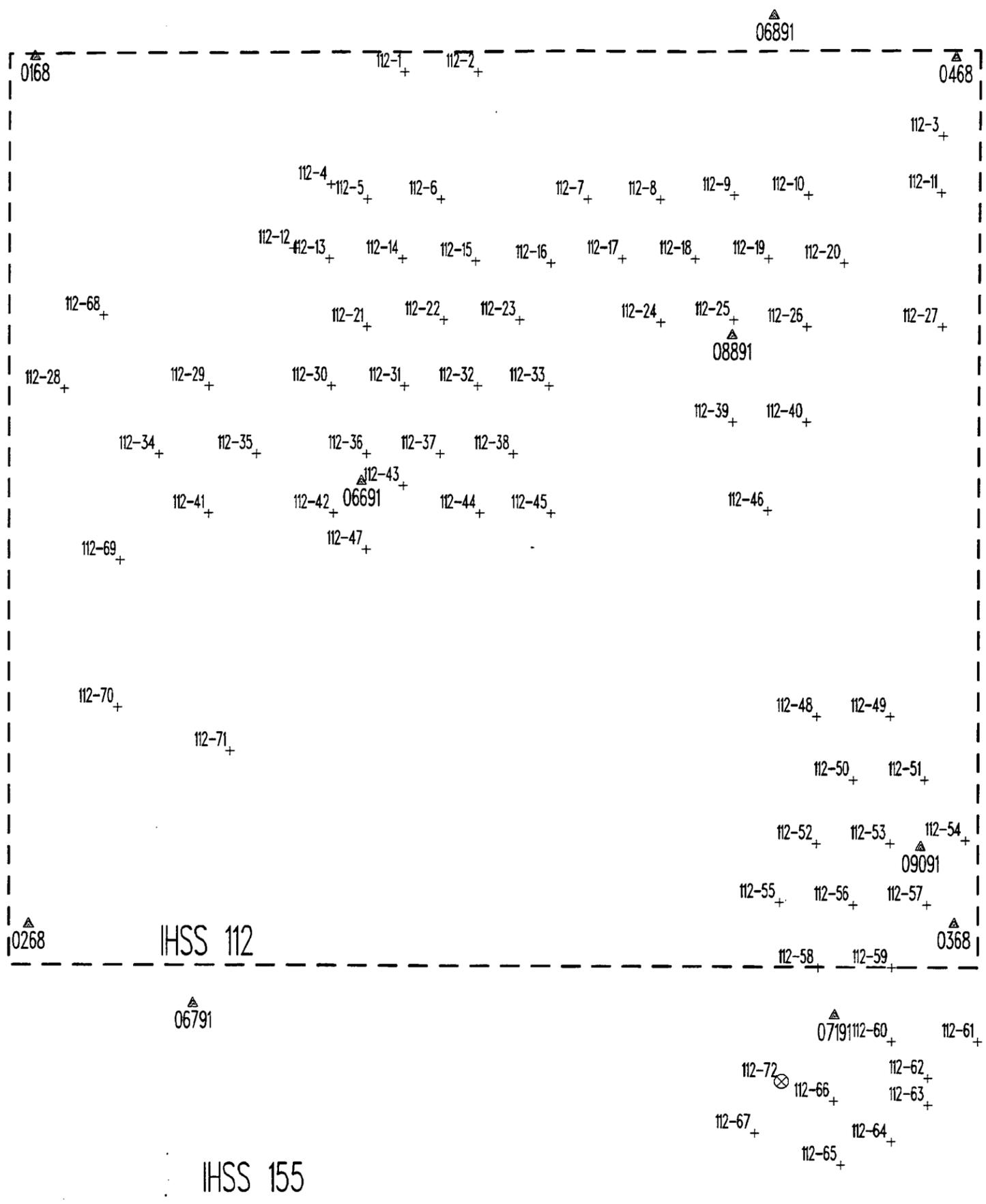
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FIGURE C-33 IHSS 110  
Perchloroethene (PCE)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 10 FOOT DEPTH

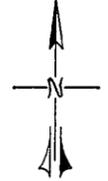


CHECKED BY:  APPROVED BY:  DRAWN BY: DDJ/KJS DATE: February 11, 1994 FILENAME: /arc/data/soi/vapor/i112/svs201.dtl REVISION NO: 0

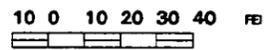
IHSS 172



IHSS 155

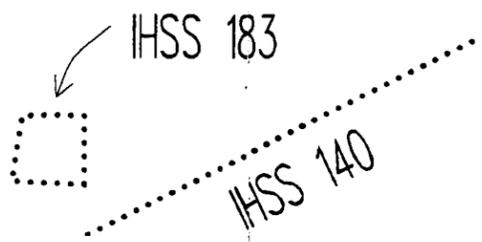


- Soil Vapor Survey Sampling Locations**
- 112-1 + 5 Foot Sample Depth
  - 112-72 ⊗ 10 Foot Sample Depth
  - ▲ Boreholes
  - Soil Vapor Survey Work Plan
  - IHSS 112 Border
  - ..... Adjacent IHSS Borders
  - Fence

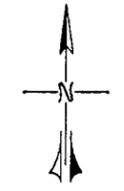
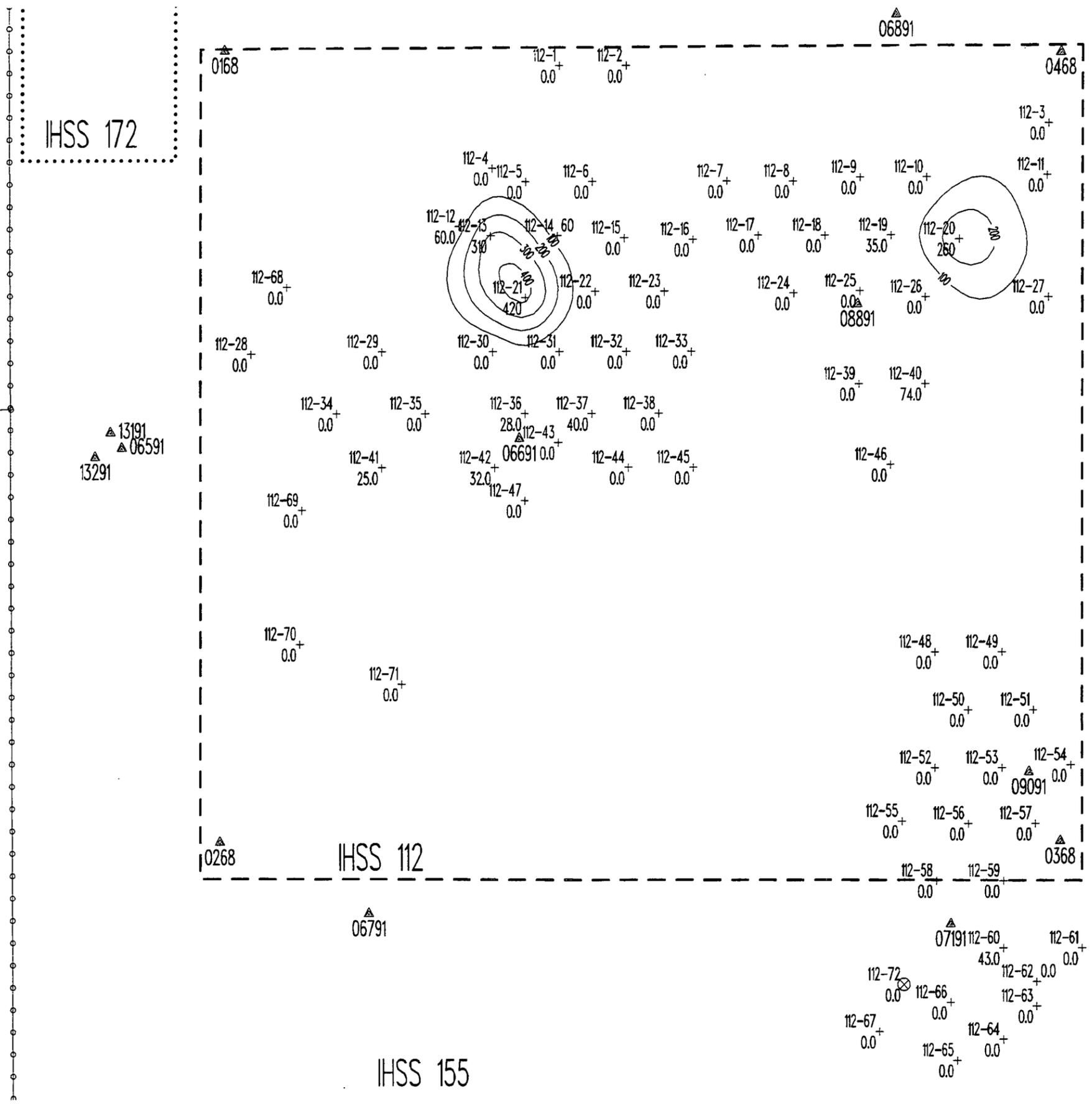


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FIGURE C-1  
 IHSS 112 (903 PAD)  
 SAMPLE LOCATION MAP



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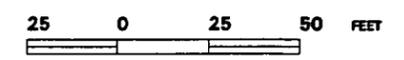


- Soil Vapor Survey Sampling Locations**  
1,1-DCA, (ug/L)
- 112-1 + 5 Foot Sample Depth
  - 112-72 ⊗ 10 Foot Sample Depth
  - △ Boreholes
  - Soil Vapor Survey Work Plan
  - IHSS 112 Border
  - ..... Adjacent IHSS Borders
  - Fence

Contour Interval = 100 ug/L

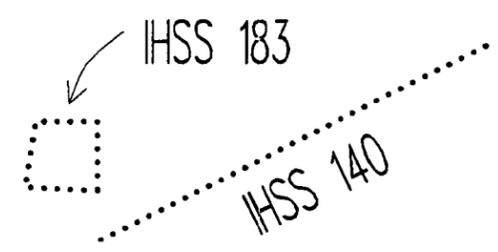
NOTE: Analyte values from the 10 foot depth were not used in the generation of the contours.

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-2 IHSS 112 (903 PAD)  
 1,1-Dichloroethane (1,1-DCA)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH



REVISION NO: 2

FILENAME: /arc/data/soil/vapor/ihss112/svs232.dml

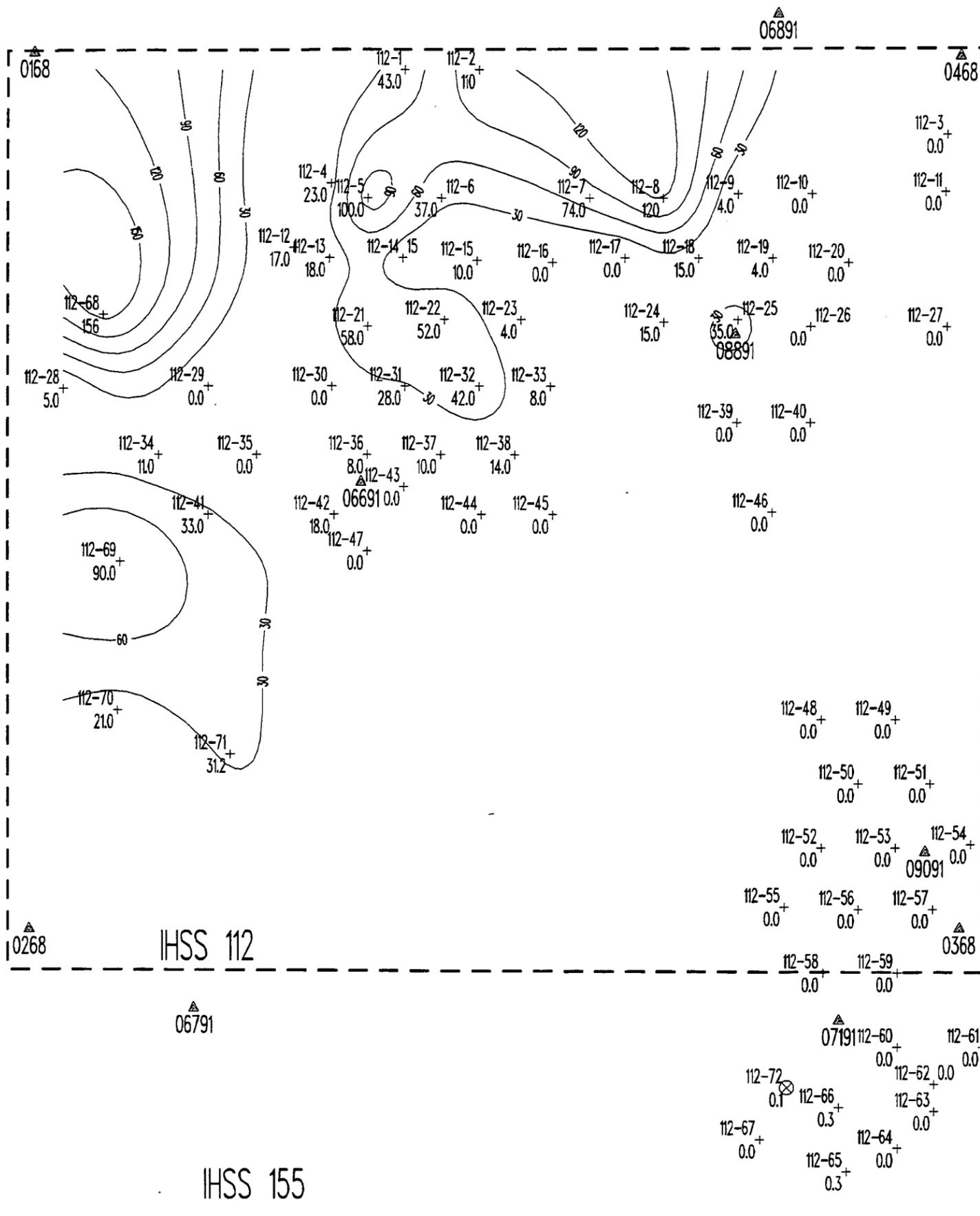
DATE: February 09, 1994

DRAWN BY: DDJ/KJS

APPROVED BY:

CHECKED BY:

IHSS 172



IHSS 155

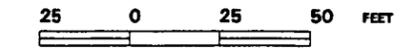


- Soil Vapor Survey Sampling Locations**  
CCl<sub>4</sub>, (ug/L)
- 112-1 + 5 Foot Sample Depth
  - 112-72 ⊗ 10 Foot Sample Depth
  - △ 06891 Boreholes
  - — Soil Vapor Survey Work Plan
  - IHSS 112 Border
  - ..... Adjacent IHSS Borders
  - ○ ○ Fence

Contour Interval = 30 ug/L

NOTE: Analyte values from the 10 foot depth were not used in the generation of the contours.

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-3 IHSS 112 (903 PAD)  
Carbon Tetrachloride (CCl<sub>4</sub>)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH

IHSS 183

IHSS 140

REVISION NO: 2

FILENAME: /arc/data/soi/vapor/ihss112/svs332.dwt

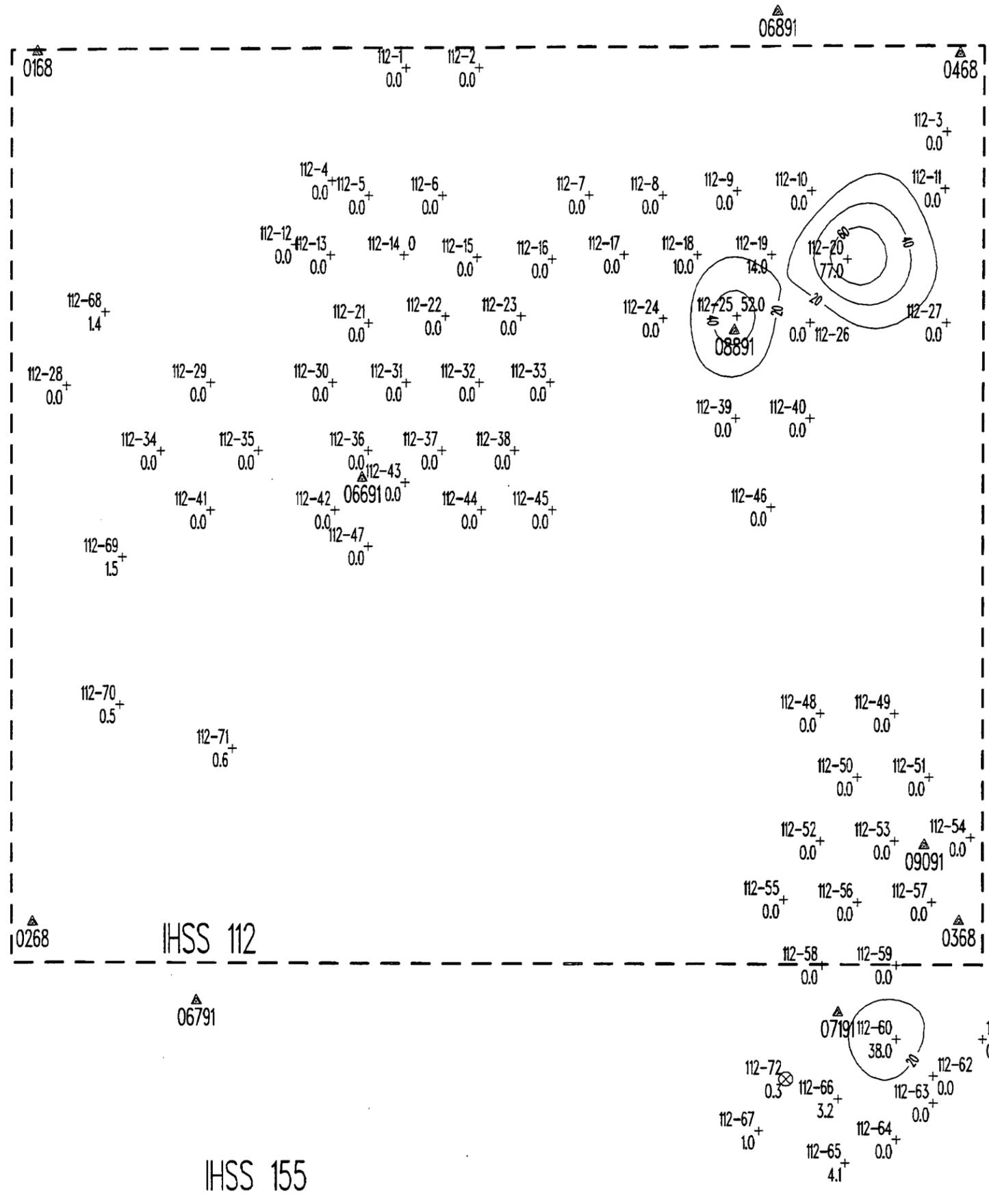
DATE: February 09, 1994

DRAWN BY: DDJ/KJS

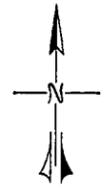
APPROVED BY:

CHECKED BY:

IHSS 172



IHSS 155

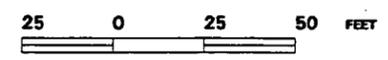


- Soil Vapor Survey Sampling Locations TCE, (ug/L)**
- 112-1 + 0.0 **5 Foot Sample Depth**
  - 112-72 ⊗ 0.0 **10 Foot Sample Depth**
  - △ 03091 **Boreholes**
  - **Soil Vapor Survey Work Plan IHSS 112 Border**
  - ..... **Adjacent IHSS Borders**
  - **Fence**

Contour Interval = 20 ug/L

NOTE: Analyte values from the 10 foot depth were not used in the generation of the contours.

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.

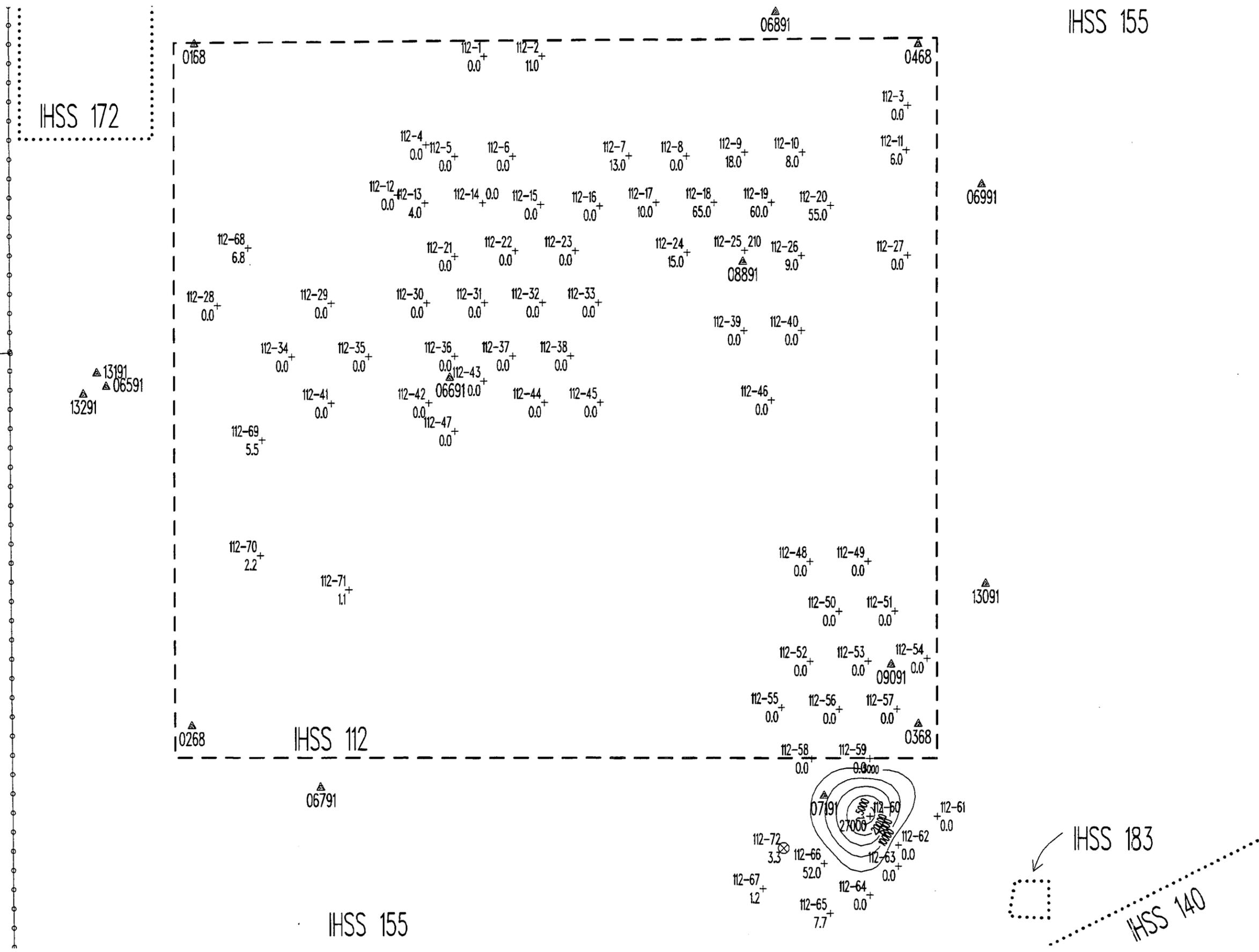


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FIGURE C-4 IHSS 112 (903 PAD) Trichloroethene (TCE) ISOCONCENTRATION CONTOUR MAP AT 5 FOOT DEPTH

IHSS 183  
IHSS 140

CHECKED BY:   
 APPROVED BY:   
 DRAWN BY: DDJ/KJS   
 DATE: February 09, 1994   
 FILENAME: /arc/data/soil/vapor/ihss112/svs2342.cnt   
 REVISION NO: 2



IHSS 155

**Soil Vapor Survey  
Sampling Locations  
PCE, (ug/L)**

112-1 + 5 Foot Sample Depth  
 112-72 ⊗ 10 Foot Sample Depth

▲ Boreholes  
 --- Soil Vapor Survey Work Plan  
 - - - IHSS 112 Border  
 ..... Adjacent IHSS Borders  
 ○—○ Fence

Contour Interval = 5000 ug/L

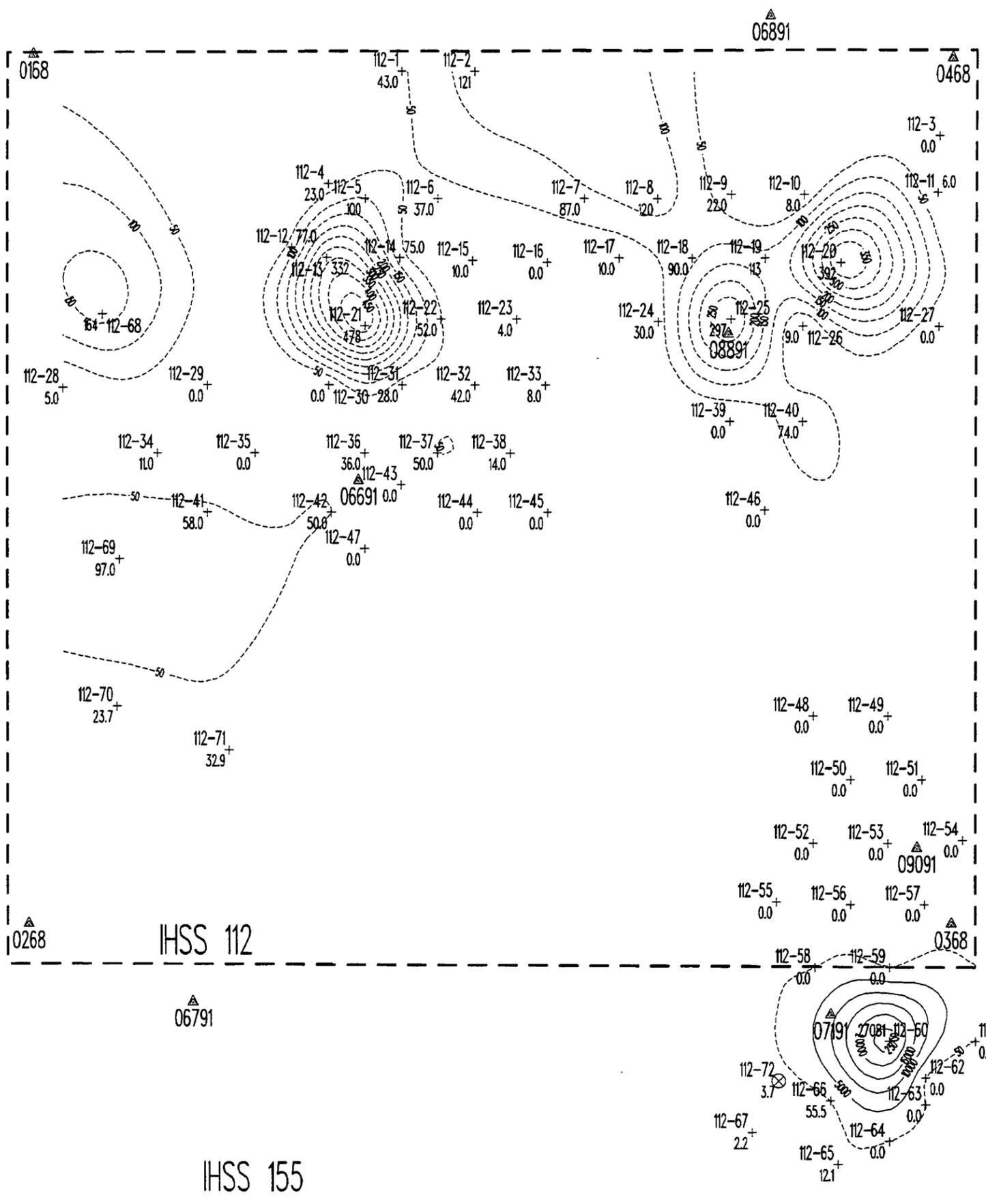
NOTE: Analyte values from the 10 foot depth were not used in the generation of the contours.  
  
 NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.

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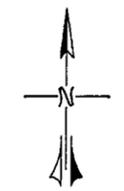
FIGURE C-5 IHSS 112 (903 PAD)  
 Perchloroethene (PCE)  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH

CHECKED BY: *HL*  
 APPROVED BY: *HL*  
 DRAWN BY: DDJ/KJS  
 DATE: February 11, 1994  
 FILENAME: /arc/data/soi/vapor/ihss112/svs352.cml  
 REVISION NO: 2

IHSS 172



IHSS 155



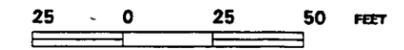
- Soil Vapor Survey Sampling Locations**  
TOTAL VOCs, (ug/L)
- 112-1 + 5 Foot Sample Depth
  - 112-72 ⊗ 10 Foot Sample Depth
  - ▲ Boreholes
  - Soil Vapor Survey Work Plan
  - IHSS 112 Border
  - ..... Adjacent IHSS Borders
  - Fence

**CONTOUR INTERVAL**

- 5000 ug/L
- 50 ug/L

**NOTE:** Analyte values from the 10 foot depth were not used in the generation of the contours.

**NOTE:** THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-6 IHSS 112 (903 PAD)  
 Total VOCs  
 ISOCONCENTRATION  
 CONTOUR MAP  
 AT 5 FOOT DEPTH

IHSS 183  
 IHSS 140

REVISION NO: 2

FILENAME: /arc/cato/soil/vapor/ihss109/svs1002.dwg

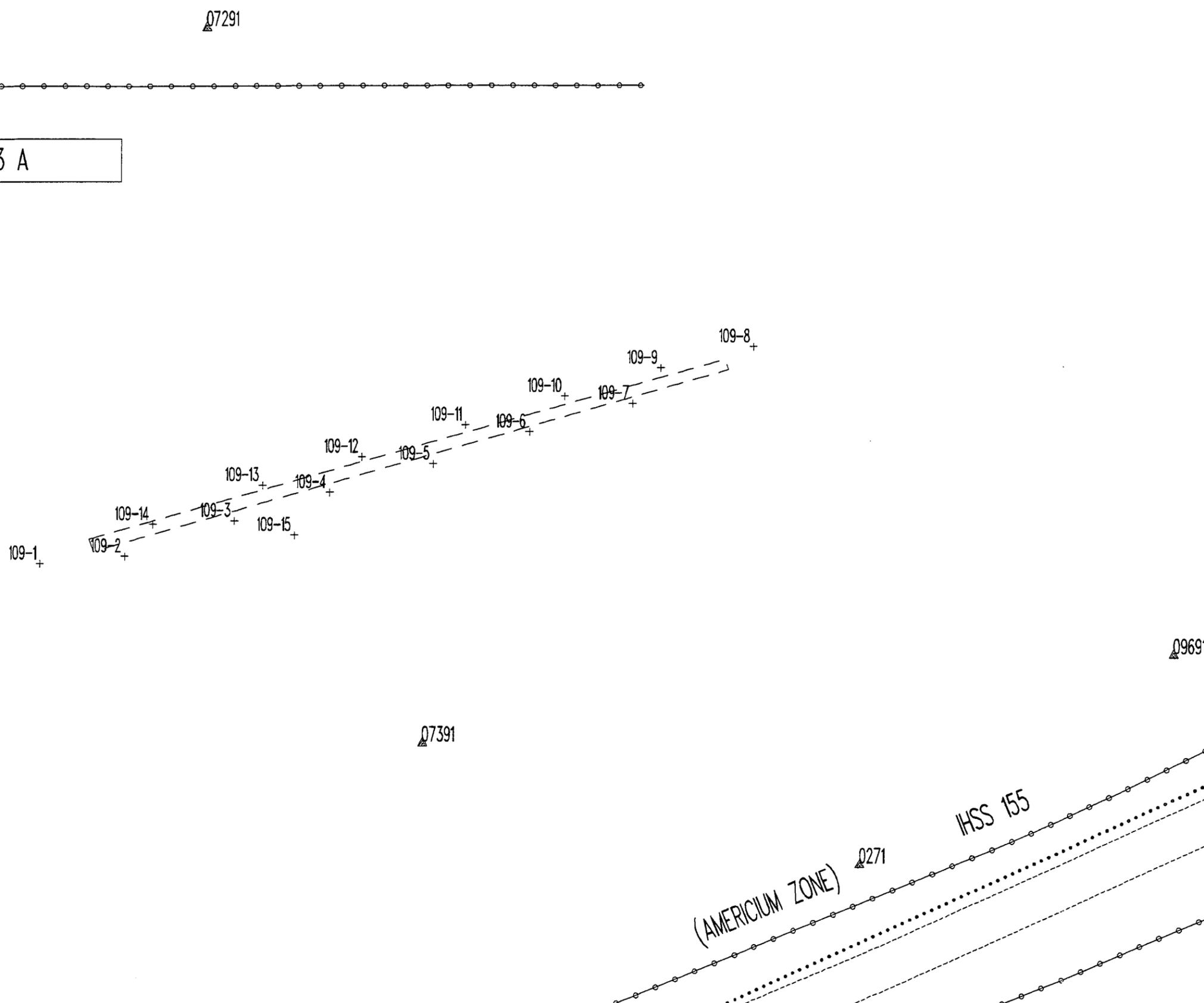
DATE: February 09, 1994

DRAWN BY: DDJ/KJS

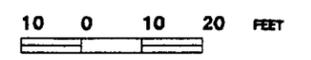
APPROVED BY:

CHECKED BY:

T 903 A



- Soil Vapor Survey Sampling Locations**
- 109-1+ 5 Foot Sample Depth
  - ▲ 03091 Boreholes
  - ..... IHSS 155 Border
  - - - Soil Vapor Survey Work Plan IHSS 109 Border
  - Fence
  - - - Edge of Road
  - ▭ Building



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FIGURE C-7  
 IHSS 109  
 SAMPLE LOCATION MAP

REVISION NO: 2

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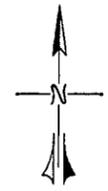
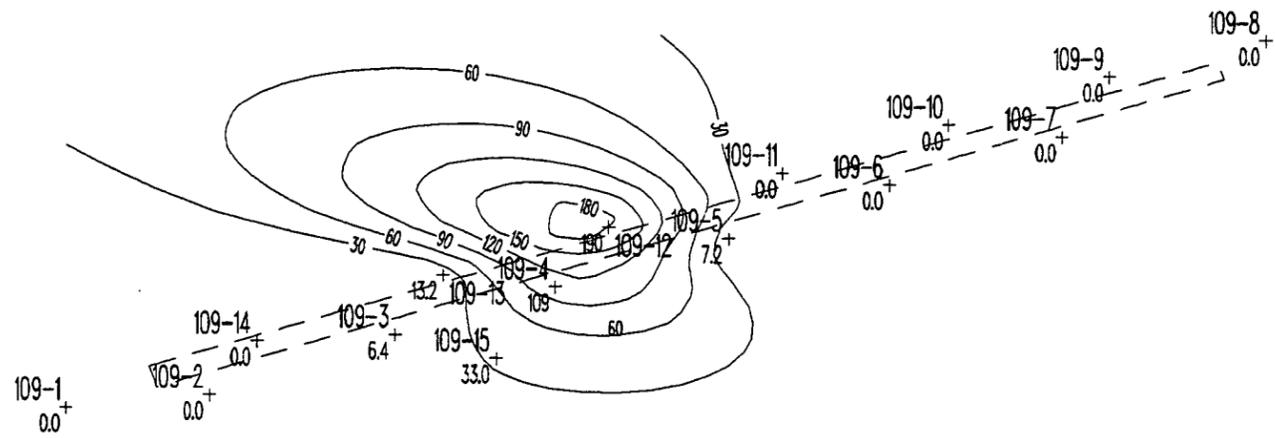
DATE: February 09, 1994

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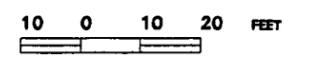
109-1+ Soil Vapor Survey Sampling Locations  
0.0 1,1-DCA, (ug/L)

5 FOOT SAMPLE DEPTH

- ▲ 03091 Boreholes
- ..... IHSS 155 Border
- Soil Vapor Survey Work Plan IHSS 109 Border
- Fence
- - - Edge of Road
- ▭ Building

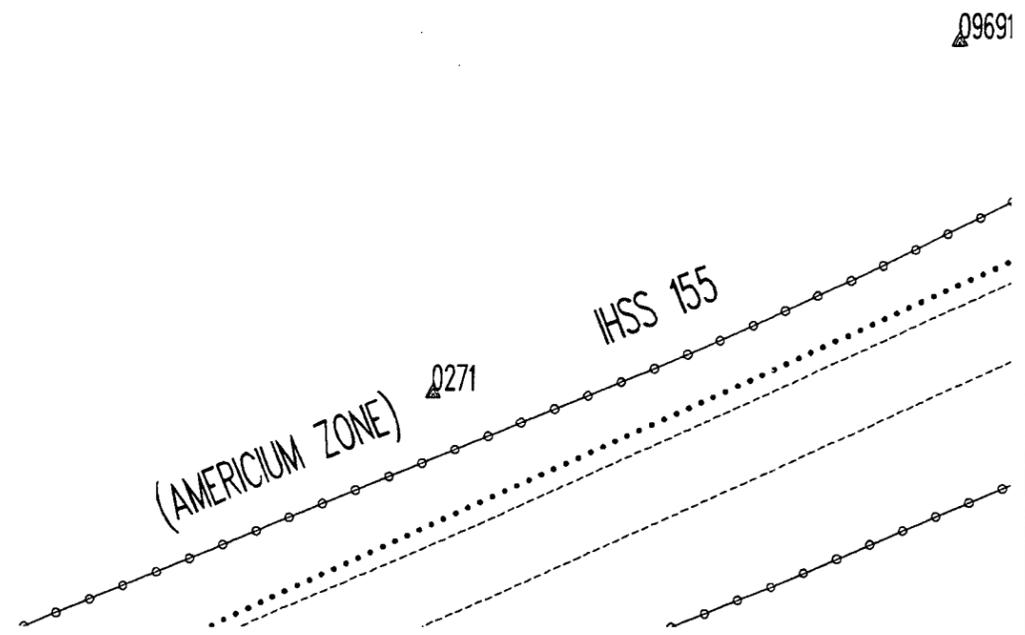
Contour Interval = 30 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-8 IHSS 109  
1,1-Dichloroethane (1,1-DCA)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH



07291

07391

09691

0271

REVISION NO: 2

FILENAME: /arc/data/soil/vapor/ihss109/svs112Z.cnt

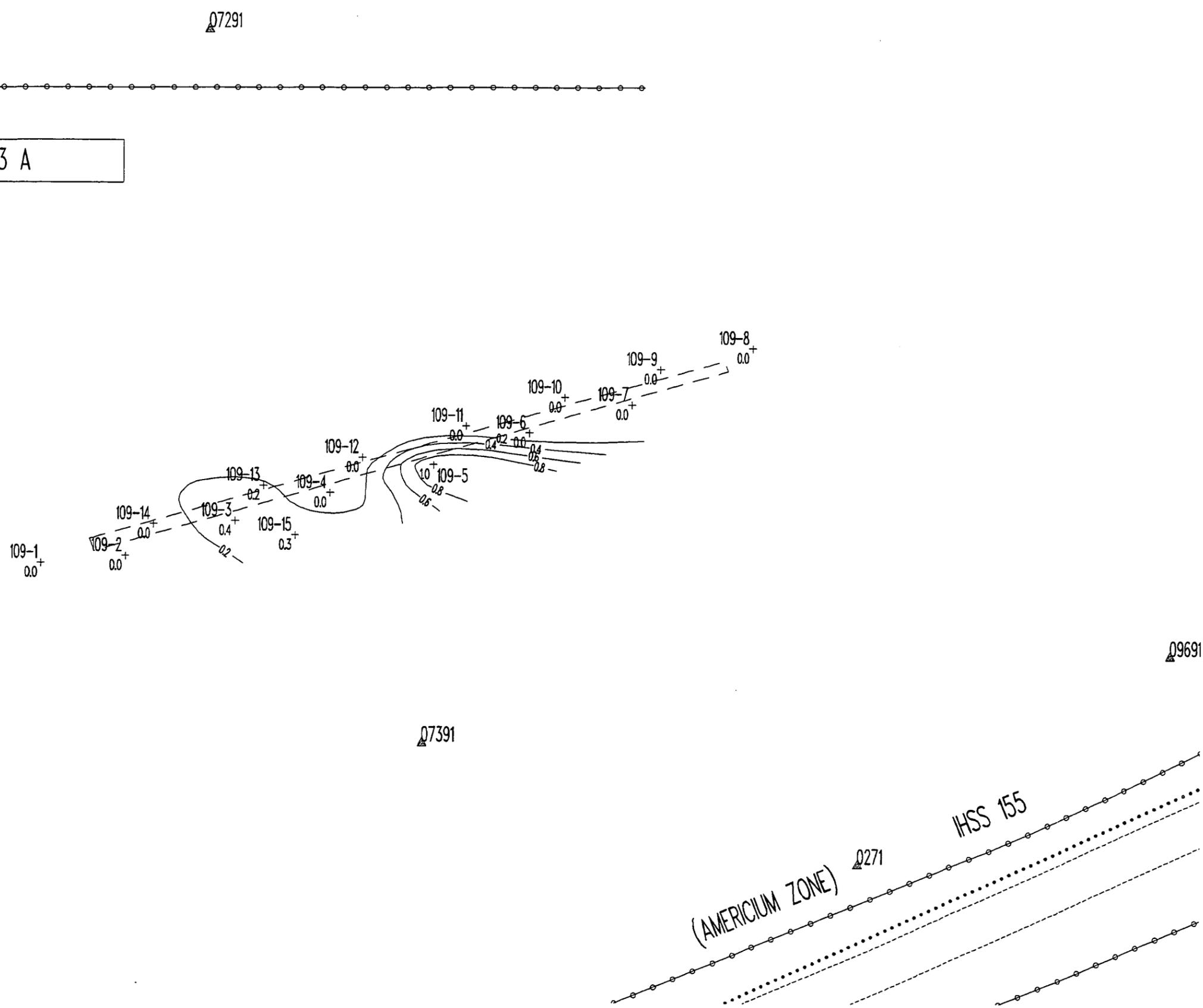
DATE: February 11, 1994

DRAWN BY: DDJ/KJS

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CHECKED BY: *[Signature]*

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109-1 + Soil Vapor Survey Sampling Locations  
0.0 CCl<sub>4</sub>, (ug/L)

**5 FOOT SAMPLE DEPTH**

03091 ▲ Boreholes

..... IHSS 155 Border

--- Soil Vapor Survey Work Plan IHSS 109 Border

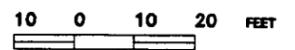
○-○ Fence

----- Edge of Road

— Building

Contour Interval = 0.2 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.

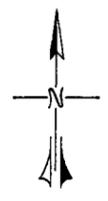
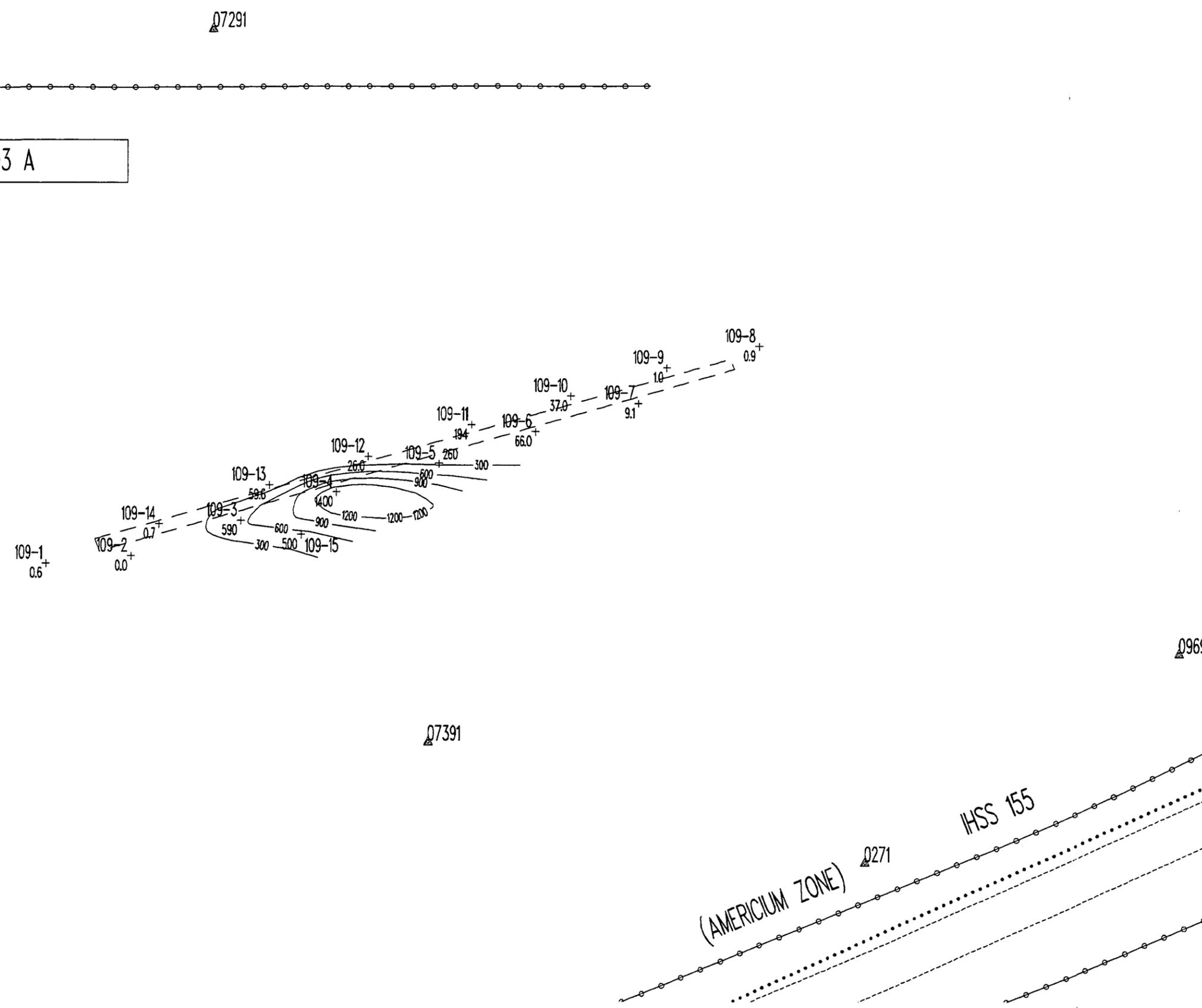


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FIGURE C-9 IHSS 109  
Carbon Tetrachloride (CCl<sub>4</sub>)  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH

REVISION NO: 2  
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 DATE: February 09, 1994  
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 APPROVED BY: [Signature]  
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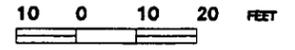
109-1+  
 0.0+ Soil Vapor Survey Sampling Locations TCE, (ug/L)

5 FOOT SAMPLE DEPTH

- ▲ 03091 Boreholes
- ..... IHSS 155 Border
- Soil Vapor Survey Work Plan IHSS 109 Border
- Fence
- - - Edge of Road
- ▬ Building

Contour Interval = 300 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.



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FIGURE C-10 IHSS 109 Trichloroethene (TCE) ISOCONCENTRATION CONTOUR MAP AT 5 FOOT DEPTH

REVISION NO: 2

FILENAME: /arc/cata/soi/vapor/hss109/svs142.dwg

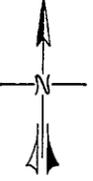
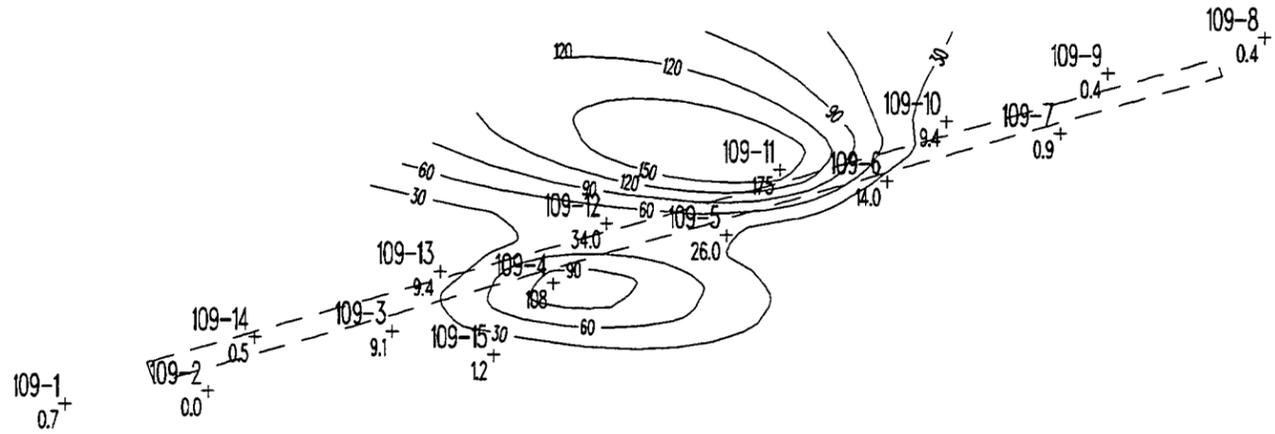
DATE: February 09, 1994

DRAWN BY: DDJ/KJS

APPROVED BY: *Hc*

CHECKED BY: *Hc*

T 903 A



109-1 + Soil Vapor Survey Sampling Locations PCE, (ug/L)

5 FOOT SAMPLE DEPTH

03091 Boreholes

..... IHSS 155 Border

— Soil Vapor Survey Work Plan IHSS 109 Border

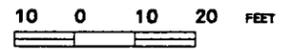
○—○ Fence

--- Edge of Road

— Building

Contour Interval = 30 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.

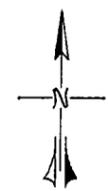
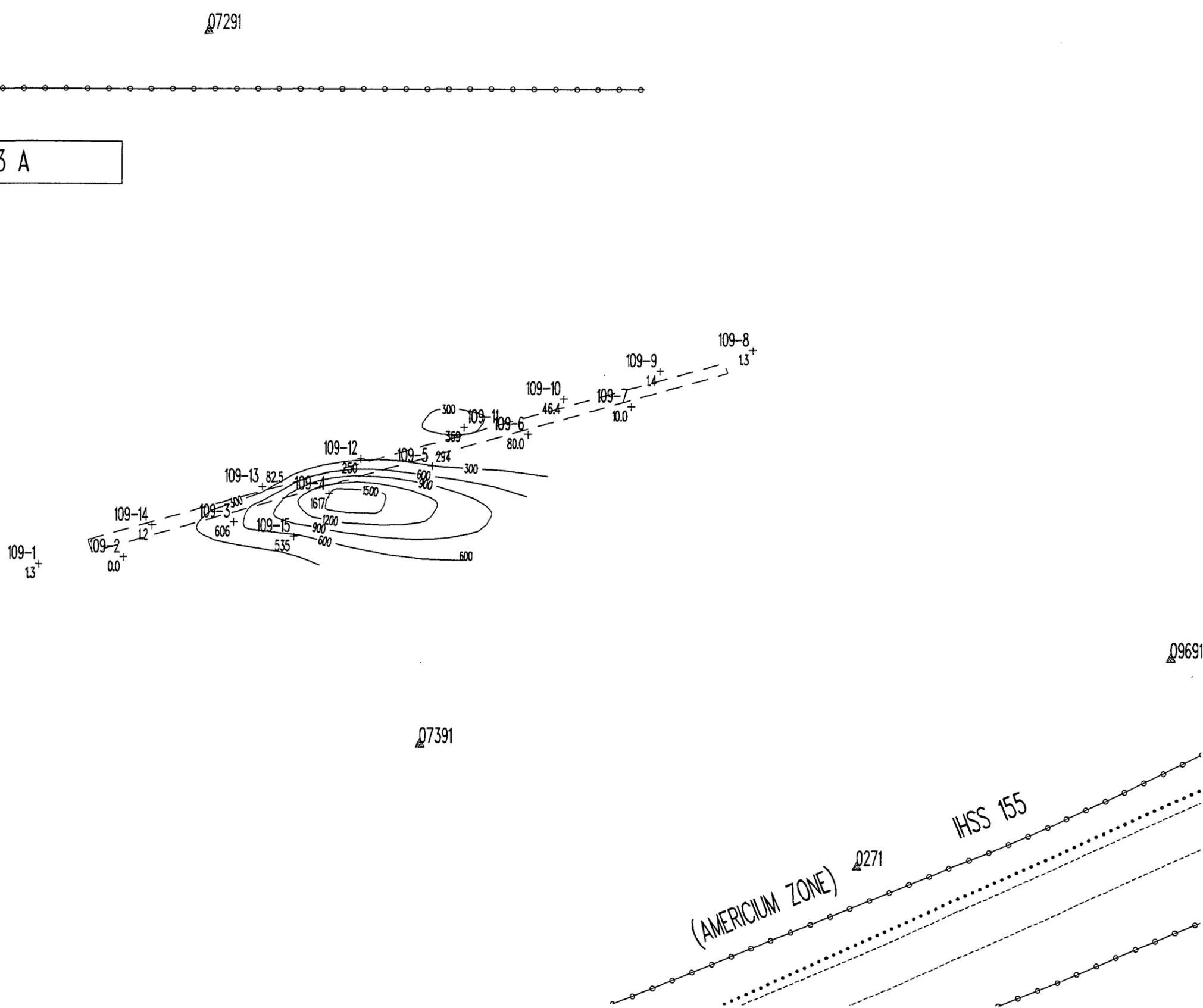


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FIGURE C-11 IHSS 109 Perchloroethene (PCE) ISOCONCENTRATION CONTOUR MAP AT 5 FOOT DEPTH

(AMERICIUM ZONE) 0271 IHSS 155

T 903 A



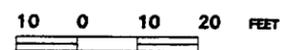
109-1+  
0.0+ Soil Vapor Survey  
Sampling Locations  
Total VOCs, (ug/L)

5 FOOT SAMPLE DEPTH

- 03091 ▲ Boreholes
- ..... IHSS 155 Border
- Soil Vapor Survey Work Plan IHSS 109 Border
- Fence
- - - Edge of Road
- Building

Contour Interval = 300 ug/L

NOTE: THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS.

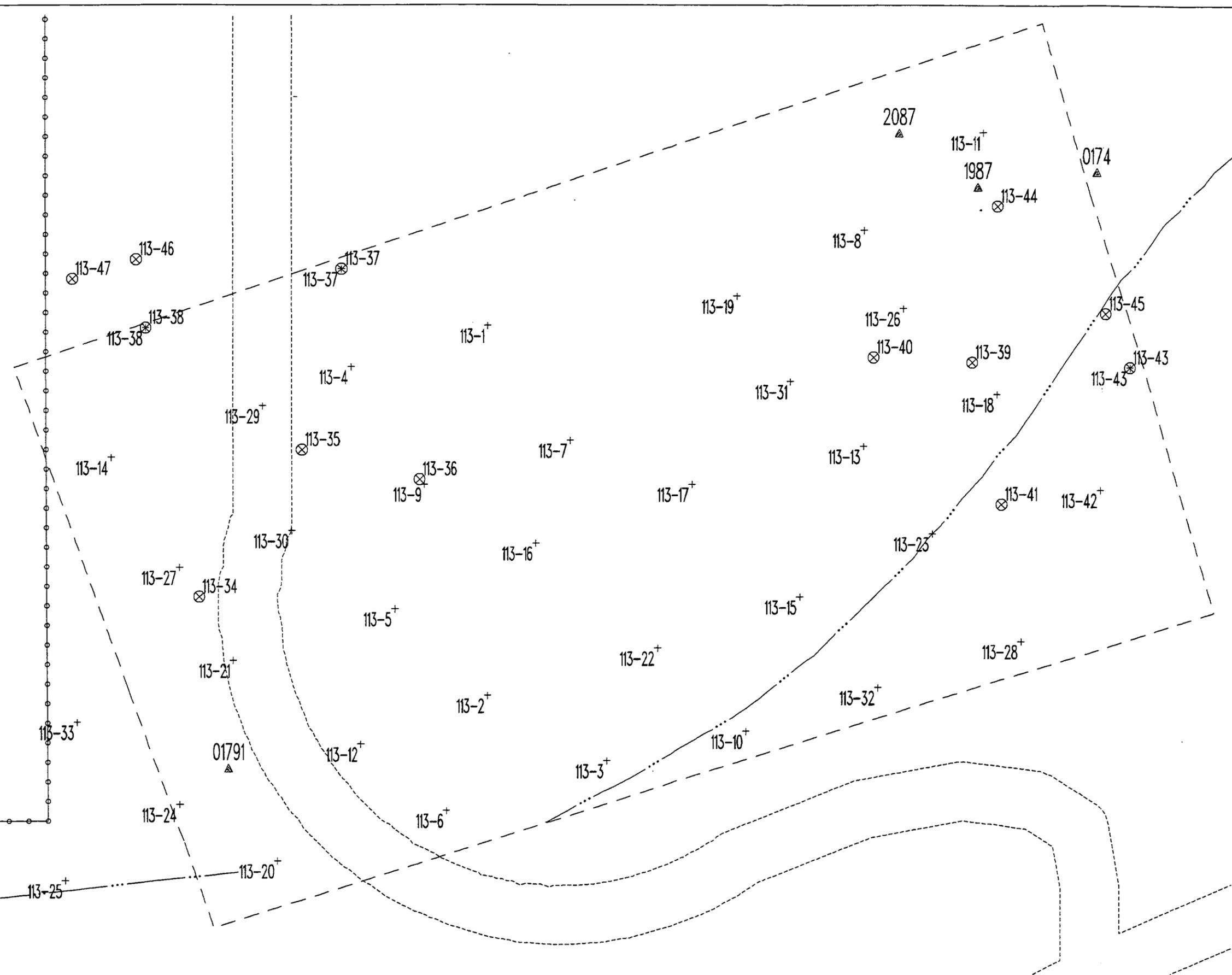


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FIGURE C-12 IHSS109  
Total VOCs  
ISOCONCENTRATION  
CONTOUR MAP  
AT 5 FOOT DEPTH

CHECKED BY: *[Signature]* APPROVED BY: *[Signature]* DRAWN BY: DDJ/KJS DATE: February 10, 1994 FILENAME: /arc/dbto/soil/vapor/i135/svs2802.cml REVISION NO: 2

PROTECTED AREA



Soil Vapor Survey Sampling Locations

- 113-1+ 5 Foot Sample Depth
- 113-46 10 Foot Sample Depth
- 1987 Boreholes
- Soil Vapor Survey Work Plan IHSS 113 Border
- Fence
- ... Drainage
- - - Edge of Road

10 0 10 20 FEET

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FIGURE C-13  
IHSS 113  
SAMPLE LOCATION MAP