Soil Vapor Intrusion Sampling
Building 101
Former Griffiss Air Force Base
Rome, New York

FINAL

WORK PLAN

DEPARTMENT OF THE AIR FORCE
MCMXLVII
UNITED STATES OF AMERICA

Contract No. DACW41-02-D-0020
Delivery Order No. 0002

Revision 0.0
September 2006

FPM group

FPM group Engineering and Environmental Science

FPM Group, Ltd.
FPM Engineering Group, P.C.
formerly Fanning, Phillips and Molnar

153 Brooks Road
Rome, NY 13441
315/336-7721
FAX 315/336-7722

September 22, 2006

Nanci E. Higginbotham
Environmental Program Manager
CEMWK-PM-ED
601 East 12th Street
Kansas City, MO 64106-2896

RE: Final Work Plan
Soil Vapor Intrusion Sampling: Building 101
Former Griffiss Air Force Base, Rome, New York
Contract No. F41624-03-D-8601-DH01
Revision 0.0
September 2006

Dear Ms. Higginbotham,

FPM Group, Ltd. (FPM) is pleased to submit two (2) copies of the above-referenced Final Work Plan for Soil Vapor Intrusion Sampling at Building 101 at the former Griffiss Air Force Base, Rome, New York. This final addresses comments received from AFRPA, USACE and USEPA.

If you have any questions or require additional information, please call me 315-336-7721 ext. 202, or e-mail me at g.atik@fpm-group.com.

Very truly yours,

Gaby A. Atik, P.E.
Director, Regional Operations

Enc.
cc: Amy Darpinian, USACE (1 copy)
ARFPA/DA-Griffiss (3 copies)

DEPARTMENT OF DEFENSE UNITED STATES OF AMERICA

DEPARTMENT OF THE AIR FORCE
AIR FORCE REAL PROPERTY AGENCY

MEMORANDUM FOR SEE DISTRIBUTION

FROM: AFRPA - Griffiss
Environmental Section
153 Brooks Road
Rome, NY 13441-4105

SEP 21 2006

SUBJECT: Final Work Plan for Soil Vapor Intrusion Sampling - Building 101

1. Enclosed, the attached subject final work plan, dated September 2006, is provided in support of investigative efforts that will be performed in the vicinity of the Building 101 Area of Concern at the former Griffiss AFB, by FPM Group, Inc. Responses to comments from the regulatory agencies on the draft work plan are included.

2. Please note that based on current Air Force policy, only soil vapor and sub-slab sampling will be performed during the initial phase of the work. Only after the initial sampling results have been evaluated, to confirm or refute the presence of soil vapor indicators, will the indoor and outdoor (ambient) air sampling phase of the work plan commence.

3. Questions that you may have pertaining to the final work plan may be directed to Mark Rabe of my environmental staff at the above address or at (315) 330-2275.

MICHAEL F. MCDERMOTT
BRAC Environmental Coordinator

Enc:
As noted

DISTRIBUTION

US Environmental Protection Agency-Region II
Attn: Mr. Douglas Pocze
Federal Facilities Section
290 Broadway, 18th Floor
New York City, NY 10007-1866

NYS Department of Environmental Conservation
Attn: Ms. Heather L. Bishop
Division of Environmental Remediation
625 Broadway, 11th Floor
Albany, NY 12233-7015

NYS Department of Health
Attn: Mr. Gregory Rys
5665 NYS Route 5
Herkimer, NY 13350

Certification of Compliance

On behalf of FPM Group, Ltd. (FPM), the undersigned certify that the document(s) listed below were developed in conformance with FPM's Quality Control Plan, and further, that the work was performed in accordance with acceptable standards of engineering and scientific practice. Comments made by reviewers will be maintained in the project files in accordance with company policy.

Final Work Plan
Soil Vapor Intrusion Sampling
Building 101
Former Griffiss Air Force Base
Rome, New York
Revision 0.0
September 2006

Contract Number: F41624-03-D-8601
Task Order No.: DH01

Prepared for:

U.S. Army Corps of Engineers
Kansas City District
601 East 12th Street
Kansas City, Missouri 64106

Concordia R van Hoesel MVH
Concordia R. van Hoesel
Technical Peer Reviewer

9/22/2006
Date

Niels D. L. van Hoesel
Editorial Reviewer

9/22/06
Date

Gaby A. Atik, P.E.
Project Manager

9/22/06
Date

FINAL

WORK PLAN

Prepared for:

Soil Vapor Intrusion Sampling
Building 101
Former Griffiss Air Force Base
Rome, New York

through

United States Army Corps of Engineers
Kansas City District
Kansas City, MO 68102

Prepared by:

FPM Group, Ltd.
153 Brooks Road
Rome, NY 13441

Project No. 32-04-02

Revision 0.0
September 2006

RESPONSE TO COMMENTS
on
Draft Work Plan, Soil Vapor Intrusion Sampling
Building 101, Revision 0.0, March 2006
Contract # DACW41-02-D-0020
(Doug Pocze, USACE)
May 19, 2006

#Comment	Comment
1	The Work Plan references the Guidance for Evaluating Soil Vapor Intrusion in the State of New York, NYS Department of Health (NYSDOH). Please clarify if this is the guidance that is being followed for this sampling assessment. In addition, please clarify if the USEPA's Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (VI Guidance) (2002) was also evaluated and utilized for this sampling event. **Response**: While the Draft EPA guidance was consulted, the plan was prepared to specifically address NYSDOH concerns and methodology.
2	The Work Plan proposes to collect only three sub-slab soil gas data points, two subsurface soil gas data points, and three indoor air data points during a single round of sampling. A data set of this size is unlikely to support certain defensible statistical evaluations - such as the estimation of an upper-bound estimate on the mean. Please clarify if the Air Force is proposing to utilize maximum detected concentrations in any future assessment of potential risk or health hazard. In addition, the NYSDOH notes that "multiple rounds of sampling may be required to characterize the nature and extent of subsurface vapor contamination. Please provide a specific evaluation criteria for the data, that would establish whether additional sub-slab soil gas and/or indoor samples would or would not be required to address the following questions: - Are subsurface vapors contaminated? If so, what are the nature and extent of contamination? What is/are the source(s) of the contamination? - What are the current and potential exposures to contaminated subsurface vapors? - What actions, if any, are needed to prevent or mitigate exposures and to remediate subsurface vapor contamination? **Response:** The level of effort that is proposed is to determine if an SVI issue exists or not. That is, the level of effort is commensurate with screening a site and not a Remedial Investigation (RI). The Air Force has not determined a need to delineate or assess the risk of/due to soil vapor.
3	The Work Plan has provided laboratory reporting limits (RLs) in the attached standard operating procedures. Some of these RLs do not achieve the EPA VI Guidance detection limits listed in Table 2c satisfy Prescribed Risk Level and/or Target Hazard Index for indoor air concentrations (e.g., vinyl chloride). Please propose a method to address this concern if the RLs for the TO-15 method are above EPA VI Guidance Table 2c listed concentrations, or to state that this concern will be addressed in a future document. **Response:** The Laboratory and SOP have been changed to achieve lower

#Comment	Comment
	detection limits.
4	Table 4-2, Page 10: This Table lists the proposed field duplicates and total number of samples. The proposed number of samples is "at least 10." Please note, EPA usually collects at least 1 duplicate per every 10 samples. Since the Work Plan indicates in Table 4-1 that "additional samples may be required", it is possible that more than 10 samples will be collected, and that the number of field duplicates may need to be increased. Please revise the Work Plan to propose the collection of field duplicates based upon the total number of samples collected, rather than to propose a fixed number of duplicate samples. **Response:** At least 1 duplicate per every 10 samples will be collected.

RESPONSE TO COMMENTS
on
Draft Work Plan, Soil Vapor Intrusion Sampling
Building 101, Revision 0.0, March 2006
Contract # DACW41-02-D-0020
(Heather Bishop, NYSDEC and
Gregory Rys, NYSDOH)

On September 20th, the AFRPA (Mark Rabe) contacted NYSDEC (Heather Bishop) by phone to inquire if the NYSDEC had any comments on the draft WP for Soil Vapor Intrusion Sampling at Building 101. The response was that neither NYSDEC nor NYSDOH had any comments on this WP.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

A – Sampling Forms
B – Centek Labs Standard Operating Procedure (SOP), EPA Method TO-15

1.0 INTRODUCTION

FPM Group, Ltd. (FPM) has been contracted by the United States Army Corps of Engineers (USACE) to assist the Air Force in addressing soil vapor intrusion (SVI) concerns at the former Griffiss Air Force Base (GAFB). This Work Plan (WP) establishes the field investigation tasks necessary to perform soil vapor, sub-slab, and indoor air sampling at the Building 101 Area of Concern (AOC).

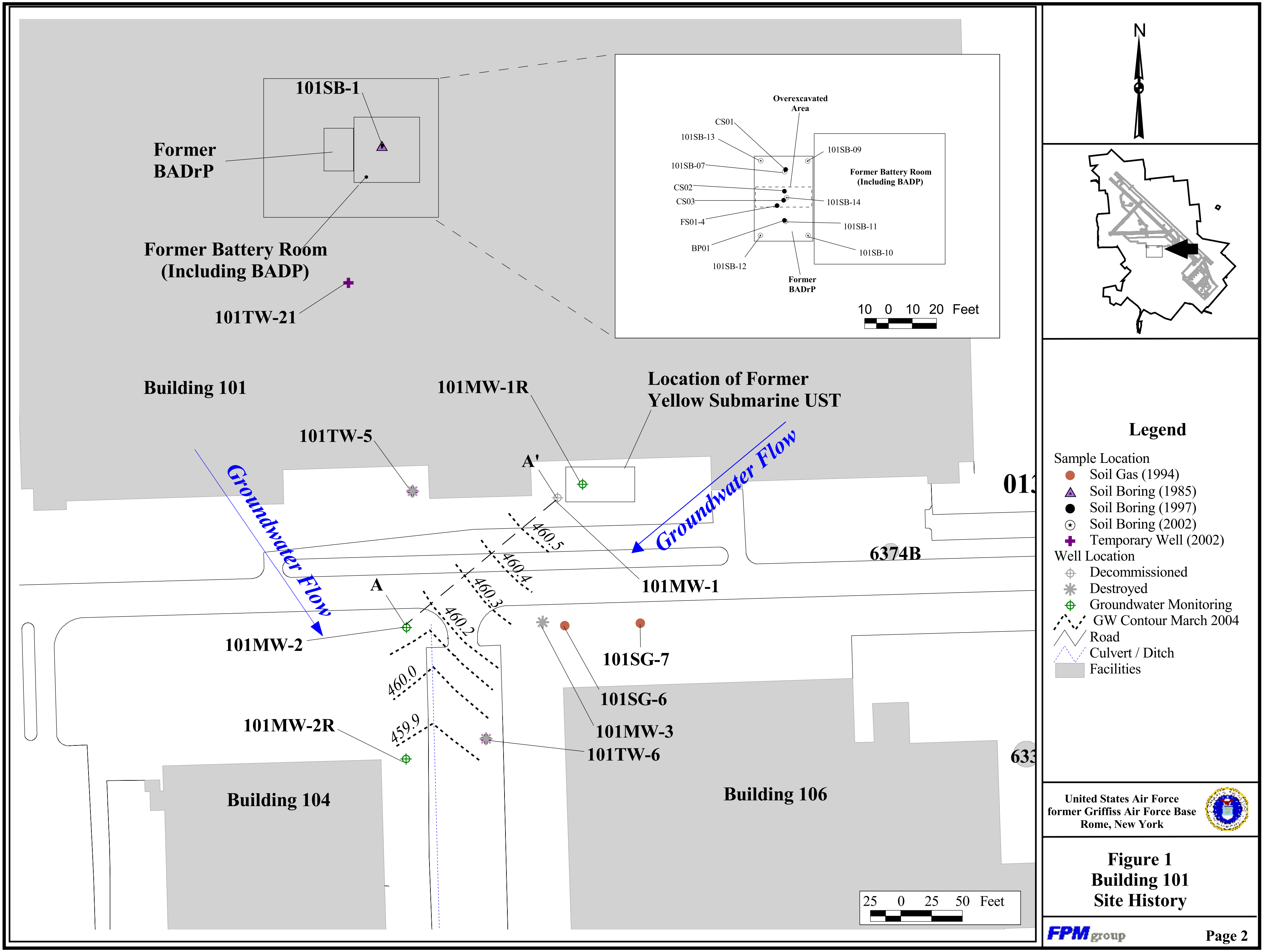
The purpose of the soil vapor sampling is to confirm the absence of volatile organic compounds (VOCs) in the soil vapor from source areas associated with the Building 101 AOC, and to address the potential for the soil vapor intrusion pathway into Building 101. Constituents of concern (COCs) reported in previous investigations for the site include chlorinated ethenes and chloroform. Concentrations of these COCs have substantially stabilized at levels close to or below New York State (NYS) Groundwater Standards (FPM, August 2005). A more detailed history of the Building 101 AOC is provided below.

2.0 SITE BACKGROUND

The Building 101 AOC includes the Battery Acid Disposal Pit (BADP), a Battery Acid Drainage Pit (BADrP), and the Yellow Submarine Underground Storage Tank (UST). The site is located south of Apron 3, in the central portion of the former GAFB. Figure 1 illustrates the building, together with the location of site features, existing monitoring wells, temporary wells, and groundwater contours.

The former BADP was located in the central portion of the building in an area designated as the Lead Battery Room. The BADP was in use from the early 1940s until 1985, when it was excavated. The BADP consisted of a pit beneath the concrete floor and was covered with a steel grate. Acids from spent batteries were neutralized with baking soda and poured into the BADP, where the neutralized liquid was allowed to percolate into the underlying soils. A 4-inch overflow pipe ran west from the BADP to the BADrP which was located beyond the west wall of the Lead Battery Room. Following the removal of the BADP, a new 4-inch floor drain was installed and piped to the BADrP. Investigation and remedial activity of the drainage pit was completed during closure activities from June 1997 through January 1998. Remedial activities consisted of the removal of residual sludge from the BADrP with subsequent removal of the concrete pit floor and underlying soils. Following the removal and endpoint sampling, the drainage pit was backfilled and sealed with concrete (OHM, July 1998).

The Yellow Submarine UST, which was located 15 feet from the south edge of Building 101, was used as a holding and dilution tank for plating wastes from a metal plating shop housed in Building 101, until June 1993 when it was excavated (LAW, December 1996).

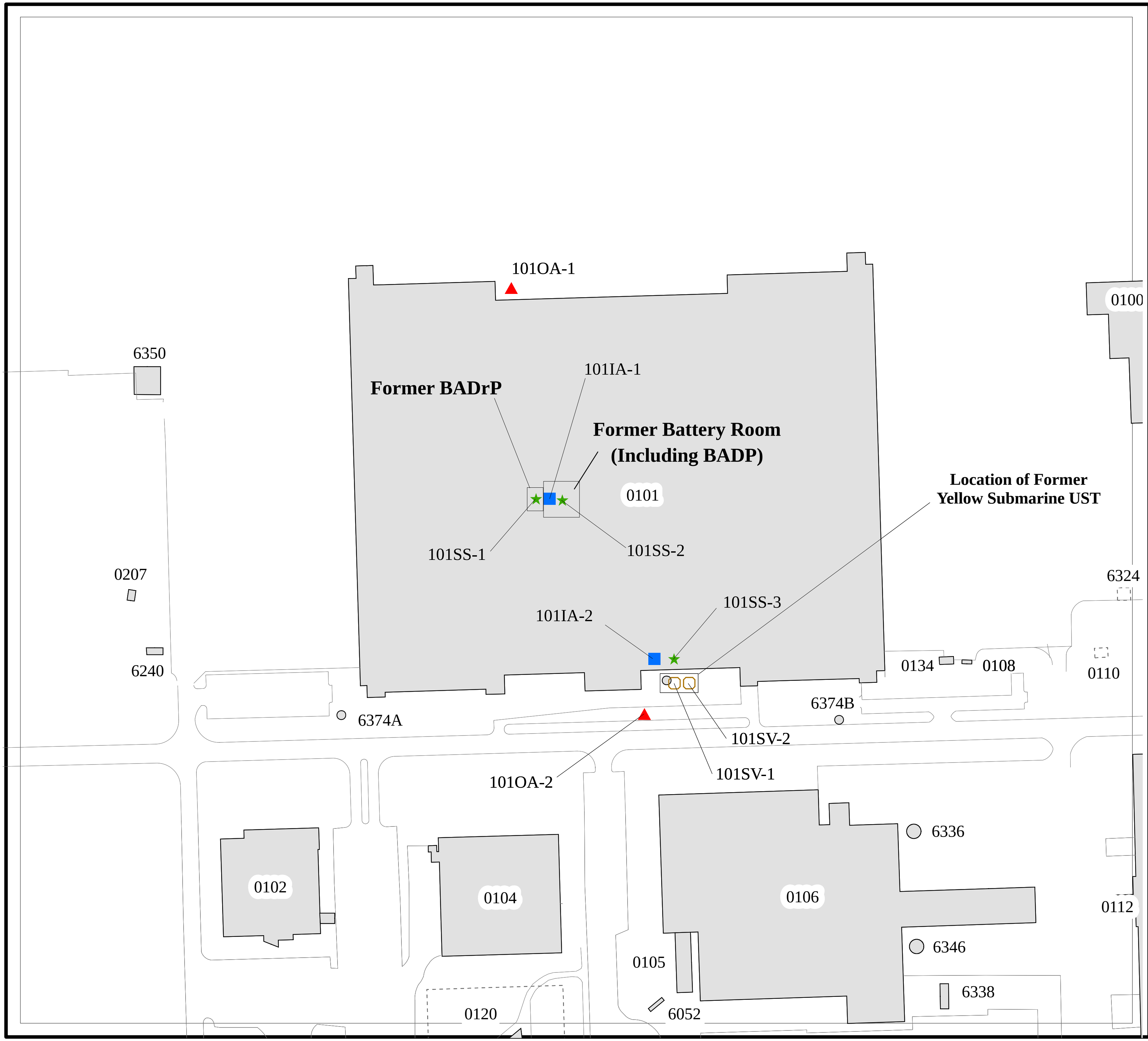


United States Air Force
former Griffiss Air Force Base
Rome, New York

Figure 1
Building 101
Site History

FPM group

Y:\\GIS_Projects\Griffiss\40-05-27\Vapor\B101 site loc map.apr

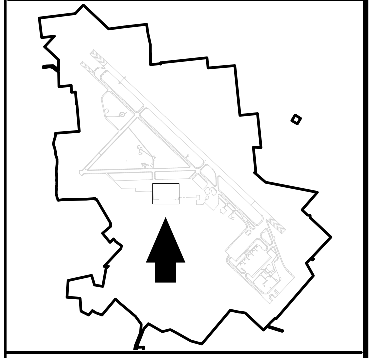


SCALE

0 200

Feet

N



Key Features

🟦 Indoor Air

🔺 Outdoor Air

○ Soil Vapor

★ Sub Slab

— Road

— Airfield

Facilities

0101 Existing

⬚ Demolished

Note:
1) Outdoor air sample locations are approximate and shall be based on wind direction.
2) Exact locations of indoor air samples to be determined on-site.

United States Air Force
Former Griffiss Air Force Base
Rome, New York

Figure 2
Building 101
Site Sampling Locations

2.1 Building Setting

Building 101 is a large steel aircraft hanger. It was built in 1943 and used for maintenance and upkeep of U.S. Air Force bombers and tankers before Griffiss AFB closed in 1995. The building consists of four aircraft bays (two on the east and two on the west side) with multiple offices, shops, storage rooms and other rooms within the footprint of the building. Each aircraft bay is 83 ft high at its highest point and over 200 ft wide. The concrete slabs inside the aircraft bays are 16-inch reinforced concrete on top of an 8-inch gravel base. The current HVAC system consists of six blast heaters, installed three along each side, in each aircraft bay with a design flow of 6,000 CFM each. Several other HVAC systems are installed in the offices and machine shops (including snorkels and dust collectors).

The total square footage of the footprint is 470,532 ft^2 or approximately 10.8 acres. In 2003, Empire Aero Center (an aircraft maintenance company) relocated to Building 101. The building was expanded 50 feet on the west side to accommodate the much larger Boeing 747 aircraft.

2.2 Hydrogeological Setting

The Building 101 AOC, consisting of the former BADP and the 12,000-gallon UST south of Building 101, has a topographic relief of less than 1 foot across the site. The soils below 0.5 feet of asphalt and concrete are characterized by borings as predominantly brown to gray, fine to medium sand with silt and gravel. Subsurface soils encountered range from predominantly gray to brown gravelly sand to gray and brown, fine to coarse sand with variable silt and gravel.

Building 101 is located approximately 3,200 feet north of Three Mile Creek (LAW, December 1996). Runoff from the site is intercepted at the site and conveyed by the storm drains running north-south to Three Mile Creek.

As reported in the Baseline Study (FPM, July 2000), the storm drains intercept the water table along their north-south course. Groundwater contouring in this area (March 2004 contours shown in Figure 1) reflects groundwater drainage to the storm drain system. The influence of the storm drains on groundwater flow is as a constant-head line sink. This causes an acute shape to the contour lines in the vicinity of the storm drains. Groundwater discharge to the storm drains may be intermittent and varies in extent because of fluctuations of the water table in relation to the storm drain invert elevation (458.6 ft MSL).

Measurements in the December 1998 Base-wide synoptic indicated groundwater depths adjacent to Building 101 were fairly level, varying from 14.14 ft bgs in monitoring well 101MW-4 located on the north to 13.63 ft bgs to the south (FPM, July 2000). A groundwater gradient indicates that the groundwater flow in the general Building 101 area is southwesterly. Water level measurements collected during the long-term monitoring (LTM) sampling rounds indicate the same flow direction.

The reported average site-specific hydraulic conductivity (K) for the Building 101 area was 18.4 feet per day, with a hydraulic gradient of 0.0028 feet per foot. Estimating the porosity to be 20 percent, the groundwater flow was calculated to be 94 feet per year (LAW, December 1996).

3.0 SUMMARY OF PREVIOUS INVESTIGATIONS

In accordance with the guidance document, "Guidance for Evaluating Soil Vapor Intrusion in the State of New York," issued by the NYS Department of Health (NYSDOH), results of individual soil vapor, sub-slab vapor, indoor air and outdoor air samples should not be reviewed in isolation, but are to be evaluated in conjunction with the data available from all environmental media associated with the contamination at the site. Therefore, previous soil, soil gas and groundwater investigations are pertinent to the results obtained during the SVI sampling event, and a summary of these historical results is provided below.

3.1 BADP Sampling

Soil sampling of the BADP conducted in 1985 before any removal actions were conducted by Roy F. Weston Inc. found high concentrations of antimony (193 mg/kg), lead (83,000 mg/kg), copper (784 mg/kg), and zinc (262 mg/kg) (101SB-1). A 1994 analysis at soil sample location 101SB-1 detected various metals as well as tetrachloroethylene (also known as perchloroethylene or tetrachloroethylene) (PCE) (0.8 µg/kg), toluene (3 µg/kg), and polynuclear aromatic hydrocarbon (PAH) compounds; of these, benzo(a)pyrene, phenol, and six metals (including antimony, arsenic, lead, and mercury) exceeded soil to-be-considereds (TBCs) (LAW, December 1996).

3.2 BADrP Closure

In 1997, OHM preformed a removal action at the BADP. During these closure activities of the adjacent BADrP (located inside Building 101, see Figure 1), soil samples collected after the removal action indicated the presence of several semivolatile organic compounds (SVOCs) and metals. All of the constituents detected were below their respective NYSDEC guidance level (as found in the Technical and Administrative Guidance Memorandum [TAGM] 3028), with the exception of 1,4-dichlorobenzene at 100 mg/kg. The entire pit including all concrete walls and floor and 3 ft of soil beneath the pit floor were removed. Confirmatory sampling indicated 1,4-dichlorobenzene was below its respective TAGM 3028 level of 8.5 mg/kg (OHM, July 1998) During most of these sampling events, the results of the soil sampling were compared to TAGM 3028 action levels, and few exceedances were encountered. However, the Air Force later determined that this site falls under CERCLA regulatory guidance, and the action levels were replaced by the recommended soil cleanup objectives in TAGM 4046. When the above results were compared to TAGM 4046 action levels, exceedances were indicated in several cases. Therefore, one additional sampling event to compare the existing soil concentrations beneath the former BADrP to TAGM 4046 levels was necessary to determine whether closure is appropriate for the site.

In June 2002, this soil and groundwater confirmatory sampling was conducted at the Building 101 BADrP and the soil and groundwater samples were analyzed for VOCs, SVOCs, metals and polychlorinated biphenyls (PCBs) and compared to TAGM 4046.. No VOC or PCB exceedances were reported at the seven soil sampling locations. The only SVOC reported at levels exceeding TAGM was phenol, reported at 310 F µg/kg (F indicating the detection was below the reporting limit [RL] of 330 µg/kg) detected at one soil boring location (101SB-10, not shown in figure) at the 4 to 6 ft interval. The detected concentration is within one order of magnitude of the TAGM cleanup objective (30 µg/kg).

Three metals were reported at levels exceeding their respective TAGM and/or Background Soil Screening Levels (from the RI, LAW, December 1996) at two sampling locations: cadmium, mercury and silver were reported in the 4 to 8 ft interval. Each of the three metals exceedances was within one order of magnitude or less of the respective TAGM cleanup objective or site background level. While cadmium and silver were found at levels exceeding their respective TAGM cleanup objectives, the levels measured at the two sample locations are below EPA Region III Residential Risk-Based Concentrations, which are 39 mg/kg for cadmium and 390 mg/kg for silver. Mercury slightly exceeds the TAGM cleanup objective, but the mercury level in the deeper sample was below the TAGM cleanup objective (0.03 mg/kg).

Neither VOCs, SVOCs, nor PCBs were reported above NYSDEC Groundwater Standards in the single temporary well installed during the June 2002 investigation (located approximately 100' south of the BADP, as shown in Figure 1). The amount of suspended solids observed during groundwater sample collection is believed to have compromised the integrity of the sample for metals evaluation.

In summary, the 2002 confirmatory sampling results indicate that the 1997 removal action was successful at eliminating the majority of the residual soil contamination, as shown in the 2002 confirmatory sampling. The small number of slight metal exceedances reported in 2002 likely are attributable to suspended solids in the samples.

3.3 Yellow Submarine UST

Monitoring well 101MW-1, located near the Yellow Submarine UST, was sampled three times during the 1992-1993 quarterly groundwater sampling program; PCE, TCE, manganese, and zinc were detected at concentrations up to 290 micrograms per liter (µg/L), 270 µg/L, 2.44 mg/L, and 0.363 mg/L, respectively. The UST was excavated and removed in June 1993, and confirmatory soil samples collected during the removal action showed metal and PCE (10 µg/kg) contamination. The results of the Remedial Investigation (RI) [Law, 1996] (from samples collected in June 1994) reported the PCE concentration in monitoring well 101MW-1 at 7.7 µg/L, a marked decline from 290 µg/L (measured in June 1993). Groundwater samples from monitoring well 101MW-2 (also collected in June 1994), located south and downgradient of

Building 101, had concentrations of 130 µg/L of chlorinated solvents, comprised mostly of cis-1,2-DCE (120 µg/L).

3.4 Soil Gas Sampling

In May-June 1994, a soil gas investigation was performed at the Building 101 Yellow Submarine UST by Target Environmental Services, Inc. after the UST was removed, to determine the extent of soil gas/groundwater contamination at this AOC. Soil gas samples were collected from 30 locations from a 400 ft by 200 ft grid from a depth of 2 to 4 ft below ground surface (bgs). The results indicate a total flame ionization detector (FID) volatiles detection of 28 µg/L at 101SG-6 and ethylbenzene and total xylenes at less that 5 µg/L at 101SG-7. No analytes were observed above the reporting limit in any of the other samples. For more details regarding this investigation, refer to the RI (Law, December 1996).

3.5 Post-RI Groundwater Sampling

Groundwater sampling during the Supplemental Investigation (SI) [E&E, November 1998] reported chloroform concentrations in both wells 101MW-1 and 101MW-3 at 19 µg/L. TCE was also detected in wells 101MW-1 (where PCE was also found), 101MW-2, 101MW-3, 101TW-5, and 101TW-6, although all levels were below cleanup criteria.

Due to construction activities related to the widening of Hangar Road in 1998, monitoring wells 101MW-1 and 101MW-2 were replaced by newly installed wells 101MW-1R and 101MW-2R, respectively. 101MW-2 was rediscovered in 2001 and added to the long-term monitoring (LTM) well sampling list. During the Baseline Study (FPM, July 2000), PCE and TCE were detected in all four rounds in well 101MW-1R at levels below cleanup criteria. cis-1,2-DCE was reported at 0.2 F µg/L in the January 1999 sampling round and was undetected in the following three sampling rounds. TCE was also detected in wells 101MW-2R and 101MW-3, but no samples exceeded the NYS Groundwater Standard or the reporting limit of 1.0 µg/L. No VOCs were detected above NYS Groundwater Standards in monitoring well 101MW-2R. This result suggests that the TCE contamination does not migrate beyond the 42-inch storm drain from the direction of the UST. No exceedances were reported for upgradient monitoring well 101MW-4 in any of the Baseline Study sampling rounds.

Samples collected during the Baseline Study from monitoring wells 101MW-1R and 101MW-3 in January 1999 showed decreases from the chloroform concentrations from the 19 µg/L reported during the SI to 4.72 µg/L and 6.33 µg/L, respectively. Subsequent sampling for chloroform showed an increase in concentration to 11.4 µg/L in well 101MW-3 in August 1999. Concentrations of chloroform in well 101MW-1R generally showed a decrease to a level of about 2 µg/L for the remainder of 1999 (FPM, July 2000). Chloroform was also detected in well 101MW-2R below the NYS Groundwater Standards. The chloroform detections are likely to be associated with potable water leaks from a nearby water supply main; potable water commonly contains chloroform (E&E, November 1998).

For LTM, quarterly groundwater sampling was conducted from September 2001 through September 2005 (in total, 17 sampling rounds thus far) and is ongoing. Wells 101MW-1R, 101MW-2, 101MW-2R, and 101MW-3 were included in the LTM sampling list, but 101MW-3 was decommissioned in November 2002. Throughout these sampling rounds, only cis-1,2-DCE has been reported at levels exceeding its NYS Groundwater Standard (5 µg/L), only at monitoring well 101MW-2. Throughout the LTM sampling rounds, exceedances for cis-1,2-DCE ranged from 7.5 µg/L in March 2005 to 26 µg/L in December 2001 (levels have been generally decreasing over time, with some seasonal variability). During the following sampling rounds, no VOC exceedances were reported: September 2002, December 2003, and September 2004.

As recommended in the August 2005 monitoring report (FPM, August 2005), Hydrogen Release Compound (HRC®) was injected at Site Building 101 in December 2005. Five injection points spaced 12.5 ft apart were used and HRC® was injected from 20 to 10 ft bgs with an application rate of 8 pound of product per ft of depth, as recommended by the manufacturer. The HRC® application should augment the natural attenuation of cis-1,2-DCE and decreased detections of chlorinated hydrocarbons are expected in future sampling rounds.

4.0 PROPOSED SAMPLING ACTIVITY FOR THE SOIL VAPOR INTRUSION PATHWAY

The objective of the sampling is to investigate the potential for the soil vapor intrusion pathway into Building 101 and to address the potential for current human exposures. This is an initial survey aimed at determining presence/absence of a potential SVI issue. Initially, only soil vapor and sub-slab sampling will be performed. After evaluation of the sub-slab sampling results, the indoor and outdoor (ambient) air sampling plan will be reassessed.

The investigation shall include the collection of the following:

- Subsurface vapor samples from the former Yellow Submarine UST source area of the Building 101 AOC,
- Sub-slab vapor sample(s) from beneath Building 101 (i.e., from beneath the former source areas: the BADP, BADrP, and the indoor area closest to the former Yellow Submarine UST), and
- Indoor/outdoor air samples.

Each type of sample is proposed to be collected in a single sampling event to enable a single mobilization and to minimize disturbances to building operations (the building is currently in use). Table 4-1 summarizes the proposed field activities. Figure 2 shows the proposed sample locations.

Table 4-1
Soil Vapor Intrusion Pathway Investigation at Building 101
Field Activity Summary

Activity	Rationale	Analytical Parameters
Collection of two subsurface vapor samples from the former Yellow Submarine UST source area associated with the Building 101 AOC.	Subsurface vapor samples collected in the source areas are most likely to address the potential for current on-site or off-site exposures.	VOCs – EPA TO-15
Collection of three sub-slab vapor samples from Building 101, one from each of the source areas: the former BADP, the former BADrP, and the indoor area closest to the former Yellow Submarine UST. Additional samples may be required, if, after a site walkover, floor cracks or additional sub-slabs are noted. The sub-slab vapor samples shall be collected simultaneously with the indoor/outdoor air samples.	Sub-slab vapor samples shall be collected to evaluate the potential for current human exposures within Building 101. Samples will also help to evaluate the indoor air results adequately. The results shall indicate whether closure with regard to the soil vapor intrusion pathway is appropriate.	VOCs – EPA TO-15
Collection of two indoor air samples within Building 101 (in the vicinity of the former BADP and BADrP and one near the Yellow Submarine). The exact number of samples shall be verified after site walkover. The indoor air samples shall be collected simultaneously.	Indoor air samples shall be collected to evaluate current human exposures. Should indoor air samples indicate VOCs that are not present in sub-slab vapor samples, either additional sub-slab vapor samples shall be collected, or other sources (i.e., from within the building) shall be suspected.	VOCs – EPA TO-15
Collection of two outdoor air samples outside of Building 101. The two outdoor air samples shall establish background and shall be collected simultaneously with the indoor air samples.	Outdoor air samples shall be collected to characterize the site-specific background air conditions, and to specifically evaluate the extent to which outdoor sources may be influencing indoor air quality. Outdoor air samples shall serve as ambient blanks for this investigation.	VOCs – EPA TO-15

In accordance with the guidance documents, “Guidance for Evaluating Soil Vapor Intrusion in the State of New York,” issued by the NYS Department of Health (NYSDOH), VOCs in air samples shall be analyzed using Method TO-15. The NYSDOH advises the full list of analytes for this sampling event, since prior soil vapor, sub-slab vapor, and/or indoor samples were collected over 10 years ago and significant building has been performed on the site since then. A sample analysis summary is provided in Table 4-2. Sample methodology is described in Section 5.0. The samples shall be collected and handled in accordance with the protocols as specified in the NYSDOH Guidance Document (NYSDOH, February 2005) and analyzed by the laboratory using EPA Method TO-15. The laboratory’s Standard Operating Procedure (SOP) for Method TO-15 is included in Appendix B. All data will then be reviewed and evaluated in accordance with these procedures, and the laboratory’s standard qualifiers would apply.

Table 4-2
Soil Vapor Intrusion Pathway Investigation at Building 101
Sample Analysis Summary

Analyte/ EPA Method Numbers	Sample Type	No. of Samples	No. of Field Dups./Reps.	No. of Trip Blanks	Total No. of Samples
VOCs – EPA TO-15	Subsurface Vapor	2	--[1]	--[1]	At least 10
VOCs – EPA TO-15	Sub-slab Vapor	3	--[1]	--[1]	
VOCs – EPA TO-15	Indoor Air	3	--[1]	--[1]	
VOCs – EPA TO-15	Outdoor Air	2	--[1]	--[1]	

[1] One trip blank is required per cooler containing VOCs. One field duplicate sample shall be collected as either a subsurface vapor or a sub-slab vapor sample.

Subsurface utilities will be identified through the acquisition of “Work Clearance Requests” (i.e., dig permits) that will be coordinated through the Air Force Real Property Agency (AFRPA).

The Health and Safety Plan associated with the Work Plan for the AOC Long-Term Monitoring Program (FPM, 2003b) will be operational in conjunction with this Work Plan.

5.0 DESCRIPTION OF SAMPLING METHODOLOGY

The sampling methodologies provided below were adapted from the NYSDOH SVI guidance document. Site-specific details and modifications are discussed, as applicable.

5.1 Soil Vapor Sampling

5.1.1 Temporary Soil Vapor Probe Installation and Abandonment

For the purposes of this investigation, it is not anticipated that multiple rounds of sampling shall be performed, so temporary soil vapor probes shall be installed. Two (2) soil vapor probes shall be installed in the footprint of the former Yellow Submarine UST. The installation procedure is as follows:

- A Geoprobe® shall be employed to attain a depth of at least 5 ft below ground surface (bgs) for each soil vapor probe. A 2.5-inch coring machine shall be used to core through the concrete prior to engaging the Geoprobe. If necessary; a hollow-stem auger can be used to attain the desired depth;
- Once the target depth is reached, the rods will be pulled up one foot, exposing the void space, and the sampling apparatus will be set up in the borehole;
- New ¼-inch laboratory grade polyethylene tubing equipped with a threaded stainless steel fitting will be attached to a disposable soil vapor drive point to prevent infiltration of the atmospheric air present at land surface directly above the soil boring (ambient air);
- A clay seal will then be placed at land surface in the annular space between the Geoprobe® rods and the concrete surface, as well as between the tip of the rods and the sample tubing;
- The sampling tubing will be connected to a ‘T’ connector three-way valve assembly, with one end of the ‘T’ connector leading to a vacuum pump and the other end leading to a pre-evacuated summa canister with a calibrated regulator;
- The soil vapor sample tubing will then be purged of approximately two volumes of the sample tubing using a vacuum pump set at a rate of approximately 0.2 liters per minute;
- After sampling is completed, the borehole shall be abandoned by being tremie grouted to land surface using a bentonite grout, in accordance with the procedures described in Section 5.5.3, in the Field Sampling Plan associated with the Work Plan for the AOC Long-Term Monitoring Program (FPM, 2003a).

5.1.2 Soil Vapor Sample Collection

The sampling procedure described below shall be followed at each location to minimize discrepancies between sampling points:

- Prior to formal sample collection, a tracer gas (i.e., helium) shall be used to verify the integrity of the soil vapor probe seal. To do so:
    - ✓ The immediate vicinity of the area where the probe intersects the ground surface shall be exposed to tracer gas using a garbage bag, cardboard box, or plastic pail;
    - ✓ At least one implant volume (i.e., the volume of the sample probe and tube) shall be purged using a flow rate of not more than 0.2 L/min;
    - ✓ Using the same flow rate as the purge (i.e., less than 0.2 L/min), a vapor sample shall be collected from the probe using a Tedlar bag;
    - ✓ The Tedlar bag shall be fitted with a portable monitoring device (i.e., a Gas Check 3000 meter, which measures the rate of the helium leakage at the land surface) and screened for helium. The enriched area (i.e., within the garbage bag/cardboard box/plastic pail) will also be screened for helium.

    - ✓ If the concentration of helium is greater than 20% of the helium detected in the enriched area, the seal is not adequate and should be reset. The sample rods will be purged again until the helium is no longer detected at levels greater than 20% of the enriched area located directly above the borehole.
- Once the integrity of the seal has been verified, to ensure samples collected are representative, three implant volumes (i.e., the volume of the sample probe and tube) must be purged prior to collecting the sample;
- Flow rates for both purging and collecting shall not exceed 0.2 L/min to minimize outdoor air filtration during sampling;
- Following the purging, the valve leading to the pump will be closed, the pump will be turned off, and the soil vapor will be directed to a 100% certified 1-L Summa® canister provided by the laboratory. The sample shall be collected using the canister's regulator to restrict the sample collection rate.
- After sample collection, the soil vapor will be screened using a photoionization detector (PID), calibrated daily with a 100 parts per million (ppm) isobutylene standard.

The field sampling team must maintain a sample log sheet summarizing the pertinent sample information, and any relevant observations such as odors and readings from field instrumentation. A sample soil vapor probe sample log sheet is provided in Appendix A.

5.2 Sub-slab Vapor Sampling

5.2.1 Temporary Sub-slab Vapor Probe Installation and Construction

As noted in the NYSDOH guidance document, during colder months, heating systems should be operating at least 24 hours prior to and during the scheduled sampling time to maintain normal indoor air temperatures. Prior to installation of the sub-slab vapor probes, the building floor should be inspected and any penetrations (i.e., cracks, floor drains, utility perforations, sumps, etc.) should be noted and recorded. Probes should be installed at locations where the potential for ambient air infiltration via floor penetrations is minimal.

For the purposes of this investigation, it is not anticipated that multiple rounds of sampling shall be performed, so temporary sub-slab vapor probes shall be installed. A total of three (3) sub-slab vapor probes are anticipated for installation, one in each of the former source areas within Building 101: the former BADP, the former BADrP, and in the indoor area closest to the former Yellow Submarine UST. Care should be made to assure that each location is clear from foundation footings.

The installation procedure is as follows:

- A rotary hammer drill will be used to create small diameter holes through concrete and into sub-slab material (e.g., sand or sand and gravel). Drilling into sub-slab material will create an open cavity to prevent obstruction of probes by small pieces of gravel
- Probes will be constructed from dedicated ¼ inch-diameter laboratory grade polyethylene tubing;
- Tubing shall not extend further than 2 inches into the sub-slab material;
- The implant shall be sealed to the surface with permagum grout, melted beeswax, putty, or other non-VOC-containing and non-shrinking product;
- After sampling is completed, the borehole shall be abandoned in accordance with the procedures described in Section 5.5.3, in the Field Sampling Plan associated with the Work Plan for the AOC Long-Term Monitoring Program (FPM, 2003a).

5.2.2 Sub-slab Vapor Sample Collection

The sampling procedure described below shall be followed at each location to minimize discrepancies between sampling points:

- To ensure samples collected are representative, three implant volumes (i.e., the volume of the sample probe and tube) must be purged prior to collecting the sample;
- Flow rates for purging shall not exceed 0.2 L/min to minimize outdoor air filtration during sampling. Purge air shall be collected in a Tedlar bag so it is not released into the building;
- Samples shall be collected over an 24-hour time period, consistent with concurrent indoor and outdoor air samples, if possible;
- Samples shall be collected in 100% certified 6-L Summa® canisters provided by the laboratory.

The field sampling team must maintain a sample log sheet summarizing the pertinent sample information, the uses of VOCs in commercial or industrial processes and/or during building maintenance, weather conditions and ventilation conditions, and any relevant observations such as spills, floor stains, odors and readings from field instrumentation. A sample sub-slab vapor probe sample log sheet is provided in Appendix A.

In addition, floor plan sketches should be drawn that include the floor layout with sample locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system air supply and return registers, compass orientation (north) and any other pertinent information. If possible, photographs should accompany floor plan sketches.

5.3 Indoor/Outdoor Air Sampling

5.3.1 Pre-sampling Inspection and Documentation

As noted in the NYSDOH guidance document, during colder months, heating systems should be operating at least 24 hours prior to and during the scheduled sampling time to maintain normal indoor air temperatures. Prior to collecting indoor air samples, a pre-sampling inspection should be performed prior to each sampling event to identify conditions that may affect or interfere with the proposed testing. The inspection should evaluate the type of structure, floor layout, physical conditions, and airflows of the building(s) being studied. The inspection information should be identified on the attached Indoor Air Quality Questionnaire and Building Inventory form. In addition, potential sources of chemicals of concern should be evaluated within the building by conducting a product inventory. The Indoor Air Quality Questionnaire and Building Inventory Form and Product Inventory Form are provided in Appendix A.

In addition, floor plan sketches should be drawn that include the floor layout with sample locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system air supply and return registers, compass orientation (north) and any other pertinent information should be documented. If possible, photographs should accompany floor plan sketches.

Finally, outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations, the location of potential interferences (e.g., gasoline stations, factories, other facilities, lawn mowers, etc.), compass orientation (north), footings that create separate foundation sections, and paved areas. Significant activities in the vicinity of the sample locations (e.g., operation of heavy equipment) should be recorded.

5.3.2 Indoor/Outdoor Air Sample Collection

Three (3) indoor air samples shall be collected in the vicinity of the sub-slab samples to be collected from the former BADP, the former BADrP, and the indoor area closest to the former Yellow Submarine UST, from a height above the ground to represent the breathing zone when occupants normally are seated (i.e., 3 ft). The locations of the outdoor samples shall be chosen from areas away from wind obstructions, and at a height above the ground to represent the breathing zone (i.e., 3 to 5 ft).

For either indoor or outdoor air samples, the sampling procedure described below shall be followed at each location to minimize discrepancies between sampling points:

- Samples should be collected during normally occupied periods to be representative of typical exposure;

- Sample collection intakes should be located to approximate the breathing zone for building occupants (i.e., 3 feet above the floor level where occupants are normally seated);
- To ensure that an air sample is representative of the conditions being tested and to avoid undue influence from sampling personnel, samples should be collected for a period of twenty-four (24) hours, and personnel should avoid lingering in the immediate area of the sampling device while samples are being collected;
- The sampling team members should avoid actions (e.g., fueling vehicles, using permanent marking pens) that can cause sample interference in the field;
- Flow rates for collecting samples shall not exceed 0.2 L/min to be consistent with concurrent sub-slab sampling;
- Samples shall be collected in 100% certified 6-L Summa® canisters provided by the laboratory; and
- Indoor and outdoor samples should be collected simultaneously;
- Ideally, samples shall be collected over the same period of time as concurrent sub-slab samples.

The field sampling team must maintain a sample log sheet summarizing the pertinent sample information, the uses of VOCs in commercial or industrial processes and/or during building maintenance, weather conditions and ventilation conditions, and any relevant observations such as spills, floor stains, odors and readings from field instrumentation. A sample indoor/outdoor air sample log sheet is provided in Appendix A.

6.0 REPORTING REQUIREMENTS

The results of the soil vapor, sub-slab vapor, and indoor/outdoor air sampling shall be summarized in a letter report. The letter report will contain figures with sampling locations and summary tables containing any detected soil vapor concentrations.

Data shall be compared to background levels of VOCs in air as provided in the NYSDOH SVI guidance document [Section 3.2.4] and the NYSDOH's guidelines for VOCs in air [Table 3.1 in the NYSDOH SVI guidance document]. It should be noted that there are currently no standards, criteria, or guidance values for concentrations of VOCs in either soil vapor or sub-slab vapor.

7.0 REFERENCES

FPM Group, Ltd., Draft Final Work Plan, AOC Long-Term Monitoring Baseline Study, Griffiss Air Force Base, Revision 1.2, December 1998.

FPM Group, Ltd., Draft Report, AOC Long-Term Monitoring Baseline Study, Griffiss Air Force Base, Revision 1.0, July 2000.

FPM Group, Ltd., Draft Field Sampling Plan, Long-Term Monitoring Program, Former Griffiss Air Force Base, Revision 0.0, June 2003a.

FPM Group, Ltd., Draft Site Safety and Health Plan, Long-Term Monitoring Program, Former Griffiss Air Force Base, Revision 0.0, June 2003b.

FPM Group, Ltd., Monitoring Report, On-Base Groundwater AOCs, Revision 0.0, August 2005.

Ecology & Environment, Inc., Final Report for Supplemental Investigations of Areas of Concern, Griffiss Air Force Base, November 1998.

Law Engineering and Environmental Services, Inc., Draft Final Primary Report, Remedial Investigation at Griffiss Air Force Base, New York, December 1996.

New York State Department of Health, Guidance for Evaluating Soil Vapor Intrusion in the State of New York, Public Comment Draft, February 2005.

OHM Remediation Services Corp., BADP Results and Recommendations Report, July 1998.

U.S. Environmental Protection Agency, Data Quality Objectives Process for Superfund, Interim Final Guidance, EPA/540/G-93/071, Publication 9355.9-01, Office of Emergency and Remedial Response, September 1993.

APPENDIX A
SAMPLING FORMS

Soil Vapor Probe Monitoring Form
Sub-slab Vapor Probe Monitoring Form
Indoor/Outdoor Air Monitoring Form
Weather Observation Form
Indoor Air Quality Questionnaire
Building Inventory

SOIL VAPOR PROBE MONITORING FORM

DATE: ______________________________ TIME: ______________________________

SAMPLE IDENTIFICATION: ____

SAMPLE DEPTH: ____

FIELD PERSONNEL: ____

INSTRUMENTS (model and serial number):

PUMP: ____

CGI: ____

TRACER GAS VERIFIED: ☐ Yes ☐ No TRACER GAS CONC. (%): ________________

SAMPLE PURGE VOLUME: ____

VOLUME OF SOIL VAPOR EXTRACTED: ____

SUMMA CANISTER: VACUUM BEFORE SAMPLING: ______________________________

VACUUM AFTER SAMPLING: ______________________________

APPARENT MOISTURE CONTENT: (DRY/MOIST/SATURATED/ETC.)

____

Comments/Observations during sampling (odor, other instrument readings):

____

____

If sampling near an industrial/commercial building, VOCs used during normal operations of facility:

____

____

Weather conditions: Outdoor temperature: ____________________________________

Barometric pressure: ______________________________

Wind speed/direction: ______________________________

SUB-SLAB VAPOR PROBE MONITORING FORM

DATE: ______________________________ TIME: ___________________________

SAMPLE IDENTIFICATION: ____

SAMPLE DEPTH: ____

FIELD PERSONNEL: ____

INSTRUMENTS (model and serial number):

PUMP: ____

CGI: ____

TRACER GAS VERIFIED: ☐ Yes ☐ No TRACER GAS CONC. (%): ________________

SAMPLE PURGE VOLUME: ____

VOLUME OF SOIL VAPOR EXTRACTED: ____

SUMMA CANISTER: VACUUM BEFORE SAMPLING: _____________________________

VACUUM AFTER SAMPLING: ______________________________

APPARENT MOISTURE CONTENT: (DRY/MOIST/SATURATED/ETC.)

____

Comments/Observations during sampling (spills, floor stains, odors, other instrument readings):

VOCs used during normal operations of facility:

____

____

Weather conditions: Outdoor temperature: ______________________________________

Barometric pressure: ____

Precipitation: ____

Ventilation conditions: ____

Heating System Active? ☐ Yes ☐ No Indoor Air Temp: __________

Location in relation to sample location: ____________________________

Windows Closed? ☐ Yes ☐ No

INDOOR/OUTDOOR AIR MONITORING FORM

DATE: ______________________________ TIME: ____________________________

SAMPLE IDENTIFICATION: ____

SAMPLE DEPTH: ____

FIELD PERSONNEL: ____

INSTRUMENTS (model and serial number):

PUMP: ____

CGI: ____

TYPE OF SAMPLE: ☐ INDOOR ☐ OUTDOOR

DURATION OF AIR SAMPLING: ____

VOLUME OF AIR SAMPLED: ____

SUMMA CANISTER: VACUUM BEFORE SAMPLING: _____________________________

VACUUM AFTER SAMPLING: ______________________________

Comments/Observations during sampling (spills, floor stains, odors, other instrument readings):

____

____

VOCs used during normal operations of facility: _____________________________________

____

Weather conditions: Outdoor temperature: ___________________________________

Barometric pressure: ___________________________________

Precipitation: ___________________________________

Ventilation conditions: ___________________________________

Heating System Active? ☐ Yes ☐ No Indoor Air Temp.:___________

Location in relation to sample location: ___________________________

Windows Closed? ☐ Yes ☐ No

WEATHER OBSERVATION FORM

LOCATION: ____

DATE: ____

FIELD PERSONNEL: ____

INSTRUMENTS (model and serial number):

Thermometer: ____

Anemometer: ____

	Time (military)	**Precip. (in)**	**Atmospheric pressure (in)**	**Temp. (degrees F)**	**Wind (mph)**	**Comments**
Prior to Sampling						
Mid Day						
End of Sampling						

Notes: Additional measurements should be taken in case of weather condition changes.
Air sampling will be postponed if conditions move outside the acceptable range.

Sampling Event Acceptable Range:
1. Precipitation: dry while conducting sampling.
2. Atmospheric pressure: 29.7 – 30.4 in Hg.
3. Temperature: 35 – 95 degrees F. The ground must be completely thawed.
4. Wind: <10 mph.

OSR – 3

NEW YORK STATE DEPARTMENT OF HEALTH
INDOOR AIR QUALITY QUESTIONNAIRE AND BUILDING INVENTORY
CENTER FOR ENVIRONMENTAL HEALTH

This form must be completed for each residence involved in indoor air testing.

Preparer's Name ____________________________________ Date/Time Prepared ______________

Preparer's Affiliation ________________________________ Phone No.______________________

Purpose of Investigation____

1. OCCUPANT:

Interviewed: Y / N

Last Name: _________________________ First Name: _________________________

Address: ____

County: _________________

Home Phone: ____________________ Office Phone: ____________________

Number of Occupants/persons at this location _______ Age of Occupants ______________________

2. OWNER OR LANDLORD: (Check if same as occupant ___)

Interviewed: Y / N

Last Name: _________________________ First Name: _________________________

Address: ____

County: _________________

Home Phone: ____________________ Office Phone: ____________________

3. BUILDING CHARACTERISTICS

Type of Building: (Circle appropriate response)

Residential School Commercial/Multi-use
Industrial Church Other: _________________

If the property is residential, type? (Circle appropriate response)

Ranch
Raised Ranch
Cape Cod
Duplex
Modular
2-Family
Split Level
Contemporary
Apartment House
Log Home
3-Family
Colonial
Mobile Home
Townhouses/Condos
Other:_______________

If multiple units, how many? ________

If the property is commercial, type?

Business Type(s) ______________________________________

Does it include residences (i.e., multi-use)? Y / N   If yes, how many? ______

Other characteristics:

Number of floors______   Building age______

Is the building insulated? Y / N   How air tight? Tight / Average / Not Tight

4. AIRFLOW

Use air current tubes or tracer smoke to evaluate airflow patterns and qualitatively describe:

Airflow between floors

Airflow near source

Outdoor air infiltration

Infiltration into air ducts

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS (Circle all that apply)

a. Above grade construction: wood frame concrete stone brick

b. Basement type: full crawlspace slab other ________

c. Basement floor: concrete dirt stone other ________

d. Basement floor: uncovered covered covered with ________________

e. Concrete floor: unsealed sealed sealed with _________________

f. Foundation walls: poured block stone other ________

g. Foundation walls: unsealed sealed sealed with _________________

h. The basement is: wet damp dry moldy

i. The basement is: finished unfinished partially finished

j. Sump present? Y / N

k. Water in sump? Y / N / not applicable

Basement/Lowest level depth below grade: ________(feet)

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

____

____

6. HEATING, VENTING and AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation
Space Heaters
Electric baseboard
Heat pump
Stream radiation
Wood stove
Hot water baseboard
Radiant floor
Outdoor wood boiler
Other ___________

The primary type of fuel used is:

Natural Gas
Electric
Wood
Fuel Oil
Propane
Coal
Kerosene
Solar

Domestic hot water tank fueled by: _____________________________

Boiler/furnace located in: Basement Outdoors Main Floor Other___________

Air conditioning: Central Air Window units Open Windows None

Are there air distribution ducts present? Y / N

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

____

____

____

____

7. OCCUPANCY

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

Level	**General Use of Each Floor (e.g., familyroom, bedroom, laundry, workshop, storage)**
Basement	____
1st Floor	____
2nd Floor	____
3rd Floor	____
4th Floor	____

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? Y / N

b. Does the garage have a separate heating unit? Y / N / NA

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, atv, car) Y / N / NA Please specify___________________

d. Has the building ever had a fire? Y / N When?_________________

e. Is a kerosene or unvented gas space heater present? Y / N Where? _________________

f. Is there a workshop or hobby/craft area? Y / N Where & Type? ________________

g. Is there smoking in the building? Y / N How frequently? ________________

h. Have cleaning products been used recently? Y / N When & Type? ________________

i. Have cosmetic products been used recently? Y / N When & Type? _________________

j. Has painting/staining been done in the last 6 months? Y / N Where & When? _______________

k. Is there new carpet, drapes or other textiles? Y / N Where & When? _______________

l. Have air fresheners been used recently? Y / N When & Type? ________________

m. Is there a kitchen exhaust fan? Y / N If yes, where vented?____________

n. Is there a bathroom exhaust fan? Y / N If yes, where vented?____________

o. Is there a clothes dryer? Y / N If yes, is it vented outside? Y / N

p. Has there been a pesticide application? Y / N When & Type?_________________

Are there odors in the building? Y / N
If yes, please describe: ____

Do any of the building occupants use solvents at work? Y / N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist

If yes, what types of solvents are used? ____

If yes, are their clothes washed at work? Y / N

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly)	No
Yes, use dry-cleaning infrequently (monthly or less)	Unknown
Yes, work at a dry-cleaning service	

Is there a radon mitigation system for the building/structure? Y / N Date of Installation: ____________
Is the system active or passive? Active/Passive

9. WATER AND SEWAGE

Water Supply:	Public Water	Drilled Well	Driven Well	Dug Well	Other: _______
Sewage Disposal:	Public Sewer	Septic Tank	Leach Field	Dry Well	Other: _______

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended: _____________________________________

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained? Y / N

d. Relocation package provided and explained to residents? Y / N

11. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:

First Floor:

12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.

13. PRODUCT INVENTORY FORM

Make & Model of field instrument used: ___________________________________

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (units)	Photo ** Y / N

* Describe the condition of the product containers as **Unopened (UO), Used (U),** or **Deteriorated (D)**
** Photographs of the **front and back** of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.

APPENDIX B
Centek Labs Standard Operating Procedure (SOP)
EPA Method TO-15

Centek Laboratories, LLC
Laboratory Division

Centek No.: TS-80
Regulation: EPA TO15

Laboratory SOP

Revision No. 1
Last Update: 02/2005

Volatile Organic Compounds By Gas Chromatography / Mass Spectroscopy and Cyro-focusing

Approved:

Russell J Pellegrino,
Technical Director

Nick Scala, Quality Assurance Officer

Russ Pellegrino, VOC Manager

13.0 PURPOSE

1.1 This SOP describes the procedure to determine whole air samples that are collected in a canister. VOC's are cryofocused on a glass trap, then concentrated on a Tenax trap and finally refocused. The sample is then injected into a GC column, and passed to an MS detector for identification and quantification. The compounds determined by this method are listed in Table 1.

1.2 This procedure may be used for the following matrices and regulations:

Matrix	Regulation
Air	EPA

1.0 RESPONSIBILITIES

2.1 All GC/MS analysts performing this method are required to read and understand the method as written in the Compendium of methods for the Determination of Toxic Organic Compounds in Ambient Air TO-15 and are required to meet all QC requirements before attempting analysis of samples.

2.2 The section supervisor is required to read and understand the method as written but is also responsible for the training and continued education of technicians performing this method.

2.3 The section supervisor is required to review reports and packages to ensure that all data are valid prior to client receipt.

3.0 DEFINITIONS

3.1 GC/MS: Gas Chromatography/Mass Spectroscopy

3.2 Capillary: Analytical column with an internal diameter less than or equal to 0.34 mm

3.3 EICP: Extracted ion current profile: Each compound contains a quantitation ion that is singled out and displayed as a peak

3.4 LIMS: Laboratory Information Management System

3.5 PQL: Practical Quantitation Limit

3.6 MDL: Method Detection Limit

3.7 IDL: Instrument Detection Limit

3.8 AMU: Atomic Mass Unit

3.9 VOA: Volatile Organic Compounds

3.10RSD: Relative Standard Deviation

3.11 RRF: Relative Standard Deviation

3.12 NIST: National Institute of Science and Technology

3.13 CRQL: Contract Required Quantitation Limit

3.14 QAPP: Quality Assurance Project Plan

3.15 LCS: Laboratory Control Sample

8.0 METHOD SUMMARY

8.1 Whole air samples that are collected in a specially prepared canister. VOC's are cryofocused on a glass trap, then concentrated on a sorent trap and finally refocused on a third trap

8.2 The volatile compounds are introduced in to the GC/MS by injecting the sample extract into the Gas Chromatograph (GC) with a narrow-bore fused-silica capillary column. The GC column is temperature programmed to separate the analytes, which are then detected with the MS connected to the GC.

8.3 The analytes eluted from the capillary column are introduced into the MS via auto injection. The identification of target analytes is accomplished by comparing their mass spectra with the electron impact spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitative) ion relative to an internal standard using a five-point calibration curve.

5.0 SAFETY

5.1 Most volatile compounds are considered hazardous. Always wear gloves and a lab coat when handling stocks and solutions.

5.2 Safety glasses with side shields are required whenever you are in the laboratory.

5.3 It is very important that special precaution be used when working with liquid nitrogen. The holding tanks are very heavy and the liquid nitrogen will cause burns.

6.0 INTERFERENCES

6.1 Raw GC/MS data from all samples and blanks must be evaluated for interference. Determine if the source of interference is in the preparation of the samples and take corrective action to eliminate the problem.

6.2 Contamination by carryover can occur whenever high-concentration and low-concentration samples are sequentially analyzed. Whenever an unusually concentrated sample is analyzed, it should be followed by the analysis of an instrument blank to check for cross-contamination.

7.0 APPARATUS AND MATERIALS

7.1 Instrument 6890N Series GC in conjunction with 5973N mass spectrometer capable of scanning from 35 to 300 amu every 1-second or less, using 70 volts (nominal) electron energy.

7.2 Entech 7100 Preconcentrator with an Entec7032L auto sampler capable of cryofocusing and concentrating samples using three separate modules.

7.2 Analytical Chromatography columns: 0.34mm ID x 60 M length and 1.4 um film thickness silicone-coated capillary column- DB-5 VRX by J & W Scientific or equivalent.

7.3 GC/MS Interface - GC to MS interface that gives acceptable calibration points at 50 ppbv per injection for each compound of interest and achieves acceptable tuning performance criteria may be used.

7.4 Data System – The computer system used is the HP Chem Station G1701DA system with Revision D.00.01 software package. This system is interfaced to the mass spectrometer. The system has continuous acquisition and storage on machine- readable media of all mass spectra obtained throughout the duration of the chromatographic program. The system has software that can search any GC/MS data file for ions of a specific mass and that can plot such ion abundance versus time or scan number. This type of plot is defined as an Extracted Ion Current Profile. The software allows integration of the abundance in any EICP between specified times or scan number limits. NBS95K version Mass Spectral Library is being used.

8.0 CHEMICALS AND REAGENTS

8.1 Helium @ 99.9999% purity

8.2 Liquid nitrogen (see section 5.3)

8.3 Stock standards

8.3.1 Stock standard solutions can be prepared from pure standard materials or purchased as certified solutions.

8.3.2 Stock standard solutions must be stored at room temperature, or as recommended by the manufacturer.

8.3.3 Stock standard solutions must be replaced after 1 year, or sooner if comparison with check standards indicates a problem.

8.4 Internal standard solutions

8.4.1 The recommended internal standards are Bromochloromethane, 1,4-Dichlorobenzene and Chlorobenzene.

8.4.2 Each 100cc of sample extract undergoing analysis and the calibration standards must be spiked with 50ppbv of each internal standard and surrogate.

8.5 GC/MS Tuning standard

8.5.1 A air sample solution containing 50ppbv of Bromofluorobenzene (BFB) must be prepared. The standard could also contain 50ppb each of internal standards.

8.5.2 The tuning standard may be– stored room temperature when not in use. When using premixed certified solutions, store according to the manufacturer's documented holding time and storage temperature recommendations.

8.6 Intermediate (working) standard

8.6.1 The working standard is prepared at 100 ppbv and 25 ppbv. It is used to make calibration standards. The working standard must contain all analytes of interest. Also a working standard is prepared at 50 ppbv containing internal standards and surrogate.

8.6.2 Working standard must be prepared every six months or sooner if comparisons with check standards indicates a problem.

8.7 Calibration standards

8.7.1 A minimum of five calibration standards must be prepared at five different concentrations. One of the calibration standards must correspond to a sample concentration at or below that necessary to meet the data quality objectives of the project. The remaining standards must correspond to the range of concentrations found in the actual samples.

8.7.2 See Table 1 for targets, surrogates, internal standards and the concentrations of the calibration standards.

8.7.3 Internal standards and surrogate is added to all calibration standards.

8.8 Internal Standards and Surrogate

8.8.1 Internal standard and surrogates are added to all calibration standards. See Table 1 for concentration.

8.8.2 The internal standard and surrogate must be prepared every six months or sooner if comparison with a check standard indicates a problem.

8.8.3 The internal standard and surrogate must be stored at room temperature.

9.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

9.1 Whole air samples are to be collected in 400cc "mini"-canister and kept at room temperature. Samples must be extracted within 14 days of collection.

9.2 Whole air samples can also be collected in Tedlar bags and kept at room temperature. Samples must be extracted within 72 hours of collection.

9.4 Program specific holding time requirements if any, must take precedence over the above-mentioned guidelines.

9.5 Samples, extracts and standards must be stored at separate locations to avoid cross-contamination.

10.0 PROCEDURE

10.1 Sample preparation

10.1.1 Once the samples have been collected and brought to room temperature. A pressure gauge is connected to the canister inlet. This will indicate the amount of sample that was collected. If amount is less the 100cc a volume of nitrogen has to be added. This volume has to be recorded for a dilution.

10.2 Analytical Procedure

10.2.1 Instrument maintenance

10.2.1.1 Appropriate instrument maintenance must be performed prior to initial calibration.

10.2.2 Instrument conditions

10.2.2.1 The following GC/MS instrument conditions are recommended:

Mass range:	35-300 amu
Scan time:	1 sec/scan
Initial temperature:	40 °C, hold for 4 minutes
Temperature program	40-250 °C at 10 °C /minute
Final temperature:	250 °C, hold until hexachloro-1,3-butadiene elutes and 1-3 more minutes.
Injector temperature:	110-150 °C
Injection volume:	100cc
Carrier gas:	Helium at 30 cm/sec

10.3 Instrument Calibration

10.3.1 Instrument Performance Check: Prior to any data collection activities involving samples, blanks, or standards it is necessary to show that the GC/MS system meets the instrument performance criteria below. The purpose of this check is to assure the correct mass calibration, mass resolution, and mass transmission. This is accomplished by the analysis of a 50-ppbv g injection of BFB.

10.3.1.1 BFB must meet the criteria before standards and samples are analyzed. The criteria must be demonstrated each 12-hour period that samples are analyzed. The BFB is analyzed once at the beginning of each 12-hour period during which samples or standards are analyzed. The 12-hour period begins with the injection time of the BFB and ends after 24 hours according to the system clock. The following abundance criteria are required before continuing analyses:

10.3.1.2 For tuning, the following approach has been found to be useful. Three scans (the peak apex scan and the scans immediately preceding and following the apex) are averaged. Alternately, other documented tuning criteria may be used, provided that method performance is not adversely affected. Background subtraction is required, and must be accomplished using a single scan acquired no more than 20 scans prior to the elution of BFB. The background subtraction is designed to eliminate column bleed and instrument background ions.

10.3.1.3 Tune acceptance criteria:

Mass	Ion Abundance Criteria
50	15.0-40.0 percent of mass 95
75	30.0-60.0 percent of mass 95
95	base peak, 100 percent relative abundance
96	5.0-9.0 percent of mass 95
173	Less than 2.0 percent of mass 174
174	greater than 50.0 percent of mass 95
175	5.0-9.0 percent of mass 174
176	Greater than 95.0 percent but greater than 101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

10.3.2 Calibration standards must be analyzed once BFB meets acceptance criteria.

10.3.3 Calibration

10.3.3.1 A 5-point calibration curve must be analyzed prior to sample analysis. Dilute the intermediate standard (100-ppbv) as necessary to obtain the concentrations of 5,25,50,75, and 100 ppbv. The internal standards must be added at 50 ppbv to each concentration level (see list below). Analyze each standard in increasing concentration order to determine the instrument sensitivity and linearity of the GC/MS response for the target compounds. Analyze the following from each working standard canister:

From the 100ppbv working standard canister:

100ppv standard…use 100cc
75 ppbv standard…use 75cc
50 ppbv standard…use 50cc

From the 25ppbv working standard canister:

25ppv standard…use 100cc
5 ppbv standard…use 205cc

10.3.3.2 Label the calibration standards in the sequence as follows:

ASTD100, STD 1
ASTD75, STD 1
ASTD50, STD 1
ASTD25, STD 1
ASTD5, STD 1

10.3.3.3 calculate the response factor for each compound using the following equation:

$$RF = \frac{Ax}{Ais} * \frac{Cis}{Cx}$$

Where:

Ax = Area of the characteristic ion for the compound to measured (see *Table 1 and 2*).

Ais = Area of the characteristic ion for the specific internal standard (see *Table 2*).

Cis = Concentration of the internal standard (µg/ml).
Cx = Concentration of the compound to be measured (µg/ml).

10.3.3.4 calculate the average RF for each analytes in the curve

10.3.3.5 calculate the % Relative Standard Deviation of RF values for the initial calibration using the following equation:

$$\%RSD = \frac{\text{Standard Deviation (n-1)}}{\text{mean RF}} * 100$$

10.3.4 Calibration acceptance criteria

10.3.4.1 The <u>BFB</u> must meet the specified criteria

10.3.4.2 The %RSD is calculated and must be less than or equal to 30% for the CCC compounds. The %RSD of all other calibration compounds must be less than or equal to 100%. This criterion must be met for the initial calibration to be valid.

10.3.4.3 The System Performance Check Compounds (SPCCs) must meet minimum RF criteria specified in Table 3.

10.3.4.4 Evaluation of retention time: The relative retention time (RRT) of each target analytes in each calibration standard should agree within 0.06RRT units.

10.4 Calibration verification

10.4.1 Instrument Performance Check: Prior to any data collection activities involving samples, blanks, or standards, analyze a 50-ppbv injection of BFB). BFB must meet same criteria as the initial calibration.

10.4.2 Calibration verification standard: Analyze a 50-ppbv-calibration standard at the beginning of each 24-hour working period (that passed the BFB tune criteria). Calculate the % Difference between the average response factor from the calibration curve and the response factor from the continuing standard using the equation below:

$$\% \text{ Difference} = \frac{|RRFi - RRFc|}{RRFi} * 100$$

Where:
RRFi = Average relative response factor from initial calibration.

RRFc = Relative response factor from the current calibration check standard.

The verification standard must meet % D criteria mentioned in Table 4.

10.4.2.1 Internal standard retention time: The retention times of the internal standards in the calibration verification standards must be evaluated immediately after the run. The retention time of any internal standard should not change by more than 30 seconds from that in the mid-point standard level of the most recent initial calibration sequence. If the retention time shift is outside this limit, associated runs must be reanalyzed after meeting the criteria.

10.4.2.2 Internal standard response: The EICP area of any of the internal standards in the calibration verification standard should not change by a factor of two (-50% to +100%) from that in the mid-point standard of the most recent initial calibration.

10.4.2.3 Manual Integration: Permits the analyst to integrate the peak(s) of interest manually. This is to be applied when a peak of interest has not been integrated (ex. split peak) from baseline to baseline. In this case the analyst must be consistent in defining the baseline. All manual integration will be flagged with an "m" and will be initialed by the analyst. The spectra will be put in for all compounds of interest showing the manual integration.

10.5 Sample analysis

10.5.1 Once the instrument check and continuing standard have passed the analysis criteria, samples may be analyzed. Label the samples in analytical sequence as follows:

WGXXXXX-X,SBLKXXXXX,matrix,dilution factor(Prep. Blank)
WGXXXXX-X,SBLKXXXXXCS,matrix,dilution factor (Check sample)
L11111-X,ClientID,matrix,dilution factor (Sample)

10.5.2 Allow the sample extract to warm to room temperature. During the analysis, add 100cc ppbv of internal standard to the 100cc extract obtained from the sample "mini"-canister.

10.5.3 Inject the sample into the GC/MS system using the same operating conditions that were used for the calibration.

10.5.4 If the response of any quantitative ion exceeds the initial calibration range of the GC/MS system, the sample extract must be diluted and reanalyzed.

10.6 Qualitative analysis

10.6.1 The qualitative identification of compounds is based on retention time and comparison of the sample spectrum with characteristic ions in a reference mass spectrum. The characteristic ions from the reference mass spectrum are defined as the three ions of greatest relative intensity, or any ions over 30% relative intensity, if less than three such ions occur in the reference spectrum. The compounds are identified when the following criteria are met:

10.6.1.1 The intensities of the characteristic ions of a compound must maximize in the same scan or within one scan of each other.

10.6.1.2 The RRT of the sample component is within ±0.06 RRT units of the RRT of the standard component.

10.6.1.3 The relative intensities of the characteristic ions agree within 30 percent of the relative intensities of these ions in the reference spectrum from the most recent calibration verification standard.

10.6.1.4 Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 25 percent of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

10.6.1.5 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component appropriate selection of analyte spectra and background spectra is important. When analytes coelute the identification criteria can be met, but each analyte spectrum will contain extraneous ions contributed by the coeluting compound.

10.6.1.6 Manual Integration: Permits the analyst to integrate the peak(s) of interest manually. This is to be applied when a peak of interest has not been integrated (ex. split peak) from baseline to baseline. In this case the analyst must be consistent in defining the baseline. All manual integration will be flagged with an "m" and will be initialed by the analyst. The spectra will be put in for all compounds of interest showing the manual integration.

10.6.2 For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification.

10.7 Quantitative identification

10.7.1 Once a compound has been identified, the quantitation of that compound is based on the integrated abundance of the primary characteristic ion from the EICP.

10.7.2 The concentration of a compound in the extract is determined using the average response factor from initial calibration.

10.7.3 Use the equations below to quantitate the appropriate matrix:

$$\mu g/L = \frac{(Ax)(Is)(Df)}{(Ais)(RRF)(Vi)}$$

Where:
Ax = Area of the characteristic ion for the compound to be measured.
Ais = Area of the characteristic ion for the internal standard.
Is = Amount of the internal standard injected in nanograms
RRF = Average response factor (from initial cal.) for the compound being measured.
Vo = Volume of water extracted in milliliters

Vi = Volume of sample injected in milliliters
Vt = Volume of concentrated extracted in microliters
Df = Dilution factor

10.7.4 The GC/MS data system contains identification files (ID files) that automatically identify target compounds in standards and samples. Quantitation is performed using the internal standard method. The list of characteristic ions for each analyte is listed in *Table 2*. In all instances where the data system report has been edited or where manual integration or quantitation has been performed the GC/MS operator must identify edits or manual procedures by initialing and dating the changes made to the report. The data system flags a manual integration on the quantitation report using a "M" next to the area. Samples that contain target analytes above the linear range of the curve (+10 percent or 110 ppbv) must be diluted to put the analytes within the curve range. Flag the analytes that exceed the linear range in the qualifier section with an "E". Report the dilution analysis with the suffix "DL" where the sample name appears. If a dilution was initially performed and no target analytes are reported above the PQL, the sample must be reanalyzed at a more concentrated level.

10.8 Technical Acceptance Criteria for Sample analysis

10.8.1 The samples must be analyzed on a system meeting BFB, initial calibration and calibration verification criteria.

10.8.2 The samples must be extracted and analyzed within contract required holding times.

10.8.3 The sample must have an associated prep. blank meeting acceptance criteria.

10.8.4 All samples and blanks must have surrogate recovery within in-house control limits. No surrogate recovery can be less than 10%

10.8.5 The relative retention time of each surrogate must be within ± 0.06 RRT units of its relative retention time in the calibration verification standard.

10.8.6 The instrumental response (EICP area) for each of the internal standards must be within –50% and +100% of the response of the internal standards in the most recent calibration verification standard.

10.8.7 The retention time shift for each of the internal standards must be within +0.5 minutes between the sample and the most recent calibration verification standard.

10.8.8 The sample spectra quant ion must be within 30% of the most recent calibration verification standard.

10.8.9 Concentration of all analytes must be within the calibration range determined from the initial calibration.

10.9 Corrective Action

10.9.1 Corrective Action for sample analysis: The sample technical acceptance criteria must be met. The samples that did not meet criteria reanalysis.

10.9.2 Corrective Action for surrogate recovery failure: Check calculations, check spike standards. Reanalyze the samples that exceeded criteria. If the samples met criteria upon reanalysis, report the reanalysis only. If the sample produced similar results upon reextraction and reanalysis, the problem may be matrix-related. Report both sets of analyses. Use 'R' qualifier for reanalysis. If the reanalysis of samples does not solve the problem, contact the project manager so the client may be notified.

10.9.3 Corrective Action for Internal Standard Response failures: If any of the internal standards exceeded acceptance criteria, check calculations. Verify that the standard concentration is accurate, and that the instrument did not malfunction. Reanalyze the sample to see if the problem was matrix related. If the reanalysis met criteria, report the reanalysis only. If the reanalysis produced similar results, report both analyses. Use 'R' qualifier to identify reanalysis results.

10.9.4 Corrective action for surrogate RRT/Internal standard retention time: If the surrogates or internal standards exceeded retention time criteria, follow the same guidelines used in Section 10.9.3

11.0 QUALITY CONTROL

11.1 Instrument performance must be evaluated to see if all BFB, initial calibration and calibration verification criteria requirements are met.

11.2 Method blanks

11.2.1 A Method blank is a volume of a clean reference matrix (nitrogen @ 99.9999% purity) carried through the entire analytical procedure. The volume of the method blank must be approximately equal to the volume of the associated samples. The purpose of the method blank is to determine the level of contamination associated with the preparation and analysis of samples.

11.2.2 Method blanks must be extracted with each batch of samples at a frequency of 1 for every 20 samples.

11.2.3 Method blanks must be analyzed under the same conditions as the samples.

11.2.4 Method blanks must contain no targets above CRQL. If the method blank does not meet this criterion, affected samples must be reanalyzed.

11.2.5 If the surrogate recoveries in the method blank do not meet the control limits, reanalyze the method blank. If the method blank does not meet criteria after reanalysis, reanalyze the associated samples.

11.3 Quality Control Check Sample.

11.3.1 A Check sample consists of an aliquot of a clean matrix similar to the sample matrix and of the same weight or volume. The CS is spiked with the all the target analytes at mid-level of the calibration curve. The spiking standard should be from a source different from that of the calibration standards.

11.3.2 A CS must be analyzed with every 20 samples or more frequently. The recoveries must be within the in-house control limits. If the recoveries fall outside control limits, the CS must be reanalyzed. If the recoveries are still outside control limits, affected samples should be reanalyzed.

11.4 Surrogate Recoveries

11.4.1 All samples, including quality control samples, are spiked with surrogates. The surrogate solution contains bromofluorobenzene at 50 ppbv.

11.4.2 All samples must meet the surrogate recovery criteria. If any samples exceed criteria, the sample must be reanalyzed. If the reanalysis produces similar results, contact the project manager.

11.5 Control Limits

11.5.1 All surrogate recoveries, and check sample data must be entered on the LIMS. In-house control limits must be calculated annually. Accuracy and precision data must be compared against the control limits.

11.6 Initial Demonstration of Proficiency (IDP)

11.6.1 IDP is established by generating data of acceptable accuracy and precision for target analytes for each preparative method and matrix by analyzing reference samples.

11.6.2 The reference samples are prepared from a spiking solution containing each analyte of interest. The solution should be made from stock standards prepared independently from those used for calibration. The concentration of targets in the reference sample may be 10-50 times the MDL.

11.6.3 Prepare and analyze 4 replicates of the reference sample by the same procedure used for analyzing actual samples. Calculate average recovery in ppbv and standard deviation of the recovery of each analyte of interest. The average recovery may fall in the range of 70-130%.

11.6.4 IDP procedure must be repeated whenever new staff is trained or significant changes in preparative or analytical methods are made.

11.7 Method Detection Limit (MDL)

11.7.1 The Method Detection Limit (MDL) for this procedure is used to judge the significance of a single measurement of a future sample. The MDL is the constituent that, when processed through the complete method, produces a signal with 99% probability that it is different from the blank. MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined by the analysis of samples in a given matrix type containing the analyte.

11.7.2 MDLs are determined annually.

11.8 Reporting Limit Check Standard (RLCS)

11.8.1 The Reporting Limit Check Standard (RLCS), used for Industrial Hygiene analysis, consists of an aliquot of a clean matrix similar to the sample matrix and of the same weight or volume. The RLCS is spiked with all the target analytes at or below the reporting limits. The spiking standard will be from the same source of the calibration standards.

11.8.2 A RLCS must be analyzed with every batch samples in a 24 hour time period. The recoveries must be within 35% (65-135%) of the spike concentration. An allowable limit of 5 compounds is allowed but will not fall within 50%. If the recoveries fall outside the limits, the RLCS must be reanalyzed. If the recoveries are still outside control limits, affected samples should be reanalyzed and/or flagged as estimated value.

12.0 DOCUMENTATION

12.1 The raw data is archived via CD-ROM and is stored in a secured area. The raw data will be kept in the laboratory for 5 years.

12.2 Chain of custody forms, instrument maintenance log, standards prep log, analytical run log, corrective action logs etc. must be filled out in a timely manner.

13.0 REFERENCES

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, January 1999

Table 1

Calibration standards for 5ppb level
(Concentration in ppbV)

COMPOUND	LV1	LV2	LV3	LV4	LV5	LV6	
Propylene	5	10	25	50	75	100	
Freon-12	5	10	25	50	75	100	
Chloromethane	5	10	25	50	75	100	
Fron-114	5	10	25	50	75	100	
Vinyl Chloride	5	10	25	50	75	100	
Bromomethane	5	10	25	50	75	100	
Chloroethane	5	10	25	50	75	100	
Vinyl Bromide	5	10	25	50	75	100	
Freon-11	5	10	25	50	75	100	
Isopropyl Alcohol	5	10	25	50	75	100	
Acetone	5	10	25	50	75	100	
1,1-Dichloroethane	5	10	25	50	75	100	
Methylene Chloride	5	10	25	50	75	100	
Freon-113	5	10	25	50	75	100	
Allyl Chloride	5	10	25	50	75	100	
Carbon Disulfide	5	10	25	50	75	100	
Trans-1,2-Dichlorethene	5	10	25	50	75	100	
Methyl Tert-Butyl Ether	5	10	25	50	75	100	
1,1-Dichloroethane	5	10	25	50	75	100	
Vinyl Acetate	5	10	25	50	75	100	
Methyl Ethyl Ketone	5	10	25	50	75	100	
Cis-1,2-Dichloroethylene	5	10	25	50	75	100	
Hexane	5	10	25	50	75	100	

Ethyl Acetate	5	10	25	50	75	100	
Chloroform	5	10	25	50	75	100	
Tetrahydrofuran	5	10	25	50	75	100	
1,2-Dichloroethane	5	10	25	50	75	100	
1,1,1-Trichloroethane	5	10	25	50	75	100	
Cyclohexane	5	10	25	50	75	100	
Carbon Tetrachloride	5	10	25	50	75	100	
Benzene	5	10	25	50	75	100	
1,4-Dioxane	5	10	25	50	75	100	
2,2,4-Trimethylpentane	5	10	25	50	75	100	
Heptane	5	10	25	50	75	100	
1,2-Dichloropropane	5	10	25	50	75	100	
Trichloroethylene	5	10	25	50	75	100	
Bromodichloromethane	5	10	25	50	75	100	
cis-1,3-Dichloropropene	5	10	25	50	75	100	
Trans-1,3-Dichloropropene	5	10	25	50	75	100	
1,1,2-Trichloroethane	5	10	25	50	75	100	
Toluene	5	10	25	50	75	100	
Dibromochloromethane	5	10	25	50	75	100	
Methyl Isobutyl Ketone	5	10	25	50	75	100	
Methyl Butyl Ketone	5	10	25	50	75	100	
1,2-Dibromomethane	5	10	25	50	75	100	
Tetrachloroethylene	5	10	25	50	75	100	
Chlorobenzene	5	10	25	50	75	100	
Ethylbenzene	5	10	25	50	75	100	
Bromoform	5	10	25	50	75	100	
Styrene	5	10	25	50	75	100	
o-xylene	5	10	25	50	75	100	
m -xylene	5	10	25	50	75	100	
p-xylene	5	10	25	50	75	100	
1,1,2,2-Tetrachloroethane	5	10	25	50	75	100	
4-Ethyltoluene	5	10	25	50	75	100	
1,3,5-Trimethylbenzene	5	10	25	50	75	100	
1,2,4-Trimethylbenzene	5	10	25	50	75	100	

1,3-Dichlorobenzene	5	10	25	50	75	100	
Benzyl Chloride	5	10	25	50	75	100	
1,4-Dichlorobenzene	5	10	25	50	75	100	
1,2-Dichlorobenzene	5	10	25	50	75	100	
1,2,4-Trichlorobenzene	5	10	25	50	75	100	
Hexachloro-1,3-Butadiene	5	10	25	50	75	100	
Bromofluorobenzene (surrogate)	50	50	50	50	50	50	
*Bromochloromethane	50	50	50	50	50	50	
*1,4-Difluorobenzene	50	50	50	50	50	50	
*Chlorobenzene-d5	50	50	50	50	50	50	

*Indicates internal standard

Table 1

Calibration standards for 1ug/M3 level (Concentration in ppbV)

COMPOUND	LV1	LV2	LV3	LV4	LV5	LV6	LV7
Propylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Freon-12	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Chloromethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Fron-114	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Vinyl Chloride	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Bromomethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Chloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Vinyl Bromide	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Freon-11	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Isopropyl Alcohol	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Acetone	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,1-Dichloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Methylene Chloride	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Freon-113	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Allyl Chloride	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Carbon Disulfide	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Trans-1,2-Dichlorethene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Methyl Tert-Butyl Ether	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,1-Dichloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Vinyl Acetate	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Methyl Ethyl Ketone	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Cis-1,2-Dichloroethylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Hexane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Ethyl Acetate	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Chloroform	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Tetrahydrofuran	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2-Dichloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,1,1-Trichloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Cyclohexane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Carbon Tetrachloride	0.15	0.30	0.50	0.75	1.0	1.5	2.0

Benzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,4-Dioxane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
2,2,4-Trimethylpentane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Heptane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2-Dichloropropane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Trichloroethylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Bromodichloromethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
cis-1,3-Dichloropropene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Trans-1,3-Dichloropropene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,1,2-Trichloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Toluene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Dibromochloromethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Methyl Isobutyl Ketone	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Methyl Butyl Ketone	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2-Dibromomethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Tetrachloroethylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Chlorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Ethylbenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Bromoform	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Styrene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
o-xylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
m -xylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
p-xylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,1,2,2-Tetrachloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
4-Ethyltoluene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,3,5-Trimethylbenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2,4-Trimethylbenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,3-Dichlorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Benzyl Chloride	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,4-Dichlorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2-Dichlorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2,4-Trichlorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Hexachloro-1,3-Butadiene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Bromofluorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0

(surrogate) Bromofluorobenzene							
*Bromochloromethane	1	1	1	1	1	1	1
*1,4-Difluorobenzene	1	1	1	1	1	1	1
*Chlorobenzene-d5	1	1	1	1	1	1	1

*Indicates internal standard

Table 2

Characteristic Ions, PQLs

COMPOUND	EI PRIMARY	EI SECONDARY	EI TERTIARY	PQL ppb
Propylene	41	39		5
Freon-12	85	87		5
Chloromethane	50	52		5
Freon-114	85	135	87	5
Vinyl Chloride	62	27	64	5
1,3-Butadiene	39	54		5
Bromomethane	94	96		5
Chloroethane	64	29	27	5
Vinyl Bromide	106	106		5
Freon-11	101	103		5
Isopropyl Alcohol	45	43		20
Acetone	43	58		5
1,1-Dichloroethene	96	96	63	5
Methylene Chloride	84	84	86	5
Freon-113	101	101	103	5
Allyl chloride	76	41	78	5
Carbon Disulfide	76	78		5
Trans-1,2-Dichloroethene	61	96	98	5
Methyl Tert-Butyl Ether	73	41	53	5
1,1-Dichloroethane	63	27	65	5
Vinyl Acetate	43	86		5
Methyl Ethyl Ketone	43	57	72	5
cis-1,2-Dichloroethylene	61	96	98	5
Hexane	57	41	43	5
Ethyl Acetate	43	45	61	5
Chloroform	83	85	47	5
Tetrahydrofuran	42	71	72	5

1,2-Dichloroethane	62	27	64	5
1,1,1-Trichloroethane	97	99	61	5
Cyclohexane	56	41	84	5
Carbon Tetrachloride	117	119		5
Benzene	78	77	50	5
1,4-Dioxane	88	58		20
2,2,4-Trimethylpentane	57	41	56	5
Heptane	43	57	71	5
1,2-Dichloropropane	63	41	62	5
Trichloroethylene	130	132	95	5
Bromodichloromethane	83	85		5
cis-1,3-Dichloropropene	75	39	77	5
Trans-1,3-Dichloropropene	75	39	77	5
1,1,2-Trichloroethane	97	83	61	5
Toluene	92	91	92	5
Dibromochloromethane	129	127		5
Methyl Isobutyl Ketone	43	57	58	20
Methyl Butyl Ketone	43	57	58	20
1,2-Dibromomethane	107	109	27	5
Tetrachloroethylene	164	164	131	5
Chlorobenzene	112	77	114	5
Ethylbenzene	91	106		5
Bromoform	173	175		5
Styrene	104	78	103	5
o-xylene	91	106		5
m–xylene	91	106		5
p –xylene	91	106		5
1,1,2,2-Tetrachloroethane	83	85		5
4-Ethyltoluene	105	120		5
1,3,5-Trimethylbenzene	105	120		5
1,2,4-Trimethylbenzene	105	120		5

1,3-Dichlorobenzene	146	148	111	5
Benzyl Chloride	91	126		5
1,4-Dichlorobenzene	146	148	111	5
1,2-Dichlorobenzene	146	148	111	5
1,2,4-Trichlorobenzene	180	182	184	5
Hexachloro-1,3-Butadiene	225	227	223	5
Bromofluorobenzene (surrogate)	95			-
*Bromochloromethane	128			-
*1,4-Difluorobenzene	114			-
*Chlorobenzene-d5	117			-

*Indicates internal standard

Table 3

Volatile Internal Standards with Corresponding Analytes
Assigned for Quantitation

*Bromochloromethane	*1,4-Difluorobenzene	*Chlorobenzene-d5
Propylene	1,1,1-Trichloroethane	Toluene
Freon-12	Cyclohexane	Dibromochloromethane
Chloromethane	Carbon Tetrachloride	Methyl Isobutyl Ketone
Fron-114	Benzene	Methyl Butyl Ketone
Vinyl Chloride	1,4-Dioxane	1,2-Dibromomethane
Bromomethane	2,2,4-Trimethylpentane	Tetrachloroethylene
Chloroethane	Heptane	Chlorobenzene
Vinyl Bromide	1,2-Dichloropropane	Ethylbenzene
Freon-11	Trichloroethylene	Bromoform
Isopropyl Alcohol	Bromodichloromethane	Styrene
Acetone	cis-1,3-Dichloropropene	o-xylene
1,1-Dichloroethane	Trans-1,3-Dichloropropene	m -xylene
Methylene Chloride	1,1,2-Trichloroethane	p-xylene
Freon-113		1,1,2,2-Tetrachloroethane
Allyl Chloride		4-Ethyltoluene
Carbon Disulfide		1,3,5-Trimethylbenzene
Trans-1,2-Dichlorethene		1,2,4-Trimethylbenzene
Methyl Tert-Butyl Ether		1,3-Dichlorobenzene
1,1-Dichloroethane		Benzyl Chloride
Vinyl Acetate		1,4-Dichlorobenzene
Methyl Ethyl Ketone		1,2-Dichlorobenzene
Cis-1,2-Dichloroethylene		1,2,4-Trichlorobenzene
Hexane		Hexachloro-1,3-Butadiene
Ethyl Acetate		Bromofluorobenzene (surrogate)
Chloroform		
Tetrahydrofuran		
1,2-Dichloroethane		

*Indicates internal standard

Centek Laboatories

MDL Study for 0.25TCE

February 28, 2006

Instrumen #1
Units=ppb

Name	***Amount***	***IDL #1***	***IDL #2***	***IDL #3***	***IDL #4***	***IDL #5***	***IDL #6***	***IDL #7***	***Avg***	***Stdev***	***%Rec***	**IDL**
Freon 12	0.100	0.140	0.140	0.130	0.130	0.120	0.120	0.120	0.129	0.009	129	0.028
Freon 114	0.100	0.120	0.140	0.130	0.140	0.130	0.130	0.120	0.130	0.008	130	0.025
Vinyl Chloride	0.100	0.120	0.120	0.110	0.110	0.120	0.120	0.110	0.116	0.005	116	0.016
Freon 11	0.100	0.140	0.140	0.120	0.130	0.130	0.130	0.120	0.130	0.008	130	0.025
1,1-dichloroethene	0.100	0.110	0.120	0.120	0.120	0.120	0.130	0.110	0.119	0.007	119	0.022
Freon 113	0.100	0.140	0.130	0.130	0.130	0.120	0.130	0.120	0.129	0.007	129	0.022
Methylene chloride	0.100	0.130	0.140	0.110	0.130	0.140	0.130	0.120	0.129	0.011	129	0.035
trans-1,2-dichloroethene	0.100	0.110	0.130	0.090	0.110	0.100	0.110	0.100	0.107	0.013	107	0.041
1,1-dichloroethane	0.100	0.120	0.130	0.110	0.120	0.120	0.110	0.110	0.117	0.008	117	0.025
cis-1,2-dichloroethene	0.100	0.100	0.100	0.090	0.110	0.090	0.100	0.100	0.099	0.007	99	0.022
1,2-dichloroethane	0.100	0.130	0.120	0.120	0.130	0.110	0.100	0.120	0.119	0.011	119	0.035
1,1,1-trichloroethane	0.100	0.140	0.160	0.140	0.170	0.140	0.140	0.140	0.147	0.013	147	0.041
Benzene	0.100	0.110	0.120	0.110	0.130	0.090	0.110	0.110	0.111	0.012	111	0.038
Trichloroethene	***0.100***	***0.090***	***0.110***	***0.100***	***0.110***	***0.100***	***0.100***	***0.110***	***0.103***	***0.008***	***103***	***0.025***
1,1,2-trichloroethane	0.100	0.140	0.160	0.150	0.140	0.130	0.130	0.130	0.140	0.012	140	0.038
Toluene	0.100	0.100	0.120	0.100	0.100	0.090	0.110	0.100	0.103	0.010	103	0.031
Tetrachloroethylene	0.100	0.140	0.140	0.120	0.140	0.120	0.120	0.130	0.130	0.010	130	0.031
Ethylbenzene	0.100	0.110	0.110	0.100	0.120	0.090	0.110	0.110	0.107	0.010	107	0.031
m&p-xylene	0.200	0.170	0.180	0.180	0.180	0.170	0.170	0.170	0.174	0.005	87	0.016
o-xylene	0.100	0.100	0.090	0.090	0.100	0.100	0.090	0.090	0.094	0.005	94	0.016
Bromofluorobenzene	1.000	0.910	0.820	0.860	0.830	0.900	0.830	0.880	0.861	0.036	86	0.113

Centek Laboatories

MDL Study for 1ug/M3

February 28, 2006

Instrumen #1
Units=ppb

Name	***Amount***	***IDL #1***	***IDL #2***	***IDL #3***	***IDL #4***	***IDL #5***	***IDL #6***	***IDL #7***	***Avg***	***Stdev***	***%Rec***	**IDL**
Propylene	0.30	0.29	0.31	0.28	0.32	0.31	0.31	0.28	0.300	0.016	100	0.050
Freon 12	0.30	0.33	0.35	0.28	0.35	0.33	0.36	0.33	0.333	0.026	111	0.082
Chloromethane	0.30	0.33	0.37	0.30	0.37	0.34	0.37	0.32	0.343	0.028	114	0.088
Freon 114	0.30	0.32	0.36	0.30	0.37	0.34	0.36	0.34	0.341	0.025	114	0.079
Vinyl Chloride	0.30	0.32	0.33	0.27	0.33	0.29	0.34	0.30	0.311	0.025	104	0.079
1,3-butadiene	0.30	0.28	0.30	0.31	0.28	0.30	0.32	0.27	0.294	0.018	98	0.057
Bromomethane	0.30	0.31	0.31	0.31	0.35	0.33	0.35	0.31	0.324	0.019	108	0.060
Chloroethane	0.30	0.32	0.35	0.28	0.33	0.32	0.33	0.33	0.323	0.021	108	0.066
Vinyl Bromide	0.30	0.31	0.32	0.27	0.32	0.30	0.32	0.30	0.306	0.018	102	0.057
Freon 11	0.30	0.33	0.35	0.30	0.35	0.32	0.35	0.32	0.331	0.020	110	0.063
Acetone	0.30	0.28	0.34	0.26	0.31	0.31	0.30	0.34	0.306	0.029	102	0.091
Isopropyl alcohol	0.30	0.30	0.33	0.29	0.28	0.31	0.30	0.34	0.307	0.021	102	0.066
1,1-dichloroethene	0.30	0.28	0.29	0.26	0.29	0.28	0.30	0.28	0.283	0.013	94	0.041
Freon 113	0.30	0.32	0.35	0.29	0.36	0.33	0.35	0.31	0.330	0.025	110	0.079
Methylene chloride	0.30	0.30	0.32	0.29	0.34	0.31	0.35	0.31	0.317	0.021	106	0.066
Allyl chloride	0.30	0.28	0.32	0.25	0.27	0.26	0.27	0.31	0.280	0.026	93	0.082
Carbon disulfide	0.30	0.30	0.32	0.27	0.33	0.30	0.33	0.32	0.310	0.022	103	0.069
trans-1,2-dichloroethene	0.30	0.28	0.31	0.29	0.31	0.28	0.28	0.25	0.286	0.021	95	0.066
methyl tert-butyl ether	0.30	0.25	0.27	0.24	0.26	0.24	0.26	0.28	0.257	0.015	86	0.047
1,1-dichloroethane	0.30	0.30	0.33	0.28	0.32	0.30	0.31	0.29	0.304	0.017	101	0.053
Vinyl acetate	0.30	0.25	0.26	0.22	0.25	0.27	0.27	0.25	0.253	0.017	84	0.053
Methyl Ethyl Ketone	0.30	0.29	0.25	0.27	0.24	0.23	0.25	0.29	0.260	0.024	87	0.075
cis-1,2-dichloroethene	0.30	0.28	0.29	0.27	0.28	0.24	0.27	0.25	0.269	0.018	90	0.057
Hexane	0.30	0.26	0.27	0.26	0.29	0.28	0.27	0.25	0.269	0.013	90	0.041
Ethyl acetate	0.30	0.28	0.29	0.30	0.30	0.28	0.27	0.33	0.293	0.020	98	0.063
Chloroform	0.30	0.32	0.34	0.28	0.36	0.33	0.34	0.31	0.326	0.026	109	0.082
Tetrahydrofuran	0.30	0.26	0.29	0.27	0.29	0.25	0.24	0.27	0.267	0.019	89	0.060
1,2-dichloroethane	0.30	0.31	0.33	0.28	0.28	0.33	0.35	0.30	0.311	0.027	104	0.085
1,1,1-trichloroethane	0.30	0.36	0.37	0.35	0.39	0.37	0.38	0.36	0.369	0.013	123	0.041
Cyclohexane	0.30	0.25	0.26	0.23	0.27	0.27	0.28	0.23	0.256	0.020	85	0.063
Carbon tetrachloride	0.30	0.37	0.39	0.36	0.44	0.41	0.42	0.37	0.394	0.030	131	0.094
Benzene	0.30	0.29	0.30	0.33	0.34	0.32	0.31	0.34	0.319	0.020	106	0.063
1,4-dioxane	0.30	0.32	0.32	0.29	0.33	0.29	0.30	0.25	0.300	0.027	100	0.085
2,2,4-trimethylpentane	0.30	0.27	0.27	0.25	0.30	0.27	0.31	0.25	0.274	0.023	91	0.072
Heptane	0.30	0.26	0.28	0.22	0.30	0.28	0.28	0.24	0.266	0.028	89	0.088

Trichloroethene	0.30	0.32	0.31	0.31	0.37	0.35	0.35	0.32	0.333	0.024	111	0.075
1,2-dichloropropane	0.30	0.33	0.34	0.37	0.37	0.35	0.37	0.34	0.353	0.017	118	0.053
Bromodichloromethane	0.30	0.35	0.37	0.35	0.38	0.38	0.38	0.35	0.366	0.015	122	0.047
cis-1,3-dichloropropene	0.30	0.28	0.28	0.29	0.30	0.29	0.30	0.26	0.286	0.014	95	0.044
trans-1,3-dichloropropene	0.30	0.27	0.33	0.32	0.30	0.34	0.32	0.29	0.310	0.024	103	0.075
1,1,2-trichloroethane	0.30	0.36	0.36	0.33	0.38	0.37	0.37	0.35	0.360	0.016	120	0.050
Toluene	0.30	0.25	0.27	0.26	0.32	0.26	0.26	0.25	0.267	0.024	89	0.075
Methyl Isobutyl Ketone	0.30	0.25	0.39	0.34	0.30	0.31	0.30	0.35	0.320	0.045	107	0.141
Dibromochloromethane	0.30	0.32	0.34	0.33	0.40	0.36	0.37	0.33	0.350	0.028	117	0.088
Methyl Butyl Ketone	0.30	0.31	0.33	0.33	0.33	0.34	0.34	0.30	0.326	0.015	109	0.047
1,2-dibromoethane	0.30	0.32	0.33	0.31	0.37	0.34	0.35	0.32	0.334	0.021	111	0.066
Tetrachloroethylene	0.30	0.30	0.35	0.32	0.38	0.34	0.35	0.32	0.337	0.026	112	0.082
Chlorobenzene	0.30	0.30	0.32	0.28	0.34	0.32	0.34	0.30	0.314	0.022	105	0.069
Ethylbenzene	0.30	0.25	0.26	0.23	0.29	0.25	0.27	0.24	0.256	0.020	85	0.063
m&p-xylene	0.60	0.48	0.50	0.47	0.55	0.48	0.50	0.47	0.493	0.028	82	0.088
Styrene	0.30	0.26	0.29	0.26	0.30	0.27	0.29	0.27	0.277	0.016	92	0.050
Bromoform	0.30	0.33	0.35	0.32	0.40	0.36	0.38	0.34	0.354	0.028	118	0.088
o-xylene	0.30	0.28	0.29	0.27	0.26	0.29	0.31	0.29	0.284	0.016	95	0.050
Bromofluorobenzene	1.00	0.90	0.91	0.92	0.92	0.91	0.88	0.89	0.904	0.015	90	0.047
1,1,2,2-tetrachloroethane	0.30	0.35	0.38	0.35	0.42	0.38	0.41	0.38	0.381	0.027	127	0.085
4-ethyltoluene	0.30	0.28	0.29	0.27	0.29	0.29	0.29	0.28	0.284	0.008	95	0.025
1,3,5-trimethylbenzene	0.30	0.24	0.24	0.23	0.25	0.24	0.26	0.22	0.240	0.013	80	0.041
1,2,4-trimethylbenzene	0.30	0.27	0.23	0.26	0.26	0.27	0.25	0.23	0.253	0.017	84	0.053
1,3-dichlorobenzene	0.30	0.28	0.30	0.25	0.33	0.29	0.30	0.27	0.289	0.025	96	0.079
benzyl chloride	0.30	0.30	0.28	0.30	0.28	0.26	0.27	0.27	0.280	0.015	93	0.047
1,4-dichlorobenzene	0.30	0.27	0.28	0.26	0.31	0.26	0.27	0.29	0.277	0.018	92	0.057
1,2-dichlorobenzene	0.30	0.27	0.29	0.30	0.32	0.29	0.32	0.29	0.297	0.018	99	0.057
1,2,4-trichlorobenzene	0.30	0.32	0.32	0.27	0.31	0.32	0.28	0.28	0.300	0.022	100	0.069
Hexachloro-1,3-butadiene	0.30	0.32	0.35	0.31	0.38	0.37	0.36	0.35	0.349	0.025	116	0.079