U.S. ARMY CORPS OF ENGINEERS

FINAL

INDOOR AIR QUALITY REPORT #5

FORMER RARITAN ARSENAL EDISON, NEW JERSEY

Contract Number:
W912BV-04-D-2024
Delivery Order 0019

March 2011

Prepared for:

U.S. ARMY CORPS OF ENGINEERS

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LIST OF ABBREVIATIONS

Amax	-	Amax Engineering Corporation
AOC	-	area of concern
ATSDR	-	Agency for Toxic Substances and Disease Registry
bgs	-	below ground surface
Brooks	-	Brooks Equipment Company
Building 151	-	151 Fieldcrest Avenue
Building 160	-	160 Fieldcrest Avenue
Building 165	-	165 Fieldcrest Avenue
C	-	cancer
CD		Compact Disc
Celsis	-	Celsis Laboratory Group
cis-1,2-DCE	-	cis-1,2-dichloroethene
Clayton	-	Clayton Group Service
CLR	-	Calcium Lime Rust
cm	-	centimeter
COPC	-	contaminant(s) of potential concern
CSSC	-	Coordinated Systems & Services Corporation
DERP-FUDS	-	Defense Environmental Restoration Program – Formerly Used Defense Sites
DOD	-	Department of Defense
EPA	-	United States Environmental Protection Agency
EPA Table 2C-GW	-	EPA Generic Screening Benchmarks for Target Indoor Air Concentrations – Groundwater
EPA Table 2C-SSG	-	EPA Generic Screening Benchmarks for Target Indoor Air Concentrations – Shallow Soil Gas
FBC	-	Federal Business Centers
Former Arsenal	-	Former Raritan Arsenal
ft	-	feet
GWQS	-	Groundwater Quality Standard(s)
i2t2	-	International Information Technology Team
IAQ	-	indoor air quality
IAQ Approach	-	Approach for Evaluating Potential Indoor Air Quality Impacts (USACE, 2001)
Mackay	-	Mackay Communications
Method TO-15	-	Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air: Method TO-15, Second Edition (EPA, January 1999)
mg/kg	-	milligram per kilogram
mg/kg-d	-	milligrams per kilogram per day
mg/L	-	milligrams per liter
MNA	-	Monitored Natural Attenuation
MOL	-	MOL America, Inc.

LIST OF ABBREVIATIONS
(Continued)

MRL	-	Minimal Risk Levels
MSDS	-	Material Safety Data Sheet
MSSCC	-	Most Stringent Soil Cleanup Criteria
MTBE	-	methyl tertiary butyl ether
N	-	Noncancer
NIOSH	-	National Institute for Occupational Safety and Health
NJDEP	-	New Jersey Department of Environmental Protection
OSHA	-	Occupational Safety and Health Administration
PCE	-	tetrachloroethylene
PEL	-	permissible exposure limits
PID	-	photoionization detector
QC	-	Quality Control
RA	-	remedial action
RAWP	-	Remedial Action Work Plan
RBC	-	EPA Region III Risk Based Concentrations for Indoor Air
RD/RA	-	remedial design/remedial action
RI/FS	-	Remedial Investigation/Feasibility Study
SOP		Standard Operating Procedure
Shaw		Shaw Environmental, Inc.
TAGA	-	trace atmospheric gas analyzer
TCE	-	trichloroethylene
THQ	-	total hazard quotient
TR	-	target risk
ug/L	-	micrograms per liter
ug/m^3	-	micrograms per cubic meter
USACE	-	United States Army Corps of Engineers
USI	-	US Infrastructure, Inc.
VIG	-	Vapor Intrusion Guidance
VOC	-	volatile organic compound
Weston®	-	Weston Solutions, Inc.

EXECUTIVE SUMMARY

The United States Army Corps of Engineers (USACE) is conducting an ongoing Remedial Investigation/Feasibility Study (RI/FS), and Remedial Design/Remedial Action (RD/RA) activities at the former Raritan Arsenal under the Defense Environmental Restoration Program/Formerly Used Defense Sites (DERP/FUDS). The New Jersey Department of Environmental Protection (NJDEP) provides regulatory oversight. The investigations have included ongoing sampling to evaluate potential vapor intrusion into buildings from volatile organic compounds (VOCs) in soil and groundwater. Beginning in 2003 the scope of the monitoring program to date has focused on Groundwater Areas of Concern (AOCs) 2, 4, 6, 8, and 10. Since that time, the USACE has been able to demonstrate that no further monitoring in AOCs 4 and 10 is required. In addition, the number of buildings that required monitoring in the remaining AOCs has also been reduced. USACE has evaluated all Groundwater AOCs with current/historical exceedances (attributable to historic Army contamination) of the New Jersey Department of Environmental Protection (NJDEP) Vapor Intrusion Guidance (VIG) groundwater screening levels. This report focuses on the results from indoor air and sub-slab soil gas sampling events completed during the period from December 2008 through May 2009, and summarize results relative to prior sampling events. Future reports will summarize sampling results on an annual basis.

Buildings requiring investigation were sampled for VOCs in sub-slab soil gas and indoor air. Building walkthroughs were conducted and the *NJDEP Building Survey and Sampling Form* was completed prior to the sampling to identify non-vapor-migration-related potential sources of indoor air contaminants. Indoor air samples were collected with a SUMMA canister. Leak tests were performed for each sub-slab soil gas sample using a tracer gas. Upon completion of indoor air sampling, sub-slab soil gas samples were collected using the previously installed sample ports through the building slab, and drawing the soil gas into a SUMMA canister. The results of all the data were evaluated collectively to determine whether the vapor intrusion pathway is complete for each building, to make recommendations for future action, and/or to determine if existing vapor mitigation systems are operating effectively. A summary of results and recommendations for each building sampled during this period is provided in Executive Summary Tables (ES) provided in this section. Leak test results are presented in Appendix A at the end of this document.

AOC 2

A total of three buildings were sampled within AOC 2 (Table ES-1) during the current investigation. The following section provides a summary of analytical results and recommendations for subject buildings located within AOC-2.

Building 165 Fieldcrest Avenue:

The building located at 165 Fieldcrest Avenue (Building 165) had recent (2009) sampling results showing a decreasing trend in volatile organic concentration in the sub-slab. Tetrachloroethelene (PCE) exceeded regulatory sub-slab screening levels at one sampling port (SG-04 Celsis). No other volatile organics exceeded sub slab screening levels. However, volatile organic compounds (benzene, chloroform and methylene chloride) continue to be detected above regulatory screening levels in the indoor air samples. After an evaluation of the data from the most recent sampling rounds (March 2009), continued semi-annual monitoring is proposed for

Building 165. For Building 165, the adequacy of the monitoring program will continue to be reevaluated on an annual basis to determine whether to remain on the same or reduced monitoring frequency for the subsequent year. It is also recommended that the vapor recovery system at Building 165 continue to be monitored on a semi-annual frequency.

Building 151 Fieldcrest Avenue:

The collection of indoor air samples within Building 151 has been discontinued based on past results that continue to show little to no volatile organic compound pathway between sub-slab and indoor air. However, because of the location of this building in relationship to the AOC-2 plume, the USACE and the NJDEP have agreed to continue annual sub-slab sampling for this building for the next 3 years. Recent analytical data collected for the building located at 151 Fieldcrest Avenue (Building 151) continues to show volatile organic compounds in the sub-slab. However, overall levels remain low with only one volatile organic compound (Benzene) exceeding only residential NJDEP soil gas screening levels. The exceedence occurred at one sub-slab port (SG-5). Sub-slab sampling will continue as per the USACE and NJDEP agreement.

A passive mitigation system was installed in June 2008 as a pre-emptive measure to address elevated soil gas concentration of VOCs. The passive mitigation system consists of six vent pipes with wind-driven turbines. Performance monitoring reports were submitted on March 17, 2009, August 20, 2009 and December 15, 2009. A Remedial Progress Report was submitted to NJDEP during May 2010. All activities for this building have been performed and submitted separately and data is not included in this Report.

Building Campus Plaza 4:

Recent sub-slab analytical results for Campus Plaza 4 continue to show elevated levels of tetrachloroethylene and trichloroethylene above regulatory residential and non-residential screening levels. Recent indoor air analytical results continue to have levels for these compounds below regulatory screening levels. The USACE has agreed to continue both sub-slab and indoor air sampling for this building.

AOC 6

Building 102-168 Fernwood Avenue:

Only one building within AOC 6 (Table ES-2) requires semi-annual monitoring. The building located at 102-168 Fernwood Avenue within AOC 6 has a history of evaluated levels of volatile organics during the current and past investigations. Recent indoor air and sub-slab analytical results continue to show volatile organic compounds exceeding regulatory screening levels at several different sampling points. During the most recent sampling event only indoor air sampling point exceed the regulatory screening levels for PCE. Trichloroethylene (TCE) was not detected above regulatory screening levels for any sampling point. However sub slab soil gas at two locations is five times the screening number for TCE. Based on this information USACE is continuing to collect indoor air/soil gas data through the fall of 2009. In addition, the USACE installed a sub-slab venting mitigation system to address volatile organic soil gas beneath the building. The system has been online since October 2, 2009. Geosyntec collected passive samples for three vents associated with the mitigation system. Passive samples were

deployed on October 19, 2009 and collected November 2, 2009 for a total duration of 20,160 minutes. Samples were analyzed for PCE and TCE. A copy of the results and system installation details is presented in Appendix B, *Interim Progress Report and Request for Site-Specific Soil Gas Screening Levels, Sub-slab Venting System 102-168 Fernwood Avenue, Former Raritan Arsenal, Edison, New Jersey*. Additional sampling beyond the fall of 2009 is dependent on the results of the Interim Progress Report and Performance Monitoring Report for the sub-slab venting system.

AOC 8

A total of five buildings were sampled within AOC 8 (Table ES-3) during the current investigation. All five buildings are owned and occupied by the United States Environmental Protection Agency (USEPA) located on Woodbridge Avenue. The following section provides a summary of analytical results and recommendations for subject buildings located within AOC-8.

USEPA Building 10:

Recent sub-slab analytical results for EPA Building 10 did not detected concentrations of PCE or TCE in the soil gas and indoor air samples above regulatory limits. However, methylene chloride was detected in one sub-slab soil gas sample (SG-03 Hallway, under electrical panel) at a concentration exceeding the regulatory screening levels. Methylene chloride was not detected in groundwater analytical data. In addition, this is the first exceedance for methylene chloride in soil gas in 10 sampling events dating back to January 2005. Methylene chloride was assumed to be related to non-DOD activities. EPA Building 10 currently has a sub-slab remediation system in place. Continued semi-annual sub-slab and indoor air sampling of this building is recommended with emphases on insuring that the sub-slab system is operating properly.

USEPA Building 18:

Recent results for EPA Building 18 detected TCE and Benzene concentrations in one sub-slab air sample that exceeded current regulatory screening levels. PCE concentrations in the most recent sampling event did not exceed regulatory limits for sub-slab soil gas. Benzene, PCE and TCE indoor air concentrations did not exceed regulatory screening levels for all samples. Indoor air concentrations of methylene chloride above regulatory screening levels were detected at two location points (018-04 and 018-05). Methylene chloride was not detected in groundwater analytical data or in any sub-slab soil gas concentration and was assumed to be related to non-DOD activities. EPA Building 18 also has a sub-slab remediation system. Continued semi-annual sub-slab and indoor air sampling of this building is recommended with emphases on insuring that the sub-slab system is operating properly.

USEPA Building 200:

Previous sub-slab and indoor air sampling results corroborated that a complete vapor intrusion pathway existed from groundwater to soil gas to indoor air at Building 200. However, data from the last five sampling events show a significant decrease in concentrations of PCE and TCE in sub-slab soil gas. Both constituents have not been detected above NJDEP VIG screening levels since November 2007. Another significant trend is that PCE has not been detected in either the indoor air or sub-slab soil gas in concentrations above NJDEP VIG screening levels since March 2006. TCE was detected in indoor air above NJDEP VIG screening levels during the December

2008 fall sampling event. Methylene chloride has also been detected in the sub-slab soil gas above NJDEP VIG screening levels, but its elevated concentration cannot be explained as it does not exist in the ground water above NJDEP Groundwater Standards.

It appears that the sub-slab venting/depressurization system installed by the building owner is operating properly. The USACE has agreed to monitor Building 200 to ensure the effectiveness of the system. It should be noted that there is no vent on this system that would allow vapor recovery samples to be collected.

Historical analytical data from sampling events starting in June 2008 through and including May 2009 continue to show no TCE or PCE concentrations above both indoor air and sub-slab soil gas screening levels. Similar to EPA Buildings 10 and 18, EPA Building 200 currently has an active sub-slab remediation system. The monitoring of Building 200 will continue to be performed to monitor the proper operation of the remediation system. However, USACE will recommend reduced frequency for monitoring of Building 200.

USEPA Building 205:

For EPA Building 205, concentrations of PCE and TCE were not detected in the sub-slab exceeding current regulatory screening levels. The last three sampling events (June 2008, September 2008 and March 2009) did not detect both PCE and TCE above the current regulatory screening levels. In addition, both PCE and TCE were not detected above regulatory screening levels for indoor air during the last sampling event. Methylene chloride was detected in the sub-slab soil gas above current regulatory screening levels at one sampling point (SG-15). It was also detected above the residential regulatory screening level for indoor air at two locations (205-11 and 205-19). Methylene chloride was not detected in groundwater analytical data or in any sub-slab soil gas concentration and was assumed to be related to non-DOD activities. However, Building 205 was undergoing renovation during the most recent sampling event and could have been affected by those activities. Building 205 also has a sub-slab remediation system. Continued semi-annual sub-slab and indoor air sampling of this building is recommended with emphases on insuring that the sub-slab system is operating properly.

USEPA Building 209:

PCE, chloroform and methylene chloride were detected in sub-slab soil gas under Building 209 at concentrations exceeding their respective regulatory screening levels. Methylene chloride was also detected in several indoor air sampling location points during this recent sampling event, as well as, previous sampling events (September 2008, June 2008, and November 2007). Therefore, continued monitoring on a semi-annual basis is recommended for EPA Building 209.

TABLE ES-1
AOC 2 SAMPLING RESULTS AND PROPOSED ACTION SUMMARY

Area of Concern AOC 2	Results Summary	Proposed Action
Building 165	This Report #5 includes data from the most recently sampled events that includes March 2009 only. PCE exceeded regulatory sub-slab screening levels at one sampling port (SG-04 Celsis). No other volatile organics exceeded sub slab screening levels. However, volatile organic compounds continue to be detected above NJDEP VIG Screening Levels in both the indoor air samples and the vapor recovery system.	Continue monitoring the building on a semiannual basis to monitor the effectiveness of the vapor recovery system. The adequacy of the monitoring program will continue to be reevaluated on an annual basis to determine whether to maintain the same or reduced monitoring frequency for the subsequent year.
Building 151	This Report #5 includes analytical data from the most recent sampling event from March 2009 only. Report #5 only includes one round of sub-slab soil gas sampling. Recent analytical data collected for the building located at 151 Fieldcrest Avenue (Building 151) continues to show volatile organic compounds in the sub-slab. However, overall levels remain low with only one volatile organic compound (Benzene) exceeding only residential NJDEP soil gas screening levels. The exceedence occurred at one sub-slab port (SG-5). There were no other sub-slab exceedances during the March 2009 sampling event.	USACE has agreed to three consecutive annual sub-slab sampling rounds over the next three years to monitor this building. The first of these rounds was collected in June 2008, the second round was collected in March 2009 (presented in this report), and the final round will be collected in February 2010.
Campus Plaza 4	Report #5 includes sub-slab and indoor air analytical for sampling conducted in March 2009. Recent sub-slab analytical results for Campus Plaza 4 continue to show elevated levels of tetrachloroethylene and trichloroethylene above regulatory residential and non-residential screening levels. Recent indoor air analytical results continue to have levels for these compounds below NJDEP VIG Generic Screening Levels.	Sampling continues to support that levels of PCE and TCE are being detected well below NJDEP Indoor Air Screening Level. This does not necessarily indicate a pathway from soil gas or groundwater, but because PCE and TCE are still be detected in indoor air, a vapor intrusion may exist. USACE proposes to continue sampling indoor air and sub slab soil gas for this building on a semi-annual basis through February 2010. .

TABLE ES-2
AOC 6 SAMPLING RESULTS AND PROPOSED ACTION SUMMARY

Area of Concern AOC 6	Results Summary	Proposed Action
102-168 Fernwood Avenue	Report #5 contains sub-slab and indoor air analytical results for February 2009. During the most recent sampling event only indoor air sampling point exceed NJDEP VIG Screening Levels for PCE. TCE was not detected above regulatory screening levels for any sampling point. However sub slab soil gas at two locations is five times the NJDEP VIG Screening Level for TCE.	A sub-slab venting mitigation system was installed by Geosyntec and was operational on October 2, 2009. Semi-annual sampling will continue thru the fall of 2010. Thereafter, semi-annual sampling will be reconsidered based on the results of the mitigation system and passive sampling by Geosyntec. A schedule is currently being developed to convert the active mitigation system to a passive system and conduct post-conversion monitoring after one month, 6 months and 12 months using WMS samplers. This approach was submitted to NJDEP in a stand-alone report dated February 2010.

TABLE ES-3
AOC 8 SAMPLING RESULTS AND PROPOSED ACTION SUMMARY

Area of Concern AOC 8	Results Summary	Proposed Action
EPA Building 10	Report #5 contains sub-slab and indoor air analytical results for March 2009. Recent sub-slab analytical results for EPA Building 10 did not detected concentrations of PCE or TCE in the soil gas and indoor air samples above regulatory limits. However, one indoor air concentration of methylene chloride above regulatory screening levels was detected in the sub-slab (SG-03 Hallway, under electrical panel). Methylene chloride was not detected in groundwater analytical data. In addition, this is the first exceedance for methylene chloride in soil gas in 10 sampling events dating back to January 2005. Methylene chloride was assumed to be related to non-DOD activities.	EPA Building 10 currently has a sub-slab remediation system in place. Sub-slab and indoor air monitoring will continue on a semi-annual frequency.
EPA Building 18	Report #5 contains sub-slab and indoor air analytical results for March 2009. Recent results for EPA Building 18 detected TCE and Benzene concentrations in one sub-slab air sample that exceeded current regulatory screening levels. PCE concentrations in the most recent sampling event did not have concentrations that exceed regulatory limits for sub-slab soil gas. Benzene, PCE and TCE indoor air concentrations did not exceed regulatory screening levels for all samples. Indoor air concentrations of methylene chloride above regulatory screening levels were detected at two location points (018-04 and 018-05). Methylene chloride was not detected in groundwater analytical data or in any sub-slab soil gas concentration and was assumed to be related to non-DOD activities.	EPA Building 18 also has a sub-slab remediation system. Continued semi-annual sub-slab and indoor air sampling of this building is recommended with emphases on insuring that the sub-slab system is operating properly.
EPA Building 200	Report #5 contains sub-slab and indoor air analytical results for 3 sampling events for December 2008, March 2009, and May 2009. Data from the last five sampling events show a significant decreasing trend in sub-slab soil gas concentrations for PCE and TCE. TCE was detected in indoor air above NJDEP VIG screening levels during the December 2008 fall sampling event. Methylene chloride has also been detected in the sub-slab soil gas above NJDEP VIG screening levels, but its elevated concentration cannot be explained as it does not exist in the ground water above NJDEP Groundwater Standards. 1-4, Dichlorobenzene was detected above the NJDEP VIG screening levels for indoor air in one sample collected in March 2009. Dichlorobenzene was never detected in any previous indoor air sample for this building during the past 12 sampling events.	Quarterly sampling has been performed June 2006 through Winter 2009. A reduction in frequency to semi-annual will be recommended beginning in Summer 2010.

TABLE ES-3 (CONTINUED)
AOC 8 SAMPLING RESULTS AND PROPOSED ACTION SUMMARY

Area of Concern AOC 8	Results Summary	Proposed Action
EPA Building 205	Report #5 contains sub-slab and indoor air analytical results for March 2009. For EPA Building 205, concentrations of PCE and TCE were not detected in the sub-slab exceeding current regulatory screening levels. The last three sampling events (June 2008, September 2008 and March 2009) did not detect both PCE and TCE above the current regulatory screening levels. In addition, both PCE and TCE were not detected above regulatory screening levels for indoor air during the last sampling event. Methylene chloride was detected in the sub soil above current regulatory screening levels at one sampling point (SG-15). It was also detected above the residential regulatory screening level for indoor air at two locations (205-11 and 205-19). Methylene chloride was not detected in groundwater analytical data or in any sub-slab soil gas concentration and was assumed to be related to non-DOD activities. However, Building 205 was undergoing renovation during the most recent sampling event and could have been affected by those activities.	Building 205 also has a sub-slab remediation system. Continued semi-annual sub-slab and indoor air sampling of this building is recommended with emphases on insuring that the sub-slab system is operating properly.
EPA Building 209	Report #5 contains sub-slab and indoor air analytical results for March 2009. PCE, chloroform and methylene chloride were detected in sub-slab soil gas under Building 209 at concentrations exceeding their respective regulatory screening levels. Methylene chloride was also detected in several indoor air sampling location points during this recent sampling event, as well as, previous sampling events (September 2008, June 2008, and November 2007). However, the elevated concentration of methylene chloride cannot be explained as it has not been detected above benchmark levels in the groundwater. It should be noted that methylene chloride was detected in the ambient air sample. This has occurred in other ambient samples during previous sampling events for EPA Building 209.	Sub-slab and indoor air monitoring will continue on a semi-annual frequency.

SECTION 1.0
INTRODUCTION

1.1 OBJECTIVE

The U.S. Army Corps of Engineers (USACE) retained Shaw Environmental, Inc. (Shaw) to evaluate the potential for vapor intrusion into buildings from contaminated groundwater at the Former Raritan Arsenal (former Arsenal) site in Edison, NJ. The objective of this report is to summarize and evaluate indoor air, sub-slab soil gas, and historical groundwater sampling results at each of the buildings recommended for continued evaluation per the Final Indoor Air Quality Semi-Annual Report #4 (Shaw, April 2009), to assess whether a complete exposure pathway exists, and to provide recommendations on the need for further action.

This document reports the recent sampling results for buildings sampled within Groundwater Areas of Concern (AOCs) 2, 6, and 8 for the period of December 2008 through May 2009. As recommended in past air quality reports (*Indoor Air Quality Semi-Annual Reports #2 through #4 Weston, September 2006, Weston, July 2008 and Shaw April 2009*) , the buildings associated with Groundwater AOC 4 and 10 did not require any further investigation or action; therefore, Groundwater AOC 4 and AOC-10 are not included in this report.

As described in this report, USACE has evaluated all Groundwater AOCs with current/historical exceedances (attributable to historic Army contamination) of the New Jersey Department of Environmental Protection (NJDEP) Vapor Intrusion Guidance (VIG) groundwater screening levels.

1.2 BACKGROUND

The USACE is conducting Remedial Investigation/Feasibility Study (RI/FS) and Remedial Design/Remedial Action (RD/RA) activities at the former Arsenal under the Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS). NJDEP provides regulatory oversight for the project. Through these activities, USACE and NJDEP have identified seven Groundwater AOCs at the former Arsenal that required evaluation for indoor air quality (IAQ), as presented in the *Draft Final Groundwater Natural Attenuation Report* dated July 2002 (Weston 2002), and more recently in the *Indoor Air Quality Evaluation (Steps One through Four)* (Weston 2005), and the Final *Supplemental Groundwater Data Report* (Weston Sept 2006).

In a 12 March 2003 comment letter concerning the *Draft Final Groundwater Natural Attenuation Report* (Weston 2002), NJDEP approved natural attenuation as a means of addressing remaining groundwater contamination at the site, provided no vapor intrusion pathway existed in buildings located above the plumes. NJDEP requested the USACE to evaluate potential vapor risks at 151 Fieldcrest Avenue (Building 151), 165 Fieldcrest Avenue (Building 165), and other buildings near monitoring well MW-114. Well MW-114 is located within Groundwater AOC 2 and historically has exhibited the highest detected concentrations of volatile organic compounds (VOCs) in groundwater at the former Arsenal. Total VOCs in groundwater have been reported up to 13 milligrams per liter (mg/L) in this well (in December 2000).

In May 2003, prior to the initiation of the USACE's indoor air program, the property owner at Building 165 conducted indoor air sampling that indicated the presence of tetrachloroethylene (PCE). Follow-up indoor air and sub-slab soil gas samples collected by USACE in June showed

no PCE in indoor air, but did show PCE in the accompanying sub-slab soil gas samples. PCE was also found in one of four sub-slab soil samples collected from beneath Building 165. A sub-slab depressurization system was subsequently installed jointly by USACE and NJDEP; this system remains in operation.

As a result of the findings at Building 165, awareness of the potential for intrusion of VOCs from soil and/or groundwater into indoor air at the former Arsenal was heightened. The NJDEP requested that the USACE evaluate the vapor intrusion pathway for all other Groundwater AOCs at the former Arsenal.

In October 2004, NJDEP agreed that assessment of the indoor air exposure pathway at the former Arsenal should be performed in accordance with the *Approach for Evaluating Potential Indoor Air Quality Impacts*, (USACE 2004), referred to hereafter as "The IAQ Approach". In accordance with the IAQ Approach, the USACE has been evaluating buildings located within 100 feet (ft) of Groundwater AOCs, currently as defined by exceedances of the (current) groundwater screening levels identified in the NJDEP's *Vapor Intrusion Guidance* (NJDEP 2005), referred to hereafter as "VIG". The primary contaminants of concern in groundwater are VOCs, mainly trichloroethylene (TCE) and PCE. Groundwater AOC 2, Groundwater AOC 8, and Groundwater AOC 10 were evaluated first due to their higher historical concentrations of VOCs in the groundwater. In addition, Groundwater AOC 2 and Groundwater AOC 8 include buildings with sensitive receptors (e.g., daycare centers). Subsequent to evaluation of Groundwater AOCs 2, 8, and 10, Groundwater AOCs 4 and 6 were evaluated for the potential of vapor intrusion into indoor air in accordance with Work Plans developed in accordance with the NJDEP's VIG.

The first semi-annual report (Weston 2005) discussed the buildings being evaluated and monitored within Groundwater AOC 2, AOC 8, and AOC 10 from September 2004 through February 2005. The following is a list of those buildings and the proposed actions from that report.

In the first *Indoor Air Quality Semi-Annual Report*, (Weston 2005) USACE made the following recommendations by groundwater AOC:

- Groundwater AOC 2
    - 165 Fieldcrest Avenue – Continue monitoring semiannually;
    - 151 Fieldcrest Avenue – Continue monitoring semiannually;
    - 160 Fieldcrest Avenue – Continue monitoring semiannually;
    - Campus Plaza 1 – No Further Action;
    - Campus Plaza 2 – One confirmatory round of indoor air and sub-slab soil gas sampling;
    - Campus Plaza 3 – One confirmatory round of indoor air and sub-slab soil gas sampling;
    - Campus Plaza 4 – One confirmatory round of indoor air and sub-slab soil gas sampling;
    - Campus Plaza 5 – One confirmatory round of indoor air and sub-slab soil gas sampling;
    - Campus Plaza 7 – One confirmatory round of indoor air and sub-slab soil gas sampling;

- Campus Plaza 8 – One confirmatory round of indoor air and sub-slab soil gas sampling;
- 25-27 Campus Drive – One confirmatory round of indoor air and sub-slab soil gas sampling; and
- 20 Northfield Avenue – One confirmatory round of indoor air and sub-slab soil gas sampling.

- Groundwater AOC 8
  - 2815 Woodbridge Avenue (Grace Reformed Church and Small Blessings Day Nursery) – No Further Action;
  - 2825 Woodbridge Avenue (Apple Montessori School) – No Further Action; and
  - U.S. Environmental Protection Agency (EPA) property (Buildings 5, 10, 18, 200, 205, 238, and the Guard Shack) – one round of indoor air and sub-slab soil gas sampling was recommended.

- Groundwater AOC 10
  - Middlesex County Training Facility – One confirmatory round of indoor air and sub-slab soil gas sampling.

The second semi-annual report (Weston 2006) discussed the buildings being evaluated and monitored within Groundwater AOC 2, AOC 4, AOC 6, AOC 8, and AOC 10 from April 2005 through April 2006. The following is a list of those buildings and the proposed actions from that report.

In the *Indoor Air Quality Semi-Annual Report #2*, (Weston September 2006) USACE made the following recommendations by groundwater AOC:

- Groundwater AOC 2
  - 165 Fieldcrest Avenue – Continue monitoring semiannually;
  - 151 Fieldcrest Avenue – No Further Action is recommended based on the weight of evidence.
  - 160 Fieldcrest Avenue – Continue monitoring semiannually; subsequently USACE agreed to quarterly monitoring.
  - Campus Plaza 1 – No Further Action; subsequently USACE agreed to one confirmatory round of indoor air and sub-slab soil gas sampling;
  - Campus Plaza 2 – Continue monitoring semiannually; subsequently USACE agreed to quarterly monitoring.
  - Campus Plaza 3 – No Further Action;
  - Campus Plaza 4 – Continue monitoring semiannually; subsequently USACE agreed to quarterly monitoring.
  - Campus Plaza 5 – No Further Action; subsequently USACE agreed to one confirmatory round of indoor air and sub-slab soil gas sampling;
  - Campus Plaza 7 – No Further Action was recommended; subsequently USACE agreed to one confirmatory round of indoor air and sub-slab soil gas sampling;
  - Campus Plaza 8 – No Further Action;
  - 25-27 Campus Drive – No Further Action;
  - 20 Northfield Avenue – No Further Action; and

- Building 150 – No additional investigation by USACE until the former tenant operations and their impact on the VOCs in the subsurface and indoor air are further evaluated by the tenant/landowner. Should the tenant/landowner investigation identify contamination that is related to the FUDS program, additional sampling by USACE may be recommended for this building.

- Groundwater AOC 4
  - 90/100-112 Northfield Avenue – one round of indoor air and sub-slab soil gas sampling was recommended; subsequently USACE agreed to semi-annual monitoring.
  - 95-97 Northfield Avenue – No Further Action;
  - 105-115 Northfield Avenue – No Further Action;
  - 114 Northfield Avenue – No Further Action;
  - 86/90-94/98-102 Mayfield Avenue and 5 Fernwood Avenue – No Further Action;
  - 75 Northfield Avenue – No Further Action;
  - 86 Northfield Avenue – No Further Action;
  - 125 Northfield Avenue – No Further Action;
  - 36/60 Mayfield Avenue – No Further Action;
  - 52/62-68/60-84 Mayfield Avenue – No Further Action;
  - 83-85 Mayfield Avenue – No Further Action;
  - 1-23 Mayfield Avenue – No Further Action;
  - 29-39 Mayfield Avenue – No Further Action; and
  - 70 Newfield Avenue – No Further Action;

- Groundwater AOC 6
  - 102-168 Fernwood Avenue – one round of indoor air and sub-slab soil gas sampling was recommended; subsequently USACE agreed to semi-annual monitoring.
  - 110 Newfield Avenue – one round of indoor air and sub-slab soil gas sampling was recommended; subsequently USACE agreed to semi-annual monitoring.
  - 45 Fernwood Avenue – one round of indoor air and sub-slab soil gas sampling was recommended; subsequently USACE agreed to semi-annual monitoring.
  - Building 467 – one round of indoor air and sub-slab soil gas sampling was recommended; subsequently USACE agreed to semi-annual monitoring.
  - 104 Sunfield Avenue – No Further Action;
  - 107 Sunfield Avenue – No Further Action;
  - Raritan Expo Center (97 Sunfield Avenue) – No Further Action;
  - 125 Newfield Avenue – No Further Action; and
  - 105 Sunfield Avenue – No Further Action;

- Groundwater AOC 8
  - 2815 Woodbridge Avenue (Grace Reformed Church and Small Blessings Day Nursery) – No Further Action;
  - 2825 Woodbridge Avenue (Apple Montessori School) – No Further Action; and
  - U.S. Environmental Protection Agency (EPA) property
    - Building 5 – No Further Action;
    - Building 10 – Continue monitoring quarterly for the first year, with an evaluation of the proposed monitoring frequency thereafter;

- Building 18 – Continue monitoring quarterly for the first year, with an evaluation of the proposed monitoring frequency thereafter;
- Building 200 – Continue monitoring quarterly for the first year, with an evaluation of the proposed monitoring frequency thereafter;
- Building 205 – Continue monitoring quarterly for the first year, with an evaluation of the proposed monitoring frequency thereafter;
- Building 209 – No Further Action; subsequently USACE agreed to continue monitoring quarterly;
- Building 238 – one round of sub-slab soil gas sampling after construction is completed and building is occupied;
- New Guard Shack – one round of indoor air and sub-slab soil gas sampling is recommended after construction of newly built Guard Shack.

- Groundwater AOC 10
  - Middlesex County Training Facility – No further Action.

In a letter dated January 12, 2007, NJDEP concurred with USACE's findings and recommendations regarding no further action at several of these buildings (listed in tables ES-1 through ES-5) so they are not further discussed in this report.

The third report (Weston 2008) discussed the buildings being evaluated and monitored within Groundwater AOC 2, AOC 4, AOC 6, and AOC 8 from April 2006 through April 2007. The following is a list of those buildings and the proposed actions from that report.

In the Final *Indoor Air Quality Semi-Annual Report #3*, (Weston 2008) USACE made the following recommendations by groundwater AOC:

- Groundwater AOC 2
  - 165 Fieldcrest Avenue – Continue monitoring semiannually;
  - 151 Fieldcrest Avenue – USACE agrees to three consecutive sub-slab soil gas sampling rounds over the next three years to monitor this building. If the average of these three rounds of sub-slab sampling is below the NJDEP VIG screening guidelines, no further monitoring will be conducted for this building;
  - 160 Fieldcrest Avenue – Continued monitoring of soil gas and indoor air on a quarterly basis;
  - Campus Plaza 1 – The USACE agrees to one additional round of sub-slab soil gas testing at all six Campus Plaza 1 locations;
  - Campus Plaza 2 –No Further Action, due to the presence of an interior source of TCE. The NJDEP concurs subject to the condition that further sub-slab soil gas sampling may be required. USACE will continue to monitor the AOC groundwater plume, but sees no further need for air or sub-slab soil gas monitoring;
  - Campus Plaza 3 – No Further Action;
  - Campus Plaza 4 – Continue semiannual monitoring while investigating potential tenant sources;
  - Campus Plaza 5 - No further monitoring at Campus Plaza 5 since no COPCs were detected in sub-slab soil gas or indoor air, and the remediation system was installed by others prior to performing an evaluation of the risk level for this building. The landowner will continue to be responsible for future operation and maintenance of the system;

- Campus Plaza 7 – No Further Action;
- Campus Plaza 8 – No Further Action;
- 25-27 Campus Drive – No Further Action;
- 20 Northfield Avenue – No Further Action; and
- Building 150 – No additional investigation by USACE until the former tenant operations and their impact on the VOCs in the subsurface and indoor air are further evaluated by the tenant/landowner. Should the tenant/landowner investigation identify contamination that is related to the FUDS program, additional sampling by USACE may be recommended for this building.

- Groundwater AOC 4
  - 90/100-112 Northfield Avenue – No further action is recommended, as neither TCE nor PCE were detected in sub-slab soil gas in exceedance of their respective NJDEP VIG Residential screening levels for two consecutive rounds. VOCs detected in indoor air are considered tenant-related;
  - 95-97 Northfield Avenue – No Further Action;
  - 105-115 Northfield Avenue – No Further Action;
  - 114 Northfield Avenue – No Further Action;
  - 86/90-94/98-102 Mayfield Avenue and 5 Fernwood Avenue – No Further Action;
  - 75 Northfield Avenue – No Further Action;
  - 86 Northfield Avenue – No Further Action;
  - 125 Northfield Avenue – No Further Action;
  - 36/60 Mayfield Avenue – No Further Action;
  - 52/62-68/60-84 Mayfield Avenue – No Further Action;
  - 83-85 Mayfield Avenue – No Further Action;
  - 1-23 Mayfield Avenue – No Further Action;
  - 29-39 Mayfield Avenue – No Further Action; and
  - 70 Newfield Avenue – No Further Action.

- Groundwater AOC 6
  - 102-168 Fernwood Avenue – One confirmatory round of sub-slab soil gas concurrent with indoor air sampling is recommended upon completion of construction in the building;
  - 110 Newfield Avenue – No Further Action;
  - 45 Fernwood Avenue – No Further Action;
  - Building 467 – No Further Action;
  - 104 Sunfield Avenue – No Further Action;
  - 107 Sunfield Avenue – No Further Action;
  - Raritan Expo Center (97 Sunfield Avenue) – No Further Action;
  - 125 Newfield Avenue – No Further Action; and
  - 105 Sunfield Avenue – No Further Action.

- Groundwater AOC 8
  - 2815 Woodbridge Avenue (Grace Reformed Church and Small Blessings Day Nursery) – No Further Action;
  - 2825 Woodbridge Avenue (Apple Montessori School) – No Further Action; and
  - U.S. Environmental Protection Agency (EPA) property
    - Building 5 – No Further Action;

- Building 10 – Reduce monitoring to a semi-annual frequency;
- Building 18 – Reduce monitoring to a semi-annual frequency;
- Building 200 – Continued monitoring of the remedial system on a quarterly basis, EPA already looked at adjusting the HVAC;
- Building 205 – Continue monitoring on a quarterly basis;
- Building 209 – Continue monitoring on a quarterly basis;
- Building 238 – No Further Action;
- New Guard Shack – No Further Action, the building in no longer occupied.

- Groundwater AOC 10
  - Middlesex County Training Facility – No Further Action.

The fourth report (Shaw, April 2009) discussed the buildings being evaluated and monitored within Groundwater AOC 2, AOC 4, AOC 6, and AOC 8 from July 2007 through October 2008. The following is a list of those buildings and the proposed actions from that report.

In the Final *Indoor Air Quality Semi-Annual Report #4*, (Shaw, April 2009) USACE made the following recommendations by groundwater AOC:

- Groundwater AOC 2
  - 165 Fieldcrest Avenue – Continue monitoring semiannually;
  - 151 Fieldcrest Avenue – USACE agrees to three consecutive sub-slab soil gas sampling rounds over the next three years to monitor this building. If the average of these three rounds of sub-slab sampling is below the NJDEP VIG screening guidelines, no further monitoring will be conducted for this building;
  - 160 Fieldcrest Avenue – Passive mitigation system was installed in June 2008. Passive sampling was recommended to document no risk to tenants and system effectiveness. Passive sampling will continue under a separate USACE contract;
  - Campus Plaza 1 – No Further Action;
  - Campus Plaza 2 –No Further Action, due to the presence of an interior source of TCE. The NJDEP concurs subject to the condition that further sub-slab soil gas sampling may be required. USACE will continue to monitor the AOC groundwater plume, but sees no further need for air or sub-slab soil gas monitoring;
  - Campus Plaza 3 – No Further Action;
  - Campus Plaza 4 – Continue semiannual monitoring while investigating potential tenant sources;
  - Campus Plaza 5 - No further monitoring at Campus Plaza 5 since no COPCs were detected in sub-slab soil gas or indoor air, and the remediation system was installed by others prior to performing an evaluation of the risk level for this building. The landowner will continue to be responsible for future operation and maintenance of the system;
  - Campus Plaza 7 – No Further Action;
  - Campus Plaza 8 – No Further Action;
  - 25-27 Campus Drive – No Further Action;
  - 20 Northfield Avenue – No Further Action; and
  - Building 150 – No additional investigation by USACE until the former tenant operations and their impact on the VOCs in the subsurface and indoor air are further evaluated by the tenant/landowner. Should the tenant/landowner investigation

identify contamination that is related to the FUDS program, additional sampling by USACE may be recommended for this building.

- Groundwater AOC 4
  - 90/100-112 Northfield Avenue – No further action is recommended, as neither TCE nor PCE were detected in sub-slab soil gas in exceedance of their respective NJDEP VIG Residential screening levels for two consecutive rounds. VOCs detected in indoor air are considered tenant-related;
  - 95-97 Northfield Avenue – No Further Action;
  - 105-115 Northfield Avenue – No Further Action;
  - 114 Northfield Avenue – No Further Action;
  - 86/90-94/98-102 Mayfield Avenue and 5 Fernwood Avenue – No Further Action;
  - 75 Northfield Avenue – No Further Action;
  - 86 Northfield Avenue – No Further Action;
  - 125 Northfield Avenue – No Further Action;
  - 36/60 Mayfield Avenue – No Further Action;
  - 52/62-68/60-84 Mayfield Avenue – No Further Action;
  - 83-85 Mayfield Avenue – No Further Action;
  - 1-23 Mayfield Avenue – No Further Action;
  - 29-39 Mayfield Avenue – No Further Action; and
  - 70 Newfield Avenue – No Further Action.

- Groundwater AOC 6
  - 102-168 Fernwood Avenue – One confirmatory round of sub-slab soil gas concurrent with indoor air sampling is recommended upon completion of construction in the building; a passive monitoring system was installed in October 2009;.
  - 110 Newfield Avenue – No Further Action;
  - 45 Fernwood Avenue – No Further Action;
  - Building 467 – No Further Action;
  - 104 Sunfield Avenue – No Further Action;
  - 107 Sunfield Avenue – No Further Action;
  - Raritan Expo Center (97 Sunfield Avenue) – No Further Action;
  - 125 Newfield Avenue – No Further Action; and
  - 105 Sunfield Avenue – No Further Action.

- Groundwater AOC 8
  - 2815 Woodbridge Avenue (Grace Reformed Church and Small Blessings Day Nursery) – No Further Action;
  - 2825 Woodbridge Avenue (Apple Montessori School) – No Further Action; and
  - U.S. Environmental Protection Agency (EPA) property
    - Building 5 – No Further Action;
    - Building 10 – Continued semi-annual sampling;
    - Building 18 – Continued semi-annual sampling;
    - Building 200 – Continued sampling with option to reduce frequency of sampling to semi-annual, EPA already looked at adjusting the HVAC;
    - Building 205 – Continued semi-annual sampling;
    - Building 209 – Continued semi-annual sampling;
    - Building 238 – No Further Action;

- New Guard Shack – No Further Action, the building in no longer occupied.

- Groundwater AOC 10
  - Middlesex County Training Facility – No Further Action.

This report presents the findings of subsequent investigations conducted during the period of December 2008 through May 2009. Table 1-1 summarizes the buildings and tenants included in the investigation described in this report.

1.3 VAPOR MIGRATION PATHWAY

This report evaluates the potential migration pathway of VOCs from groundwater and soils to indoor air following NJDEP Guidelines and the January 2009 US Department of Defense Vapor Intrusion Handbook. Due to their high vapor pressures, VOCs dissolved in groundwater readily volatilize from the groundwater and move by diffusion and advection (which is actually the more dominant mechanism) through the capillary and unsaturated zones of the soil, eventually discharging to the atmosphere at the ground surface. Lateral and vertical migration of soil gas occurs in response to variations in pressure and can be quite complex. For example, high-pressure weather systems tend to keep soil gas in the subsurface, while low pressure weather systems allow the soil gas to move readily into the atmosphere. Variations in soil texture and permeability greatly affect the movement of soil gas.

In areas where the ground surface is covered by a building or paved surface, VOCs in soil gas can become trapped beneath these structures, resulting in a mounding effect. These vapors are capable of entering structures through minute cracks in foundations, pipe or utility penetrations through the concrete floor slabs or walls, and through foundation drains.

Soil gas entry into structures is usually the result of pressure differentials, which are mainly caused by indoor-outdoor thermal differences, wind loading on structures, and unbalanced ventilation systems that can result in the depressurization of a building (Hodgson, *et al.* 1992). Most buildings maintain an indoor air pressure that is lower than outdoor air. Under this negative pressure, subsurface soil gas may be drawn to cracks in the basement or slab floor and into the building. A building in this situation has an “area of influence” which may draw subsurface soil gas toward the building slab from surrounding areas.

Many factors influence the rate of soil gas entry into a building at any given time. Increased soil moisture, which often occurs in the spring after the ground thaws and snow melts, can also drive soil gas from surrounding areas into the relatively dry soils beneath structures, increasing the potential for vapor infiltration. Heavy rainfall can also result in a lens/layer of clean water at the water table, reducing the source soil gas concentrations. Frozen ground can also limit the vertical migration of subsurface gases and increase mounding effects and lateral migration. Under heating conditions, building basements or the first floor above the concrete slab can be under less pressure relative to the surrounding soil (Hodgson, *et al.* 1992). This is sometimes referred to as the “stack or chimney effect,” and can greatly increase the rate of soil gas infiltration. For the above reasons, winter and spring conditions tend to promote the infiltration of soil gas into structures, and generally represent “worst-case” conditions. As indicated in Section 6.1.3.3 of the NJDEP VIG, indoor air samples collected from November through March are required prior to making remedial decisions as this timeframe is considered as being most representative of the presumed “worst case” conditions.

1.4 USACE INDOOR AIR EVALUATION PROCESS

The IAQ Approach for the former Arsenal establishes the priorities for further investigation of potential IAQ impacts (Figure 1-1). The IAQ Approach, which has been approved by the NJDEP, is a step-wise approach to evaluate the potential for IAQ impacts from contaminated groundwater and residual soil sources at the former Arsenal. Steps One through Four of the IAQ Approach are:

- Step One: Complete preliminary inventory of buildings potentially affected by Groundwater AOC plumes.
- Step Two: Develop conceptual model for each Groundwater AOC plume.
- Step Three: Determine constituents of potential concern (COPCs) for further evaluation by comparing historical groundwater data to Table 2C-GW screening benchmarks.
- Step Four: Prioritize Groundwater AOC plumes to be evaluated for potential vapor intrusion based on sensitive receptors and historical groundwater data. Expedite evaluation process where groundwater concentrations are 50 times greater than Table 2C-GW screening benchmarks. It should be noted that going forward, the decision process set forth in the NJDEP VIG will be used to determine the need for expedited review of the potential for vapor intrusion at the former Arsenal, if specific Groundwater AOCs and the buildings associated with those AOCs have not yet been evaluated.

The information gathered under Steps One through Four will provide a basis for Steps Five through Twelve of the IAQ Approach.

- Step Five: Using existing groundwater quality data assess whether there is potential for a complete vapor intrusion pathway from groundwater to indoor air and evaluate the potential IAQ impacts. If groundwater data indicate potential exceedence of residential indoor air screening benchmarks, then go to Step Six.
- Step Six: Conduct sub-slab soil gas sampling.
- Step Seven: Compare soil gas concentrations to the sub-slab soil gas screening benchmarks. Predict concentrations of VOCs in indoor air based on sub-slab soil gas data. If soil gas data indicate potential exceedence of residential indoor air screening benchmarks, then go to Step Eight. While the IAQ Approach originally required comparison of site-specific data to the EPA Table 2C criteria, this approach was developed prior to publication of the NJDEP VIG. Moving forward, site-specific data have been and will be compared to the most recent screening levels set forth in the NJDEP VIG.
- Step Eight: Evaluate indoor air impacts by conducting sampling to determine if indoor VOC concentrations exceed ambient air sample results and/or residential indoor air limits. Identify other buildings for soil gas sampling.

- Step Nine: Perform confirmatory sampling of sub-slab soil gas and indoor air at the building (to assess temporal variability and verify the initial findings).
- Step Ten: If the confirmatory sampling verifies the initial results, evaluate remedial alternatives for the building.
- Step Eleven: Implement remedy for the building and collect post-remedial indoor air and sub-slab soil gas samples to document system effectiveness.
- Step Twelve: Prepare report documenting process and results for the NJDEP.

1.5 REPORT ORGANIZATION

This report presents the findings of the IAQ Investigation for Groundwater AOC 2, AOC 6, and AOC 8 at the former Arsenal, as well as supporting sub-slab soil gas data evaluations. Section 2.0, Methodology, describes the data collection methods employed, and defines the regulatory screening levels against which the analytical data are evaluated. Sections 3.0 through 5.0 present the analytical data for the various media sampled and provide discussion, conclusions, and recommendations based on the results for data collected by building. Data for each building is separated by color tabs specific to each building. Section 6.0 identifies references used in developing this report. Figures and tables for each section of the report are provided at the back of each building-specific color-coded tab. Building Survey Forms, meteorological data and Material Safety Data Sheets and the Appendices are provided electronically in Adobe format on the enclosed compact disk.

SECTION 2.0
METHODOLOGY

2.1 SAMPLING DESIGN

From December 2008 through May 2009, USACE collected samples of sub-slab soil gas, ambient air, and indoor air at selected buildings within Groundwater AOCs 2, 6, and 8 for VOC analysis. Specific sample locations, parameters, methods, and dates sampled are presented in Tables 2-1 and 2-2 (Groundwater AOC 2), Tables 2-3 and 2-4 (Groundwater AOC 6), and Tables 2-5 and 2-6 (Groundwater AOC 8).

Under the IAQ process for the former Arsenal, the decision to sample indoor air is based upon whether concentrations of VOCs in sub-slab soil gas exceed screening levels. The decision to sample sub-slab soil gas is determined by the presence of VOCs in groundwater at concentrations exceeding groundwater screening levels (previously evaluated against EPA Table 2C values, but currently evaluated against the groundwater screening levels identified in the NJDEP VIG). However, in several cases individual landowners have opted to sample indoor air directly, before sub-slab soil gas or groundwater was fully evaluated by USACE. In those cases, USACE proceeded to sample both sub-slab soil gas and indoor air for analysis of VOCs at those buildings. The objectives were to confirm the landowner's initial findings and to monitor the situation at each building where landowner testing indicated a potential vapor intrusion concern.

The USACE evaluated the remaining buildings by determining what buildings fall within 100 feet of each plume, comparing most recent groundwater concentrations in each plume to the NJDEP Table 1 Generic Vapor Intrusion Screening Levels for Groundwater (NJDEP Table 1-GW), and analyzing sub-slab soil gas below each building potentially affected by Department of Defense (DOD)-related COPCs in groundwater and soil. Methods for each element of this IAQ approach are described below.

2.2 SAMPLING METHODS

2.2.1 Groundwater Evaluation

The evaluation of groundwater has already been completed. The following section provides a summary of the methodology used to perform this past evaluation.

The process of identifying COPCs in groundwater has been described in the Draft Indoor Air Quality Investigation Report (Steps 1-4) (Weston 2004), and originally consisted of comparing the maximum concentration of VOCs in wells within a groundwater plume to the EPA Table 2c criteria for VOCs to determine if they are exceeded at any location. (Currently, groundwater data are evaluated against the groundwater screening criteria provided in the NJDEP VIG to determine which plumes/buildings require evaluation for potential vapor intrusion.) This approach is conservative from the perspective that in some cases the only groundwater data available may be from wells located several hundred feet away from a given building. Generally, concentrations have been attenuating over time, and so in many cases, the maximum concentrations do not reflect current conditions. Once it is determined that a groundwater plume contains VOCs at concentrations presenting a potential vapor intrusion pathway threat, sub-slab soil gas is sampled from below buildings that are potentially affected by the contamination. The process of evaluating which specific buildings will require sub-slab soil gas sampling is determined on a building-by-building basis in accordance with the IAQ Approach (Weston 2004).

Specific methods for groundwater sampling upon which the groundwater data are based have been described in prior reports such as the:

- *Final Site-wide Hydrogeology Report for the Former Raritan Arsenal (Weston 1994);*
- *Draft Monitored Natural Attenuation Report for the Former Raritan Arsenal (Weston 2002);* and
- Final Supplemental Groundwater Data Report (Weston 2006).

2.2.2 Sub-slab Soil Gas Sampling Method

Once it was determined that a given building required sub-slab soil gas sampling, a work plan was prepared with proposed sampling locations, and was submitted to the NJDEP for approval. Locations were chosen in concurrence with the landowner to avoid interrupting their operations or biasing the sample. Where practical, sample locations were biased to anticipated conservative locations. Given that mounding effects would be more pronounced toward the center of a building, sample locations are generally located away from sidewalls, and also are oriented toward the center of the plume.

Permanent sub-slab sampling ports were installed by Weston several sampling events prior to the events presented in this report. The sub-slab soil gas sampling point installation procedure followed by Weston utilized the *New Jersey Department of Environmental Protection Vapor Intrusion Guidance Document* (NJDEP 2005). The first step was to drill a 3/8-inch hole approximately 1 to 2 inches below the concrete slab. Then, the top 1 inch of the hole was over-drilled to a 1-inch diameter. Next, the brass vapor probe was inserted to a point flush with the top of the concrete slab (initial sub-slab sample points were installed prior to the 2005 NJDEP VIG, and brass ports were selected in accordance with the Draft NJDEP VIG; subsequent sample ports were installed to be consistent with those installed during earlier phases of investigation). Quick expansive Portland cement was used to seal the annular space between the probe and the slab and allowed to cure for 30 minutes to secure the vapor probe in place.

Sampling of secured ports involved a "T" setup made of Teflon tubing, a shut-off valve and three-way "T" was attached to the vacuum pump at one end and the SUMMA canister at the other. A middle line was connected to the sample port. While the valve allowing soil gas to flow from the sample port to SUMMA canister remained closed, the portable vacuum pump purged the vapor probe. After two minutes, the pump was shut off, and the shut-off valve and the SUMMA canister valve were opened allowing the sample to be collected. Sub-slab soil gas samples were collected over a one-hour (approximate) period. Leak test was also performed using 1,1-difluoroethane. Sub slab leak test results are presented in Appendix A. Once the sample was collected, the SUMMA canister valve was closed and the sample port was capped.

In cases where the vapor probe may have come loose from the surrounding cement, Shaw repaired and resealed the port prior to sampling. Two damaged sample ports were replaced in 102-168 Fernwood. There were no ports repaired in Building 10 and only one port is currently damaged (CP4-SG-5) that needs to be replaced.

2.2.3 Building Survey Method

In the event that sub-slab soil gas concentrations indicated a potential vapor intrusion pathway, indoor air sampling was performed consistent with the *Approach for Evaluating Potential Indoor Air Quality Impacts* (USACE 2004). However, prior to indoor air sampling it was necessary to

evaluate each building proposed for sampling to determine if there were facility conditions that could affect sampling results. Shaw conducted an inspection of each building being investigated for potential indoor air vapor intrusion to determine potential sampling locations, as well as chemical use within each building. Shaw completed the Indoor Air Building Survey and Sampling Form (the Form) for each building tenant space with a tenant representative and/or the landlord during the site walkthrough for each building. The Form was completed for each building space being evaluated in order to identify and evaluate site conditions that could impact the sample results, including any possible indoor air emission sources that could generate target VOCs. Possible emission sources include cleaning products, new carpet, recent painting, new furniture, indoor smoking areas, insecticides, gasoline storage and/or gasoline-powered equipment.

The Form includes a list of the products identified during the inspection for indoor contaminants. If available, material safety data sheets (MSDSs) were provided by some tenants for the chemicals observed. Shaw identified potential sample locations for indoor air and sub-slab soil gas sampling during the site inspection. The sample locations and sample collection information are also identified on the Form. Prior to subsequent sampling events, Shaw reevaluated conditions for new products and chemicals being used or stored by building tenants that could potentially impact the indoor air quality results, and updated the Form with the date and observations.

2.2.4 Indoor Air Sampling Method

If appropriate, indoor air sampling was conducted, with locations selected in advance and approved by NJDEP. Indoor air samples were collected over a 24-hour (approximate) period using evacuated stainless-steel SUMMA canisters equipped with appropriate pre-programmed flow-control valves (regulators). The indoor samples were collected from the breathing zone height (3 ft to 5 ft). All windows and overhead doors were closed to the extent possible. Appliances that induce large pressure differences (e.g., exhaust fans) were not used 12 hours before measurements began and during sample collection. Ventilation systems were operated as normal. Vacuum readings on the SUMMA canisters were recorded before the start of each sample collection and after the completion of each sample collection to ensure that all regulators were working properly.

At buildings in which both sub-slab soil gas and indoor air samples were collected concurrently, the indoor air samples were collected immediately prior to collection of the sub-slab soil gas samples. This was done to reduce the potential for contaminants that may be present in the sub-slab soil gas from impacting the indoor air samples, which have analytical detection limits an order of magnitude less than those obtainable for sub-slab soil gas samples.

2.2.5 Background Air Sampling Method

Background ambient air samples were collected for comparison with indoor air sampling results at each building in order to interpret whether the results from each building were potentially related to ambient sources outside of the building. Background air samples were collected over a 24-hour period using evacuated stainless-steel SUMMA canisters equipped with appropriate pre-programmed flow-control valves (regulators). One background sample was collected while indoor air samples were being collected at each building. The background air sample for each building was collected at ground level. The ground level background air samples were collected from the breathing zone height (3 ft to 5 ft) and in a location away from pedestrian and vehicle traffic. The results of the background samples are compared to NJDEP Residential and Non-

Residential Vapor Intrusion Guidelines so that results from indoor air sampling are viewed in an appropriate context reflective of the localized air quality.

2.2.6 Meteorological Data

Meteorological data was provided by NOAA's National Climactic Data Center located in Ashville, North Carolina. Data was collected by the National Weather Service for the Newark Liberty International AP (KEWR) weather station. This location was considered to be a representative and reliable collection point for the entire Raritan Arsenal project area. The meteorological data were included in the indoor air survey forms, and in data tables included in the introductory sections for each AOC.

2.2.7 Quality Assurance/Control

Field quality control (QC) samples consisting of field blanks and field duplicates are not required according to the guidelines outlined in the *Indoor Air VOC Sampling Analysis Requirements* (NJDEP, April 2003), and were not collected.

2.2.8 Sample Handling and Shipping

Cleaned and certified 6-liter SUMMA canisters and regulators were obtained from a New Jersey certified laboratory as outlined in the *Indoor Air VOC Sampling Analysis Requirements* (NJDEP, April 2003) and the *NJDEP Vapor Intrusion Guidelines* (NJDEP 2006). After sampling, all SUMMA canisters were packaged in a box and transported to the selected New Jersey certified laboratory. The certified laboratory used for samples presented in this report was Chemtech Analytical, Mountainside, New Jersey.

2.2.9 Data Validation Procedures

Analytical data review includes a review of the data package materials to check whether the data entry, transcription and calculation/reduction were properly performed. The sample data is reviewed to verify that holding times were met and the laboratory QC sample data was appropriate and met QC limits.

Data verification was performed by the laboratory to provide for data package completeness, correctness and compliance against the analytical method, procedural and contractual requirements of the project. The chains of custody and internal chains of custody forms were reviewed to verify proper sample receipt, storage, sample preparation, and sample analysis. The analyst and QC staff also review instrument performance criteria, calibration results, detection limits, surrogate spike recovery and laboratory control recovery data, matrix spike results, internal standard responses, QC blank contamination results, as well as extraction and analytical run logs to verify proper sample preparation and analysis conditions.

Deviations from the QAPP and project laboratory QA Plan and SOPs are documented, often in the form of a case narrative included with the data package. Problems experienced during sample analysis are also identified and presented in the case narrative of the analytical data package.

2.3 SCREENING BENCHMARKS

Air sampling analytical data were compared to applicable regulatory screening levels to assess potential adverse impacts. These regulatory levels included**:**

1. NJDEP (March 2007) Residential and Non-Residential Vapor Intrusion Guidance Screening Levels for Sub-slab Soil Gas;
2. NJDEP (March 2007) Residential and Non-Residential Vapor Intrusion Guidance for Indoor Air; and
3. EPA Generic screening benchmarks for Target Indoor Air Concentrations and Shallow Soil Gas as provided in the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (EPA, November 2002). (Indoor Air and Soil Gas, respectively, predominantly for evaluation of historic data.)

The following is a brief discussion of each screening benchmark used, including assumptions and applicability. None of these benchmarks are promulgated regulatory criteria.

2.3.1 NJDEP Vapor Intrusion Guidelines for Indoor Air and Sub-slab Soil Gas

In October 2005, the NJDEP published the final *Vapor Intrusion Guidance* (VIG). As the title implies, the VIG is intended as a guidance document, and is not purely a regulatory requirement. However, while the NJDEP will consider alternative methods for VI investigations, they generally require that the analytical results of any VI investigation be compared to the (current) benchmarks included in Table 1 (NJDEP Master Table; Generic Vapor Intrusion Screening Levels, originally issued October 2005) of the VIG. Table 1 consists of benchmark concentrations for a number of COPCs, as both residential and nonresidential concentrations. These concentrations will be revised periodically as the "state of the science" of VI changes over time, the most recent revision being in March 2007.

In this report, the tables of results from the current sampling events and tables containing comparison of historical data from previous sampling rounds have highlighted exceedances of the NJDEP VIG benchmarks. These tables are specific to individual buildings within each AOC, and specific table numbers are referenced within the text in association with each building.

2.3.2 EPA Generic Screening Benchmarks for Target Indoor Air and Shallow Soil Gas Concentrations

EPA published the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils Vapor Intrusion* (EPA 2002). Target screening benchmark soil gas and indoor air concentrations are published in this guidance and are intended to provide a screening tool for determining whether direct indoor air sampling is appropriate. They are based on potential migration of VOCs from groundwater through soils and into the interior of a residence or office building. The screening numbers for each chemical equate to an indoor air concentration that is protective of a residential exposure (30 years, 350 days/year, 24 hours/day) based on defined target risk or hazard quotient levels. The target soil gas and indoor air levels were based on noncancer (N) or cancer (C) effects at a Target Risk (TR) of 1E-06 or a Target Hazard Quotient (THQ) of 1.

COPCs for each Groundwater AOC were evaluated by comparing their maximum detected concentrations to the screening benchmarks provided in Table 2C of EPA's Subsurface Vapor Intrusion Guidance. The generic screening benchmark groundwater concentrations in EPA's Table 2C reflect reasonable worst-case conditions. The USACE has identified the most recent groundwater concentrations at the same locations where maximum concentrations were detected.

Sub-slab soil gas sample results were compared to the EPA target shallow soil gas screening benchmarks, and indoor air sample results were compared directly with the target indoor air screening benchmarks. Remedial decisions are being made based on comparison of sample concentrations to screening benchmarks presented in the NJDEP VIG. However, the EPA VI screening benchmarks continue to be presented for consistency sake, since the former Arsenal investigation began prior to publication of the VIG and the EPA Table 2c screening benchmarks were used at the onset of the sampling program.

On January 15, 2009 the USEPA signed a significant memorandum, "Interim Recommended Trichloroethylene (TCE) Toxicity Values to Assess Human Health Risk and Recommendations for the Vapor Intrusion (VI) Pathway Analysis." They key element of the memorandum is the establishment of an interim action level of TCE in indoor residential air: 1.2 micrograms per cubic meter (ug/m3), based upon California EPA's inhalation unit risk value. Currently NJDEP has not yet accepted this proposed interim action level.

2.4 PHYSICAL STATUS OF SUB SLAB PORTS

During each sampling event, the integrity of each port is visually inspected for damage, thread integrity, and whether the port has been covered by tenant activities. The following is a list of sampling ports that had issues observed during the March 2009 semi-annual sampling event.

151 Fieldcrest Avenue
Soil Gas Port SG-3 was not sampled because it could not be located and was probably

Campus Plaza 4
Campus Plaza 4 had one damaged port (SG-5) that could not be sampled. Currently there are no plans to replace this port. The last soil gas data from SG-5 was collected on September 24, 2008.

USEPA Building 205
Due to renovation activities Soil Gas Ports SG-11 and SG-12 located in former Bay B were covered with a fresh layer of concrete and were not sampled. Currently there are no plans to replace these ports. The last soil gas data from SG-11 and SG-12 were collected on September 30, 2008.

2.5 LEAK TEST METHODOLOGY

For the sampling of sub slab ports, a leak test is performed at the beginning of each test. After the sampling train is attached to the sub slab port, it is covered with a bucket or shroud. A Teflon tube is attached to a fitting on the sampling train that extends through a sealed opening on the top of the shroud. A PID meter or equivalent is then inserted into this Teflon tube after the tracer gas is released under the shroud. The regulator on the canister is opened and the evacuated cylinder begins to collect the sub slab sample. At this point, 1,1 difluoroethane or tetrafluoroethane is released under the shroud. After about 1 minute (or equal to the purging time of the soil gas sample), the PID meter probe is inserted into the Teflon tubing and the fitting attaching this tubing to the sampling train is opened. If the percent of gas exceeds 5% the regulator is closed and the fitting are tighten or resealed with self-sealing tape. The regulator is opened and the test repeated. However, typical sub slab soil gas samples typically occur during a one hour period. Due to vibrations, poor integrity of the sampling port, or accidental

disturbance, a leak could occur after the screening test. To document that there are no leakages during this sampling period, the tracer gas is also analyzed by EPA Method TO-15 as a tentatively identified compound (TIC). If the tracer gas analysis exceeds 1,000 µg/m^3 (*NJDEP Vapor Intrusion Guidance Document October 2005*), then a leak has been confirmed and another sample should be collected.

2.5.1 Leak Test Summary Results

Leak test analytical results by EPA TO-Method 15 are included in this section (Appendix A). Building 102-168 Fernwood had elevated levels of tracer gas 1,1 difluoroethane in 4 of the 5 soil gas samples. The highest results being 480.30 µg/m^3. However, results remain below NJDEP Guidance criteria of 1,000 micrograms per liter (1,000,000 µg/m^3). Otherwise, all other leak test analytical results were either near or just below the reporting limit.

SECTION 3.0
SAMPLING RESULTS FOR GROUNDWATER AREA OF CONCERN 2

This section focuses on sampling results for indoor air and sub-slab soil gas collected in March 2009 from three buildings evaluated within Groundwater AOC 2. Results are presented by building within the Groundwater AOC. Prior to the discussion of the sub-slab soil gas/indoor air results, a description of historic groundwater contaminant concentrations is presented. The plume boundaries, as revised per the *Supplemental Groundwater Data Report* (Weston, September 2006), defined the extent of the groundwater plume necessary to identify what buildings required evaluation for potential vapor intrusion.

Per the recommendations from the *Indoor Air Quality Semi-Annual Report #4* (Shaw, 2009), three buildings are still being evaluated and/or monitored for vapor intrusion issues in AOC 2. The buildings evaluated are:

- 165 Fieldcrest Avenue;
- 151 Fieldcrest Avenue; and
- Campus Plaza 4

The three buildings evaluated within Groundwater AOC 2 consist of either warehouse or office space. The buildings are mostly surrounded by parking areas and roadways; few open/landscaped areas exist.

Buildings for which no further action was proposed in the vicinity of Groundwater AOC 2, and agreed to in NJDEP's 12 January 2007 and 7 May 2008 letters, include the following:

- Campus Plaza 3;
- Campus Plaza 7;
- Campus Plaza 8;
- 25-27 Campus Drive and
- 20 Northfield Avenue.

After completion of Report #4, it was decided that the following buildings would no longer be sampled:

- Campus Plaza 1;
- Campus Plaza 2; and
- Campus Plaza 5

These buildings were not sampled during the current investigation, and are not discussed in this report. For information regarding the evaluation of the potential for vapor intrusion within these buildings, refer to the *Indoor Air Quality Semi-Annual Report* #3 (Weston, July 2008) and *Indoor Air Quality Semi-Annual Report* #4 (Shaw, April 2009).

In addition, it was recommended that passive sampling be continued at 160 Fieldcrest Avenue to insure no risk to tenants and effectiveness of passive wind-driven vapor mitigation. This sampling is being performed under a different and separate contract.

3.1 OVERVIEW OF GROUNDWATER AOC 2 RESULTS

3.1.1 Groundwater AOC 2

Groundwater AOC 2 is located within the north central portion of the former Arsenal, beginning near Building 256 in Area 18C (previously identified and remediated source area). The 2004-2005 site-wide groundwater investigation redefined the plume boundary (*Supplemental Groundwater Data Report*, September 2006).

The historic constituents of concern in Groundwater AOC 2 are VOCs such as TCE, PCE, and cis-1,2-dichloroethene (cis-1,2-DCE), among others, as described in the *Final Site-Wide Hydrogeology Report* (Weston 1996) and the 2002 *Draft Final Groundwater Natural Attenuation Report* (NAR). Current constituents of concern for Groundwater AOC 2 are cis-1,2-DCE, PCE, TCE, vinyl chloride, and total-1,2-dichloroethene (total-1,2-DCE) as described in the September 2006 *Final Supplemental Groundwater Data Report*.

Groundwater analytical data for overburden monitoring wells and direct-push samples from 1994 to 2007 were reviewed and compared to screening levels presented in Table 1 of NJDEP's Vapor Intrusion Guidance (October 2005, updated March 2007) to characterize the COPCs in Groundwater AOC 2. Table 3-1 provides these data for all VOCs that have historically been detected in any of the groundwater samples collected from within the bounds of Groundwater AOC 2. Those VOCs that are considered COPCs for Groundwater AOC 2 are highlighted on Table 3-1 through the use of shading. Specifically, current constituents of concern for Groundwater AOC 2 are TCE, total-1,2-DCE, PCE, cis-1,2-DCE, and vinyl chloride. The current COPC list is based on the most recent concentrations detected in groundwater samples collected from the location with the historic highest concentration in Groundwater AOC 2. The historic constituents of concern in Groundwater AOC 2 are TCE, total-1,2-DCE, PCE, cis-1,2-DCE, vinyl chloride, 1,1,2-trichloroethane (1,1,2-TCA), benzene, and chloroform as shown in Table 3-1.

The COPC list for Groundwater AOC 2 includes one chemical that is considered to be unrelated to historic DOD activities. Benzene was detected during the second quarter (October 1998) sampling at MW-126; its historic highest concentration was detected in MW-13 during the remedial investigation activities performed in November 1994. The detection of benzene in MW-126 indicates an unknown non-DOD source of contamination in the southern portion of Groundwater AOC 2.

The VOC concentrations in groundwater at and near the source area in Groundwater AOC 2 historically were the highest encountered in the former Arsenal, exceeding the NJDEP GWQS for TCE, PCE, and vinyl chloride. However, the main source of contamination (Building 256 UST system and leach field) was remediated in 1998 by removal of approximately 2,450 cubic yards of contaminated soils, as approved by the NJDEP. USACE conducted additional remedial activities from August to December 2002, when approximately an additional 3,500 cubic yards of contaminated soil were removed from the Area 18C-Building 265 Ramp Area, in the immediate vicinity of the earlier source removal, but from deeper within the subsurface. Monitoring well MW-114 is located immediately down gradient of the former source area and up gradient of Buildings 151 and 165. Since the groundwater sampling event following the first removal action, the total VOC concentration in groundwater at this well has decreased by two orders of magnitude.

In-situ treatment of groundwater (remedial action) associated with Groundwater AOC 2 is being proposed. Pre-pilot study field activities, bench scale treatability testing, and a pilot study associated with Groundwater AOC 2 have been undertaken, to evaluate the effectiveness of permanganate or a similar in-situ treatment for full-scale remediation.

Because of the concentrations of VOCs that have been detected in Groundwater AOC 2, IAQ sampling has been conducted below and at several buildings within 100 feet of the groundwater plume (further discussed below).

A groundwater treatability study was conducted by Shaw Environmental, Inc. for the source area of the groundwater AOC 2 plume during the reporting period. The findings of the study are presented in a letter report dated November 6, 2007; a copy of this letter report is provided on the CD attached to this report.

3.1.2 Sub-slab Soil Gas

In March 2009, one round of sub-slab soil gas samples was collected at the buildings being evaluated for vapor intrusion. The table below summarizes the number of sub-slab soil gas samples collected during this period at each building.

Building	Number of Sub-Slab Soil Gas Sample	Sampling Date	Sampling Round
Building 165	4	5 March 2009	Tenth Round
Building 151	4	4 March 2009	Eleventh Round
Campus Plaza 4	4	5 March 2009	Eleventh Round

Results of the sub-slab soil gas analyses for VOCs below buildings in Groundwater AOC 2 are discussed building by building in the following subsections of this report. Shaded values in the tables indicate exceedances of the NJDEP VIG residential screening levels, whereas bolded and shaded values indicate exceedances of the NJDEP VIG non-residential sub-slab soil gas screening levels. Compounds exceeding the VIG screening levels in sub-slab soil gas during the current sampling events included toluene, methylene chloride, chloroform, benzene, TCE and PCE (in two buildings - 165 Fieldcrest and CP-4).

Per the IAQ approach, and consistent with the NJDEP VIG, indoor air samples were collected from all the buildings sampled in AOC 2 in conjunction with the sub-slab soil gas sampling. The only exception was Building 151, which was agreed upon with NJDEP to only collect sub-slab soil gas in two monitoring events over the next two years.

3.1.3 Building Survey

Prior to collection of indoor air samples, a *NJDEP Building Survey and Sampling Form* was completed for each tenant space from/under which samples were being collected in each building under evaluation for vapor intrusion. The buildings within Groundwater AOC 2 are primarily used as office space combined with attached warehouses. Common cleaning products were found in all of the buildings evaluated, but generally in small quantities and properly stored. As a result, in most cases, these cleaners may not necessarily constitute "significant" potential VOC sources. It should also be noted that Shaw conducted file reviews, interviews or inspections only in tenant spaces where sub-slab soil gas and indoor air samples were collected. Additional VOC sources may be associated with those tenant spaces.

A review of publicly available NJDEP and local government files indicates that several industries are present (or have been present since 1963 when the Army sold the property) within Groundwater AOC 2. These include American Grocery Company, Compac Industries, Inc., Clayton Environmental/Bureau Veritas, General Cable Company, Salwen Paper Company, IT Corporation, and ML Systems. According to the public files reviewed, each of these facilities presently stores, or has stored in the past, compounds also present in the Groundwater AOC 2 plume. Furthermore, Inland Container Corporation (diesel), American Grocery Company (gasoline and diesel), and Compac Industries, Inc. (toluene) have all had confirmed past releases of these compounds to the environment.

3.1.4 Indoor Air

In March 2009, USACE collected two rounds of indoor air samples at the buildings currently being evaluated for vapor intrusion. The table below summarizes the number of indoor air samples collected during this period at each building.

Building	Number of Indoor Air Samples	Ambient Air Samples	Sampling Date	Sampling Round
Building 165	7	1	4 March 2009	Fourteenth Round
Building 151	0	0	No Indoor Air Samples Collected	-
Campus Plaza 4	5	0	4 March 2009	Eleventh Round

Results of the indoor air and background ambient air analyses for VOCs in the buildings within Groundwater AOC 2 are discussed building by building in the following subsections of this report. Shaded values in the tables indicate exceedances of the NJDEP VIG residential screening levels, whereas bolded and shaded values indicate exceedances of the NJDEP VIG non-residential indoor air screening levels. Some of the compounds exceeding the screening levels in indoor air and sub-slab soil gas samples collected during the current sampling events included, chloroform, benzene, methylene chloride, 1,4-dichlorobenzene, benzene, and chloroform.

The following discussion focuses on soil gas and indoor air results on a building-by-building basis within Groundwater AOC 2.

3.1.5 Meteorological Data

Meteorological data for the March 2009 sampling event was downloaded from National Climatic Data Center consistent with guidance provided in the NJDEP VIG. The data was taken from the Local Climatological Data (LCD) for Newark Liberty International Airport. The average meteorological parameters collected for the dates that AOC 2 buildings were sampled are summarized below. See Appendix A on the attached compact disk (CD) for the complete meteorological data.

Building	Dates Sampled	Temperature Range Min-Max (°F)	Barometric Pressure Station Average (Inches of mercury)	Precipitation (Inches)	Relative Humidity Average (%)
Building 165	3-6 March 2009	12-56	30.28	0.00	45.80
Building 151	4 March 2009	16-35	30.35	0.00	42.17
Campus Plaza 4	3-5 March 2009	12-45	30.34	0.00	43.40

3.2 165 FIELDCREST AVENUE

Building 165 is a one-story concrete and steel building built on a concrete slab on grade, located at 165 Fieldcrest Avenue, along the western boundary of the Groundwater AOC 2 plume. The building consists of warehouse and office space and is currently occupied by six tenants. Building 165 is surrounded by a parking lot with a small landscaped lawn area.

Fourteen total rounds of indoor air sampling were conducted at 165 Fieldcrest Avenue from June 2003 to March 2009. Ten total rounds of sub-slab soil gas sampling were conducted by USACE, from June 2003 to March 2009. Current investigation activities included sub-slab soil gas, vapor recovery system, and indoor air sample collection during March 2009.

3.2.1 Prior Investigations

Building 165 is located in proximity to the 18C Ramp Area, a soil area of concern located on the eastern side of Building 256. Several phases of investigation and remediation have been completed within Area 18C, including a Supplemental Phase II Remedial Investigation (RI). In 1998, this investigation led to the removal of one 6,000-gallon steel underground storage tank (UST), three smaller concrete USTs, former leach field piping, and associated contaminated soils. Additional oil-contaminated soil and buried construction debris were encountered beneath the asphalt pavement northeast of Building 256 and west of the UST excavation area during the 1998 remediation of the leach field system. USACE removed approximately 2,450 cubic yards of contaminated soil from this area in 1998, and during the summer of 2002, approximately 5,300 additional tons of TCE-contaminated soils were removed from this area (Weston, June 2005b).

Additional investigations were completed in Area 18C and in the vicinity of Building 165. Those investigations included the collection of additional soil, soil gas and groundwater samples for VOC analysis. The results of analyses of the soil, soil gas and groundwater samples from the additional investigations were submitted to the NJDEP in the *Final Supplemental Remedial Investigation Report Areas 18C Ramp Area and Buildings 151/165* (Weston, June 2005b).

In a 12 March 2003 comment letter from the NJDEP concerning the USACE's *Draft Final Groundwater Natural Attenuation Report* (Weston, July 2002), for groundwater, NJDEP requested that potential vapor risks at 165 Fieldcrest Avenue be evaluated.

Indoor air sampling conducted in May 2003 at Building 165 by the property owner's consultant, Environmental Waste Management Associates (EWMA), indicated that PCE was detected in the indoor air in building tenant spaces.

Weston conducted an inspection of the building in June 2003, and completed the *Indoor Air Building Survey and Sampling Form* for each building tenant space. The most-recently updated *Indoor Air Building Survey and Sampling Forms*, and lists of products encountered, are included in Attachment A.

Subsequent indoor air sampling conducted by USACE in June 2003 did not detect any PCE in the indoor air. However, PCE was detected in four sub-slab soil gas samples and in one soil sample collected from below the building, indicating a potential subsurface source of PCE below the building. Other VOCs that were detected in the indoor air samples collected during the June 2003 sampling event at concentrations above the indoor air guidance values were either not detected in the sub-slab soil gas samples or detected at concentrations below those detected in the indoor air samples (Tables 3-2 and 3-4).

In August 2003, a subsurface vapor remediation system was installed at Building 165 to mitigate potential migration of VOC vapors from the sub-slab soil gas into the building. The system consists of 20 sub-slab vapor extraction points spaced throughout the building in order to obtain coverage of the entire floor space. The 20 extraction points are connected to two blowers that apply vacuum to the vapors beneath the building. Indoor air in Building 165 and the vapor recovery system sample ports were sampled for one year on a quarterly basis (October 2003 through July 2004) to evaluate the effectiveness of the subsurface vapor remediation system in compliance with the work plan for the *Indoor Air Monitoring Work Plan for Building 165* (Weston, October 2003).

After four quarters of post-remediation sampling, the NJDEP and USACE agreed to semi-annual sampling at Building 165. At each blower, vapor recovery samples are also being taken during each monitoring event to monitor the vapor remediation system. As compared to current NJDEP VIG guidance, the vapor recovery system samples indicate exceedances of NJDEP VIG residential sub-slab soil gas screening levels for PCE during the January 2007 sampling event. A PCE exceedance was observed previously during the July 2005 sampling event. Chloroform and 1,4-dichlorobenzene have also been detected. A summary of historic vapor recovery sample analytical results is presented on Table 3-3.

During the January 2005 sampling event (the first semi-annual event following the quarterly post-remediation sampling program), four sub-slab soil gas points were installed in the same locations as were first sampled in June 2003. The sub-slab gas monitoring points were installed at Peppermint Tree Day Care Center, Amax Engineering, Celcis and the vacant location which was later occupied by GVT Skin Care and subsequently re-vacated. In addition, a total of seven indoor air quality samples and one background air sample were collected at Building 165 for analysis of VOCs. The samples were collected from the same locations as each previous sampling event. The indoor air samples were collected at the following tenant locations: Peppermint Tree Day Care Center (one sample and duplicate), Celsis Laboratories Group (Celcis), Rockwell Automation, Amax Engineering Corp. (Amax), Mackay Communications (Mackay), and the vacant location (formerly GVT Skin Care) (Figure 3-2). The background air sample was collected from next to the playground at the Peppermint Tree Day Care Center. The two vapor recovery samples were collected from the shed behind the building, and the shed on the side of the building. These have been designated as the sampling locations for any samples that are or may be in Building 165 since the January 2005 sampling event.

One pre-remediation and ten post-remediation rounds of sampling have been performed by USACE at Building 165. Sampling events from August 2007 through September 2008 showed decreasing levels of PCE in sub-slab soil gas. Exceedance of PCE in sub-slab soil gas only occurred in August 2007. It was not detected above NJDEP VIG sub-slab screening levels in May and September 2008. From August 2007 through September 2008, PCE was not detected above NJDEP VIG sub-slab screening levels from samples collected from the Vapor Extraction System. During sampling events in August 2007 and September 2008, chloroform and methylene chloride were detected in the vapor extraction system above NJDEP VIG sub-slab screening levels. From August 2007 through September 2008 the following compounds were detected in indoor air above NJDEP VIG screening levels; methylene chloride, benzene, chloroform and 1,4-dichlorobenzene.

The most recent sampling event (September 2009) results are discussed in detail under the Current Investigation subsection, below. A compendium of sub-slab soil gas, vapor recovery

monitoring, and indoor air results for all samples collected from Building 165, in comparison to the NJDEP VIG residential and non-residential screening levels, are provided in Tables 3-2, 3-3, and 3-4, respectively. These tables summarize the number of detections and exceedances of NJDEP VIG screening levels, by sampling event, as well as the range of concentrations detected. The tables include only those VOCs that have been detected in any of the historic and current samples (i.e., those compounds that have never been detected in sub-slab soil gas, or indoor air samples collected by USACE at Building 165 are not included on Tables 3-2, 3-3, and 3-4).

3.2.2 Current Investigation

The samples collected during the March 2009 event were collected from the same locations and in a similar manner to the previous sampling events, as detailed in section 3.2.1. A pre-sampling walk-through was conducted to verify the locations of the sub-slab soil gas sampling points and to update the indoor air survey. One sample was collected from the each of the two vapor recovery sample ports during the March 2009 sampling event, as in the previous rounds. The following table summarizes the samples collected during the current investigation at Building 165.

Matrix	Number of Samples	Parameters/Method	Date Sampled
Sub-slab Soil Gas	4	VOCs/TO-15	5 March 2009
Vapor Recovery	2	VOCs/TO-15	6 March 2009
Indoor Air	7	VOCs/TO-15	3 March 2009
Background	1	VOCs/TO-15	3 March 2009

3.2.3 Sub-slab Soil Gas and Vapor Recovery System Results

During the March 2009 sampling event PCE was the only volatile organic compound detected above NJDEP VIG sub-slab screening levels. This exceedance occurred at Celsis/True Form location (Sample SG-03). This was the first exceedance of PCE above NJDEP VIG screening levels since the August 2007 sampling event. No other VOCs were detected in sub slab soil gas at concentrations greater than the NJDEP VIG residential and non-residential screening levels during the March 2009 sampling event.

The following table summarizes the sub-slab soil gas exceedances in comparison with NJDEP VIG non-residential and residential sub-slab soil gas screening levels:

	NJDEP VIG Table 1 Non-Residential Sub-slab Soil Gas Screening Level			**NJDEP VIG Table 1 Residential Sub-slab Soil Gas Screening Level**		
Compound	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m3)*	**Criterion** *(ug/m3)*	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m3)*	**Criterion** *(ug/m3)*
PCE (March 2009)	1 of 4	42.72	36	1 of 4	42.72	34

In the vapor recovery samples, no volatile organic compounds exceeding NJDEP VIG screening levels were detected during the March 2009 sampling event (Table 3-6). However, methylene

chloride and chloroform (March 2009) were detected at concentrations exceeding USEPA Generic Screening Levels Target Soil Gas Concentrations.

The following table summarizes the maximum vapor recovery exceedances in comparison with NJDEP VIG non-residential and residential sub-slab soil gas screening levels:

	NJDEP VIG Table 1 Non-Residential Sub-slab Soil Gas Screening Level			NJDEP VIG Table 1 Residential Sub-slab Soil Gas Screening Level		
Compound	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
No VOC Exceedances (March 2009)	0 of 2	-	-	0 of 2	-	-

The PCE sub-slab soil gas and vapor recovery sampling results from March 2009 are shown on Figure 3-1.

3.2.4 Building Survey

Shaw conducted a building survey and completed the *Indoor Air Building Survey and Sampling Form* for each building tenant space in order to identify and evaluate site conditions that could impact the sample results, including any possible indoor air emission sources that could generate target VOCs in the building. The survey and sampling form are updated concurrent with each sampling event to include any changes observed. The forms and lists of products used by building tenants are included in the attached CD.

3.2.5 Indoor Air Sampling Results

The indoor air and background sample results from the most recent sampling event (March 2009) are shown in Table 3-7. No DOD-related VOCs were detected at concentrations above VIG screening levels. VOCs detected at concentrations above their NJDEP VIG screening levels included benzene, chloroform, and methylene chloride.

A summary table of indoor air exceeding NJDEP VIG screening levels from the March 2009 winter sampling event is included below:

	NJDEP VIG Table 1 Non-Residential Indoor Air Screening Level			NJDEP VIG Table 1 Residential Indoor Air Screening Level		
Compound	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
Benzene (March 2009)	1 of 8	2.3	2	1of 8	2.3	2
Chloroform (March 2009)	1of 8	2.15	2	1of 8	2.15	2
Methylene Chloride (March 2009)	2 of 8	10.53-34.39	9	5 of 8	10.53-34.39	4

3.2.6 Integrated Discussion of Results

The results from the current investigation indicate that until this past sampling event (March 2009), the sub-slab remediation system has been effective in reducing concentrations of PCE in sub-slab soil gas. PCE was detected in sub-slab soil gas samples greater than the NJDEP VIG screening levels in the most recent sampling event (March 2009). The previous two sampling events after August 2007 (May 2008 and September 2008) did not detect PCE above NJDEP VIG screening levels and thus showed a decreasing trend. However, in the most recent sampling event (March 2009), PCE was detected at one sample location above the NJDEP VIG screening level. In addition PCE was not detected at concentration greater than the NJDEP VIG screening levels in both indoor air samples and vapor recovery samples.

Other VOCs have been detected in indoor air (benzene, chloroform, and methylene chloride) during the last sampling event and previous sampling events. The VOCs have been suspected to be present due to building tenant-related activities, as all three were not detected in sub-slab soil gas samples at concentrations above NJDEP VIG screening levels and historically have not been detected in groundwater at concentrations above the NJDEP VIG groundwater screening levels.

3.2.7 Conclusions and Recommendations

PCE and TCE levels in the soil gas samples, vapor recovery samples and indoor air samples are all trending lower when compared to past sampling events. TCE was not detected in sub-slab soil gas, vapor recovery or indoor air samples greater then NJDEP VIG screening levels. PCE was detected in one sample above the NJDEP VIG screening level but not at an extremely high concentration (42.72 ug/m^3). This continues to indicate that the vapor recovery system is still functioning.

Based upon the vapor recovery results over the past year, the USACE recommends continue evaluating the operation of the system to determine the best flow rate of the vapor recovery system to maximize removal of the vapors from beneath the sub-slab and continued monitoring of the building.

3.3 151 FIELDCREST AVENUE

Building 151 is a two-story concrete and steel building built on a concrete slab on grade, located at 151 Fieldcrest Avenue within the Groundwater AOC 2 plume. The building consists of warehouse with little office space and the current tenant is Plastic Express. Building 151 is surrounded by a parking lot with a small landscaped lawn area.

Eleven total rounds of indoor air sampling and eleven total rounds of sub-slab soil gas sampling were conducted at 151 Fieldcrest Avenue from June 2003 through March 2009. Current investigation activities included sub-slab soil gas sample collection **only** during the March 2009 event.

3.3.1 Prior Investigations

Building 151 is located in proximity to the 18C Ramp Area, which is a soil area of investigation located on the eastern side of Building 256 (described above under Sections 3.1.1 and 3.2.1). The results of analyses of the soil, soil gas and groundwater samples from the most recent investigation, including in the vicinity of Building 151, were submitted to the NJDEP in the *Final Supplemental Remedial Investigation Report Areas 18C Ramp Area and Buildings 151/165* (Weston, June 2005b).

In a 12 March 2003 comment letter from the NJDEP concerning the USACE's *Draft Final Natural Attenuation Report* (Weston, July 2002), NJDEP requested that potential vapor risks at Building 151 be evaluated.

Fourteen sampling events have been completed prior to the most recent event detailed in this indoor air quality report. Indoor air sampling was conducted on a quarterly basis between June 2003 and November 2004, and was changed to semi-annually beginning with the July 2005 event. Historically, indoor air was sampled during each event, while sub-slab soil gas was sampled in June 2003 (Round 1), November 2004 (Round 6) and concurrently with indoor air since. Indoor air was not sampled during the May 2008 sampling event and was not sampled in the most recent event (March 2009).

During prior investigations, PCE was detected in sub-slab soil gas in excess of its NJDEP VIG sub-slab soil gas screening level only during the June 2003 sampling event, while benzene was detected in sub-slab soil gas in excess of its NJDEP VIG sub-slab soil gas screening levels only during the July 2005 sampling event. In the air samples, several compounds in addition to PCE and TCE exhibited concentrations exceeding their NJDEP VIG screening levels. These compounds were: benzene, chloroform, methylene chloride, and MTBE. These compounds were attributed to building tenant-related activities and, in some cases, background (ambient) conditions, and do not provide evidence of a vapor intrusion pathway. Support for this theory includes the fact that VOCs have not been detected in indoor air at concentrations in excess of the NJDEP VIG screening levels during (and since) the January 2006 sampling event, which was the first event following the tenant's cessation of operations and departure from the building. However, the recommendation was made to continue monitoring on a semi-annual basis.

During the November 2007 sampling event, PCE and TCE were not detected at concentration above NJDEP VIG screening levels for sub-slab soil gas. However, PCE and TCE were again detected above NJDEP VIG screening levels for sub-slab soil gas during the June 2008 sampling event.

A compendium of sub-slab soil gas sample results for the samples collected from Building 151 is provided in Tables 3-8 and 3-9, respectively. These tables summarize the number of detections and concentrations that exceed NJDEP VIG screening levels by sampling event, as well as the range of concentrations detected. The tables include only those VOCs that have been detected in any of the historic or current samples (i.e., those compounds that have never been detected in sub-slab soil gas or indoor air samples collected by USACE at Building 151 are not included on Tables 3-8 and 3-9).

3.3.2 Current Investigation

One sampling event, which included sub-slab soil gas only, has taken place since the last indoor air quality report was issued. Sub-slab soil gas sampling occurred on 4 March 2009. The building has been occupied by Plastic Express since the August 2007 event.

Four sub-slab soil gas samples were taken during the March 2009 event. No sub-slab soil gas samples were taken at 151-SG3, because it was covered by several large pallets containing product. Sub-slab port 151-SG3 was last sampled on May 30, 2008. No indoor air was sampled during the March 2009. All samples were analyzed for VOCs. The locations of the sub-slab soil gas samples are shown on Figure 3-2. The locations of the samples corresponded to sample locations from earlier rounds.

The following table summarizes the samples collected under the current investigation at Building 151.

Matrix	Number of Samples	Parameters/Method	Dates Sampled
Sub-slab Soil Gas	4	VOCs/TO-15	4 March 2009

3.3.3 Sub-slab Soil Gas Results

During the sampling event in March 2009 only benzene was detected slightly above its residential NJDEP VIG screening level. It was detected at only one sub-slab port (SG-5). Figure 3-2 shows the sampling locations and analytical results in sub-slab soil gas samples at Building 151. The complete sub-slab soil gas results for the most recent round of samples are shown on Table 3-9.

The following table summarizes the sub-slab soil gas exceeding NJDEP VIG non-residential and residential sub-slab soil gas screening levels:

	NJDEP VIG Table 1 Non-Residential Sub-slab Soil Gas Screening Level			NJDEP VIG Table 1 Residential Sub-slab Soil Gas Screening Level		
Compound	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
Benzene (March 2009)	0 of 4	-	26	1 of 4	16.96	16

3.3.4 Building Survey

Prior to each subsequent indoor air sampling event, the *Indoor Air Building Survey and Sampling Form* was updated to reflect current conditions. These forms are included in the attached CD. The results of the site inspection have not revealed minor potential sources of VOCs in the building.

Prior to January 2006, 151 Fieldcrest was occupied by World Pac, Inc. World Pac vacated the premises and removed all chemicals following the July 2005 sampling event and prior to the January 2006 sampling event. Prior to the August 2007 sampling event, the building was vacant, but Plastic Express has occupied the building since the August 2007 event. During the March 2009 sampling event, the following chemicals were observed onsite: Nylon, Polypropylene, Polyethylene, and Polystyrene. However, these chemicals were self-contained in packaging.

3.3.5 Indoor Air Sampling Results

Indoor air samples were not collected during the March 2009 sampling event at Building 151.

3.3.6 Integrated Discussion of Results

PCE or TCE were not detected in any of the sub-slab soil samples above the NJDEP VIG screening level during the March 2009 sampling event. PCE and TCE were detected at concentrations above NJDEP VIG screening levels during the previous sampling event (June 2008). Only benzene was detected above sub-slab soil gas screening levels, but only slightly above the residential standard. Indoor air data collected to prior to this sampling event, most recently in June 2008, continues to show that there is no vapor intrusion pathway in Building 151, corroborating the conclusion presented in the previous Indoor Air Quality Reports. In January 2006, the building was vacated by the previous tenants, who had stored numerous chemicals on site that may have been the sources of VOCs previously detected in indoor air. Since the tenant left the building, concentrations of VOCs reported in indoor air were either below NJDEP VIG screening levels or were detected at concentrations lower than their reporting limits.

3.3.7 Conclusions and Recommendations

There does not appear to be a vapor intrusion pathway for Building 151 as supported by multiple lines of evidence. The USACE has agreed to annual sub-slab soil gas monitoring for a total of three years. The March 2009 sampling event completes the second of three years of annual sub-slab soil gas sampling. The third round of sampling will be completed in February 2010 and will be included in Report #6. If the averages of these rounds of sub-slab samples are below the NJDEP screening criteria, no further monitoring will be recommended for this building.

3.4 CAMPUS PLAZA 4

Campus Plaza 4 is a single-story concrete and steel building built on a concrete slab on grade, located within footprint of the Groundwater AOC 2 plume. The building consists of office and warehouse space and is occupied by three tenants. All four tenant locations were chosen as sample sites. Campus Plaza 4 is surrounded by parking lot with small landscaped and lawn areas.

Nine previous rounds of indoor air and ten previous sub-slab soil gas samples were collected at Campus Plaza 4 by Weston and Shaw for USACE from October 2004 through September 2008. Current investigation activities included sub-slab soil gas and indoor air sample collection during March 2009.

3.4.1 Prior Investigations

The original indoor air sampling at Campus Plaza 4 was conducted in May 2004 by EWMA under contract to FBC, the building owner. At the time, the levels of PCE and TCE were reported below detection limits. However, benchmark exceedances were reported for both benzene and methylene chloride.

Weston collected a round of indoor air, sub-slab soil, and sub-slab soil gas samples in October and November 2004. The results of this investigation indicated the possibility of a vapor intrusion pathway based on the presence of TCE in both sub-slab soil gas and indoor air. However, the tenant at 284 Campus Drive (Englehard) utilizes a number of VOCs in their business, and may be contributing to the prior indoor air exceedances (of EPA Table 2C benchmarks) detected during that sampling event of benzene, ethyl benzene, methylene chloride, MTBE, and toluene, as well as PCE and TCE. A confirmatory round of indoor air sampling was recommended per the IAQ approach.

A second round of indoor air and sub-slab soil gas samples were collected in January 2006. Only one VOC, TCE, was detected in three of five sub-slab soil gas samples at concentrations above NJDEP VIG screening levels. The indoor air sampling results showed exceedances of NJDEP VIG screening levels for TCE, PCE, and methylene chloride in one of five samples, of MTBE in two of five samples, and of 1,4-dichlorobenzene and benzene in four of five indoor air samples. USACE recommended continued semi-annual monitoring of sub-slab soil gas and indoor air monitoring along with an evaluation of remedial alternatives. Subsequently, USACE and NJDEP agreed to increase the monitoring frequency for Campus Plaza 4 to quarterly monitoring, beginning with the September 2006 sampling event. However, after the September 2008 summer sampling event, the USACE and NJDEP agreed to continue sampling on a semi-annual basis.

A compendium of sub-slab soil gas and indoor air sample results is provided in Tables 3-10 and 3-11, respectively. These tables summarize the number of detections and exceedances of the current NJDEP VIG screening levels, by sampling event. The tables include only those VOCs that have been detected in any of the current or prior USACE investigation samples (i.e., those compounds that have never been detected in sub-slab soil gas or indoor air samples collected by USACE at Campus Plaza 4 are not included on Tables 3-10 and 3-11).

3.4.2 Current Investigation

At Campus Plaza 4, sub-slab soil gas and indoor air samples were collected from two Federal Business Center locations, Bareweb, Fabritex and Agilysys (indoor air only). For continuity,

samples were placed and collected from similar location associated with past sampling events. However, one sub-slab gas sampling port (SG-5) located in this building was damaged and could not be sampled. The following table summarizes the samples collected under the current investigation at Campus Plaza 4.

Matrix	Number of Samples	Parameters/Method	Dates Sampled
Sub-slab Soil Gas	4	VOCs/TO-15	5 March 2009
Indoor Air	5	VOCs/TO-15	3 March 2009

3.4.3 Sub-slab Soil Gas Results

During the current sampling event, TCE and PCE were detected in soil gas samples at concentrations that exceeded its NJDEP VIG screening level. No other VOC was detected in sub-slab soil gas samples that exceeded its NJDEP residential screening level during this sampling event. The sub-slab soil gas results are shown on Table 3-12. The PCE and TCE results are shown on Figure 3-6. The following table summarizes the NJDEP VIG exceedances in sub-slab soil gas samples during the current investigation:

	NJDEP VIG Table 1 Non-Residential Sub-slab Soil Gas Screening Level			NJDEP VIG Table 1 Residential Sub-slab Soil Gas Screening Level		
Compound	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
TCE (March 2009)	2 of 4	39.98-876	27	2 of 4	39.98-876	27
PCE (March 2009)	1 of 4	92.9	36	1 of 4	92.9	34

3.4.4 Building Survey

At Campus Plaza 4, there were four tenant locations surveyed. These locations cumulatively encompass the entire building. The locations are American Income Life/Agilysys (274 Raritan Center Parkway), Fabrictex (278/284 Raritan Center Parkway) Bareweb (280 Raritan Center Parkway), and FBC (300 Raritan Center Parkway). The *Indoor Air Building Survey and Sampling Forms* were updated at the time indoor air samples are collected. The updated forms include information on chemicals observed and building size and construction; the updated forms and MSDS forms can be found on the attached CD. The facilities are mostly office and warehouse spaces. During the site inspections, only daily-use cleaning supplies were observed. These cleaning products would only produce a minimal potential source of VOC. The only except is Federal Business Center (FBC).

FBC plans, builds and manages office and distribution space within Raritan Center. During the most recent site inspection and past site inspections of this facility, many potential VOC sources were located and noted on the survey form. These included several brands of paint thinner containing benzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene; multiple brands of paint primer containing ethyl benzene, acetone, and toluene; liquid nail adhesive containing toluene; Siperstein™ brand acrylic urethane primer containing 1,3,5-trimethylbenzene, methyl

isobutyl ketone, and 1,2,4-trimethylbenzene; Wasp and Hornet Killer containing 1,1,1-trichloroethane; and Imperial brand Rapid Brush Cleaner containing acetone, xylenes, and ethyl benzene. The storage and quantity of these products vary depending on current FBC needs. Daily-use cleaning products were found throughout the location; however, these products did not present any significant potential VOC sources.

3.4.5 Indoor Air Sampling Results

Both PCE and TCE were not detected in indoor air at concentration greater than the NJDEP VIG screening levels. Methylene chloride and 1, 4 dichlorobenzene were detected in indoor air above NJDEP VIG screening levels during the March 2009 sampling event. The analytical data is provided on Table 3-13, while the following table summarizes VOC concentrations exceeding NJDEP VIG screening levels in indoor air samples:

	NJDEP VIG Table 1 Non-Residential Indoor Air Screening Level			**NJDEP VIG Table 1 Residential Indoor Air Screening Level**		
Compound	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
1,4-Dichlorobenzene (March 2009)	1 of 5	3.25	3	1 of 5	3.25	3
Methylene Chloride (March 2009)	3 of 5	11.5-19.84	9	4 of 5	7.57-19.84	4

3.4.6 Integrated Discussion of Results

Except for the June 2008 sampling event, past sampling events dating back to January 2007 continue to show exceedances of TCE and PCE in soil gas samples. Indoor air results for the current investigation, however, show no exceedances of TCE or PCE.

Other VOCS such as methylene chloride and 1,4-dichlorobenzene detected at concentration above NJDEP VIG screening levels for indoor air are present in the indoor air due to potential tenant-related activities. These volatile organic compounds were not detected in indoor air samples exceeding NJDEP VIG screening levels.

3.4.7 Conclusions and Recommendations

Recent sub-slab analytical results for Campus Plaza 4 continue to show elevated levels of tetrachloroethylene and trichloroethylene above regulatory screening levels. Though recent indoor air analytical results have levels for these compounds below regulatory screening levels, the USACE has agreed to continue both sub-slab and indoor air sampling for this building.

SECTION 4.0
SAMPLING RESULTS FOR GROUNDWATER AREA OF CONCERN 6

4.1 OVERVIEW OF GROUNDWATER AOC 6 RESULTS

This section focuses on sampling results for sub-slab soil gas and indoor air collected during February 2009 (Winter 2009) to evaluate the potential for vapor intrusion at one building in the vicinity of Groundwater AOC 6. Prior to the discussion of the sub-slab soil gas and indoor air results, a description of historic groundwater contaminant concentrations is presented. The plume boundaries, as revised per the *Final Supplemental Groundwater Data Report* (Weston September 2006) were those that defined the extent of the groundwater plume for identification of buildings requiring evaluation of the potential for vapor intrusion.

Per the recommendations from the *Indoor Air Quality Semi-Annual Report #4* (Shaw 2009), Building 102-168 Fernwood is still being evaluated and/or monitored for vapor intrusion issues in AOC 6.

This building is commercial/industrial, and can be described as warehouse and/or office space. The building is, for the most part, surrounded by parking areas and roadways. Few open/landscaped areas exist. Sub-slab soil gas samples and indoor air samples were collected at this building within Groundwater AOC 6.

4.1.1 Groundwater AOC 6

Groundwater AOC 6 is located in the central portion of the site. The plume has been subdivided into Groundwater AOC 6A, Groundwater AOC 6B and Groundwater AOC 6C. The northern extent of Groundwater AOC 6A lies north of the building located at 110 Fernwood Avenue and underlies a portion of Area 10, within Raritan Center, and a portion of Area 9. This plume extends into the wetland area south of the building located at 45 Fernwood Avenue. The northern extent of Groundwater AOC 6B lies north of the building located at 104 Sunfield Avenue and extends just south of the southern boundary of Area 19. The Groundwater AOC 6C boundary begins just south of the southeastern side of the Raritan Expo Center and encompasses a portion of a parking lot, a landscaped area, a portion of a wetland area, and an undeveloped area of Area 8.

With the exception of possible DOD-related storage activities associated with Building 520 (Groundwater AOC 6C), source area(s) have not been identified for Groundwater AOC 6. Other potential sources may have included historic, or more recent, site activities not related to DOD activities (e.g., light manufacturing or industrial processes) as identified during a previously conducted file review.

Groundwater analytical data for overburden monitoring wells and direct-push samples from 1994 to 2005 were reviewed and compared to screening levels presented in Table 1 of NJDEP's Vapor Intrusion Guidance (October 2005, updated March 2007) to characterize the COPCs in Groundwater AOC 6. The location of the monitoring wells and shallow groundwater screening sample locations for AOC 6 are shown on Figures 7 and 13 of the 2006 *Final Supplemental Groundwater Data Report*. Table 5-1 provides these data for all VOCs that have historically been detected in any of the groundwater samples collected from within the bounds of Groundwater AOC 6. The historic contaminants of concern in Groundwater AOC 6 were TCE, PCE, total-1,2-dichloroethene (total-1,2-DCE), vinyl chloride, benzene, and cis-1,2-DCE as

shown in Table 5-1. TCE concentration contours in groundwater for AOC 6 are shown on Figure 13 of the 2006 Final *Supplemental Groundwater Data Report*.

The *Final Supplemental Groundwater Data Report* (Weston, 2006) stated that USACE will prepare a Groundwater RAWP with MNA proposed as the remedial action for Groundwater AOC 6A and proposed no further action in association with Groundwater AOC 6B. Additionally, the report stated that USACE will prepare a RAWP for AOC 6C after further investigation is completed to evaluate the vapor intrusion pathway.

In the meantime buildings within a 100-foot radius of the groundwater plume boundaries for Groundwater AOCs 6A, 6B and 6C were evaluated to determine if a potential vapor intrusion pathway existed, and sub-slab soil gas sampling was warranted. Groundwater data from the *Final Supplemental Groundwater Data Report* (Weston, September 2006) in conjunction with historic groundwater data were evaluated to determine which buildings would be considered for sub-slab soil gas sampling. If the groundwater data exceeded the NJDEP Table 1 Generic Vapor Intrusion Screening Levels for Groundwater (NJDEP Table 1-GW), it would indicate that groundwater could potentially be a source of vapors that could enter a building. If not, then a building was excluded from further vapor intrusion evaluation and sampling. In evaluating each building for vapor intrusion, recent groundwater data were given more importance than historic data, and the data from both monitoring wells and shallow groundwater screening (SGWS) points were included. Additionally, the position of the building in relation to the plume boundaries, the groundwater flow direction, and the most appropriate groundwater data points were used in determining whether a potential vapor intrusion pathway exists at each building.

A total of nine buildings within AOC 6 were previously evaluated to determine which specific buildings would require sub-slab soil gas sampling. Of the nine buildings evaluated, two were screened out of the sampling program based on groundwater data near the buildings, and seven buildings were sampled for sub-slab soil gas during the initial sampling effort conducted in March/April 2006. Since that time only 102-168 Fernwood Avenue remains and is included in this report (Report #5).

4.1.2 Sub-slab Soil Gas

In February 2009, USACE collected one round of sub-slab soil gas samples at 102-168 Fernwood, which is the only remaining building being sampled in the vicinity of Groundwater AOCs 6A, 6B and 6C. The table below summarizes the number of sub-slab soil gas samples collected during each sampling event at this building.

Building	Number of Sub-slab Soil Gas Samples	Sampling Date	Sampling Round
102-168 Fernwood Avenue	5	13 February 2009	Seventh Round

Results of the indoor air and sub-slab soil gas analyses for VOCs at 102-168 Fernwood are discussed in the following subsections of this report, and are provided in Tables 4-2 through 4-5. Shaded values in the tables indicate exceedances of the NJDEP VIG residential screening levels whereas bolded and shaded values indicate exceedances of the NJDEP VIG non-residential sub-slab soil gas screening levels.

Figure 4-1 shows the PCE and TCE concentrations for buildings investigated in the vicinity of Groundwater AOC 6, including 102-168 Fernwood. Concentrations exceeding NJDEP VIG screening levels are noted in red font.

4.1.3 Building Survey

Prior to collection of indoor air samples, a *NJDEP Building Survey and Sampling Form* was completed for 102-168 Fernwood. Building 102-168 Fernwood located within Groundwater AOC 6 is primarily used as office space combined with attached warehouses. Common cleaning products were found in the building evaluated, but generally in small quantities and properly stored. As a result, in most cases, these cleaners may not necessarily constitute "significant" potential VOC sources. In addition, printing inks are used in a small area within the building. However, the containers are stored and used in a "clean-room" with a separate HVAC and is not located near any sub-slab ports or indoor air samples. Currently the only tenant is Computershare Inc. The area of SG-01 and IA-01 is an unoccupied warehouse owned by Computershare.

4.1.4 Indoor Air

As previously mentioned, only one building is currently being sampled in the vicinity of Groundwater AOCs 6A, 6B and 6C. The table below summarizes the number of indoor air samples collected during the most recent sampling event.

Building	Number of Indoor Air Samples	Ambient Air Samples	Sampling Date	Sampling Round
102-168 Fernwood Avenue	7	1	12 February 2009	Seventh Round

At the request of the Computershare, one additional indoor air sample (IA-07) was added for the March 2009 sampling event. This sample was added to document indoor air level concentration in an occupied office area. Results of the indoor air and background ambient air analyses for VOCs in this remaining building within Groundwater AOC 6 are discussed in the following subsection of this report. Shaded values in the tables indicate exceedances of the NJDEP VIG residential screening levels, whereas bolded and shaded values indicate exceedances of the NJDEP VIG non-residential indoor air screening levels. Figure 4-1 shows the PCE and TCE concentrations for the building investigated in the vicinity of Groundwater AOC 6. Exceedances of the NJDEP VIG screening levels are noted in red font.

4.1.5 Meteorological Data

Meteorological data for this sampling event was received from the National Climatic Data Center and utilized National Weather Service Data from Newark Liberty International Airport. 1. The meteorological data collected during the sampling of the Groundwater AOC 6 buildings is summarized below. See the attached CD for the complete meteorological data.

Building	Dates Sampled	Temperature Range Min-Max (°F)	Barometric Pressure Station Average (Inches)	Precipitation (Inches)	Relative Humidity Average (%)
102-168 Fernwood Avenue	12-13 February 2009	32-57	29.58	0.00	42.63

4.2 102-168 FERNWOOD AVENUE

102-168 Fernwood Avenue is a single-story concrete and steel building built on a concrete slab on grade, located within the Groundwater AOC 6 plume. The building consists of office space and/or warehouse. Currently (January 2009), it only has one tenant; Computershare.

Six previous sampling events dating back to March 2006 were performed in 102-168 Fernwood. The current sampling event presented in Report #5 included sub-slab soil gas and indoor air sample collection during March 2009.

4.2.1 Prior Investigations

The 102-168 Fernwood Avenue building is located to the north of AOC 6A, but within the 100-foot radius of the groundwater plume boundary. The closest sampling locations for which recent groundwater data (2004/2005) are available are SGWS219 (about 300 feet north of the building and up-gradient of the plume), SGWS220 (about 270 feet northwest and up-gradient), SGWS221 (about 60 feet to the west and side-gradient), SGWS223 (about 120 feet to the southwest), SGWS229 (within 60 feet to the southeast and down-gradient of the plume), and MW-47A (about 100 feet south and down-gradient). In addition, the closest historical sample (sampled in 1994) is about 50 feet from the northeast corner of the building at location SGWS113.

- Recent (October 2004) groundwater data from SGWS219, SGWS220, and SGWS221 located up-gradient of this building did not show volatile organic compound (VOC) concentrations exceeding the NJDEP Table 1-GW screening levels.
- Historic (1994) groundwater data from sample location SGWS113 located up-gradient of this building did not indicate detectable levels of VOCs.
- The most recent sampling data from the closest point's down-gradient of the building indicate slight exceedance of several VOCs above the NJDEP Table 1-GW. SGWS223 exhibited a vinyl chloride concentration at 13 micrograms per liter (µg/l) compared with an NJDEP Table 1-GW screening level of 1 µg/l. SGWS229 exhibited concentrations of vinyl chloride and TCE at 9.6 µg/l and at 37 µg/l, respectively, which exceed the NJDEP Table 1-GW screening level.
- Monitoring well MW-47A, also located down-gradient and sampled in 2005, exhibited a TCE concentration of 13 µg/l that also exceeded the NJDEP screening level.
- The concentrations of VOCs detected in groundwater at the closest down-gradient monitoring well MW-47A are demonstrating a consistently decreasing trend, as shown on Figure 7 of the *Draft Supplemental Groundwater Data Report* (Weston, October 2005).
- This building is primarily located outside of the groundwater plume in a hydraulically up-gradient direction, as shown on Figures 7 and 13 of the *Draft Supplemental Groundwater Data Report* (Weston, October 2005).

Shaw and Weston collected several rounds of sub-slab soil gas samples from March 2006 through October 2008. The results of this investigation indicated the possibility of a vapor intrusion pathway as TCE and PCE was detected in several sub-slab soil gas samples in exceedance of the NJDEP VIG screening levels for almost every sampling event during that period. Indoor air samples were collected concurrent with the sub-slab soil gas samples and show several concentration of PCE exceeding NJDEP VIG screening levels.

4.2.2 Current Investigation

Five sub-slab soil gas and indoor air samples were collected at 102-168 Fernwood Avenue on 13 February 2009. All five sub-slab soil gas points were sampled at 102 Fernwood Avenue (Computershare). Sub-slab soil gas sample locations for 102-168 Fernwood Avenue are shown on Figure 4-1.

The following table summarizes the samples collected under the current investigation.

Matrix	Number of Samples	Parameters/Method	Dates Sampled
Sub-slab Soil Gas	5	VOCs/TO-15	13 February 2009
Indoor Air	6	VOCs/TO-15	12 February 2009
Ambient	1	VOCs/TO-15	12 February 2009

4.2.3 Sub-slab Soil Gas Results

Two VOCs (TCE and PCE) were detected in sub-slab soil gas at concentrations exceeding both the residential and non-residential NJDEP VIG screening levels during the February 2009 winter sampling event. TCE exceeded the NJDEP VIG screening levels in three of the five sub-slab soil gas samples collected during the February 2009 winter sampling events. PCE exceeded the NJDEP VIG screening levels in two of the five sub-slab soil gas samples collected during the February 2009 winter sampling event.

All other VOCs were either not detected or were detected at concentrations lower than their respective NJDEP VIG soil gas screening levels.

A summary of the detection frequency and concentration range of compounds detected in sub-slab soil gas is provided on Table 4-2. The complete sub-slab soil gas results for the current investigation are shown on Table 4-4. The following table contains a summary of the sub-slab soil gas exceeding NJDEP VIG screening levels.

	NJDEP VIG Table 1 Non-Residential Sub-slab Soil Gas Screening Criteria and Exceedances			NJDEP VIG Table 1 Residential Sub-slab Soil Gas Screening Criteria and Exceedances		
Compound	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
TCE (February 2009)	3 of 5	48.48-116.08	27	3 of 5	48.48-116.08	27
PCE (February 2009)	2 of 5	71.2-80.7	36	2 of 5	71.2-80.7	34

The PCE and TCE sub-slab soil gas sampling results from February 2009 are shown on Figure 4-1.

4.2.4 Building Survey

Shaw completed the *Indoor Air Building Survey and Sampling Form* for each building space in order to identify and evaluate site conditions that could impact the sample results, including any possible indoor air emission sources that could generate target VOCs in the building. There were

no chemicals observed that are considered significant potential VOC sources during the initial and subsequent sampling events. The Indoor Air Building Survey and Sampling Form are included on the CD attached to this report.

4.2.5 Indoor Air Sampling Results

During the February 2009 winter sampling events, PCE was detected in one of six total indoor air samples that exceeded NJDEP VIG screening levels. All other VOCs were either not detected or were detected at concentrations lower than their respective NJDEP VIG soil gas screening levels.

A summary of the detection frequency and concentration range of compounds detected in indoor air is provided on Table 4-3. The complete indoor air results for the current investigation are shown on Table 4-5. The following table contains a summary of the indoor air concentrations that exceeded NJDEP VIG screening levels.

	NJDEP VIG Table 1 Non-Residential Indoor Air Screening Criteria and Exceedances			**NJDEP VIG Table 1 Residential Indoor Air Screening Criteria and Exceedances**		
Compound	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
PCE (February 2009)	1 of 7	88.16	3	1 of 7	88.16	3

The PCE and TCE indoor air sampling results from November 2007 through October 2008 are shown on Figure 4-1.

4.2.6 Integrated Discussion of Results

PCE and TCE were detected at concentrations greater than NJDEP VIG screening levels in several sub-slab soil gas samples during the February 2009 winter sampling event. PCE was detected above NJDEP VIG screening levels for indoor air for one sampling points during the February 2009 winter sampling event. However, this elevated concentration occurred at a new indoor air sample location point (IA-07). The concentration at this sample point is significantly higher when compared to other indoor air sampling points. There is no historical data for this sample point, which will have to be monitored in future sampling events to determine if there is some local activity influencing the results.

The other VOCs detected in indoor air at concentrations greater than their NJDEP VIG screening levels (methylene chloride in two samples during the October 2008 sampling event) appear to be related to tenant activities since these compounds were not recently detected above NJDEP VIG screening levels in the sub-slab soil gas.

4.2.7 Conclusions and Recommendations

The presence of TCE and PCE in both the sub-slab soil gas and nearby groundwater sampling locations suggests the potential for a vapor intrusion pathway into the 102-168 Fernwood Avenue building. The USACE and NJDEP agreed to install a sub-slab venting system at 102-168 Fernwood. This system was installed in the fall of 2009 as a pre-emptive mitigation measure, despite the fact that indoor air concentrations do not consistently exceed NJDEP Indoor Air Screening Levels. The performance of the system was monitored on October 1 and 19 and

December 15, 2009 by Geosyntec Consultants. Vapor extraction points were monitored for PCE, TCE and cDCE using polydimethylsiloxane (PSMS) passive monitors. Results indicate that the sub-soil venting system has depressurized the subsurface and is operating as intended. Continued PDMS monitoring will occur and the USACE may request that current vapor extraction points be converted to passive vapor extraction points using wind or solar powered fans after a final installation summary report is submitted to NJDEP for review. Until then, semi-annual sub-slab and indoor air sampling will be suspended pending the findings of the installation study. A copy of Geosyntec's December 23, 2009 letter report to NJDEP, *Interim Progress Report and Request for Site-Specific Soil Gas Screening Levels, Sub-Slab Venting System, Former Raritan Arsenal, Edison, New Jersey* is presented in Appendix B.

SECTION 5.0
SAMPLING RESULTS FOR GROUNDWATER AREA OF CONCERN 8

5.1 OVERVIEW OF GROUNDWATER AOC 8 RESULTS

This section focuses on sampling results for sub-slab soil gas and indoor air collected from December 2008 through May 2009 to evaluate the potential for vapor intrusion at five buildings in the vicinity of Groundwater AOC 8. Prior to the discussion of the sub-slab soil gas and indoor air results, a description of historic groundwater contaminant concentrations is presented. The plume boundaries, as revised per the *Supplemental Groundwater Data Report* (Weston 2006) were those that defined the extent of the groundwater plume for identification of buildings requiring evaluation of the potential for vapor intrusion.

Per the recommendations from the *Indoor Air Quality Semi-Annual Reports #3 and #4* (Weston, 2008, Shaw 2009), five buildings are still being evaluated and/or monitored for vapor intrusion issues in AOC 8. The buildings evaluated within Groundwater AOC 8 are:

- EPA Building 10;
- EPA Building 18;
- EPA Building 200;
- EPA Building 205;
- EPA Building 209;

The buildings are mostly surrounded by parking lots, roads and few open/landscaped areas.

Buildings for which no further action was proposed in the vicinity of Groundwater AOC 8, and agreed to in NJDEP's 12 January 2007 and 7 May 2008 letters, include the following:

- 2815 Woodbridge Avenue);
- EPA Building 5; and
- the former EPA Guard Shack, which has been replaced by the New EPA Guard Shack, and is currently used for tool storage, is no longer occupied.

These buildings were not sampled during the current investigation, and are not discussed in this report. For information regarding the evaluation of the potential for vapor intrusion within these buildings, refer to the *Indoor Air Quality Semi-Annual Report # 2 & 3*

5.1.1 Groundwater AOC 8

Groundwater AOC 8 is located near the northern boundary of the former Arsenal in the central portion of the site, in the vicinity of Area 18E. On the basis of recent groundwater data (*Final Supplemental Groundwater Data Report,* Sept 2006), Groundwater AOC 8 has been subdivided into Groundwater plumes AOC 8A/B, AOC 8B, and, AOC 8D. AOC 8A/B footprint encompasses the former motor pool (Building 238) and the former GSA automotive shop (Building 241), AOC 8C encompasses the area along the southern investigation boundary of the dump area in Area 18G, former dump area and Groundwater AOC 8D is located in the vicinity of Area 1. There are no buildings within 100 ft of AOC 8C and AOC 8D.

Current contaminants of concern in Groundwater AOC 8 are TCE, PCE, and vinyl chloride, as described in the 2006 *Supplemental Groundwater Data Report* (Table 5-1). The location of the monitoring wells and shallow groundwater screening sample locations for AOC 8 are shown on Figures 5 and 11 of the 2006 *Supplemental Groundwater Data Report*. The historic

contaminants of concern in Groundwater AOC 8 are VOCs such as TCE, PCE, total 1,2-DCE, and chloroform, as described in the *Final Site-Wide Hydrogeology Report* (Weston, 1996) and the 2002 *Draft Final Groundwater Natural Attenuation Report* (NAR). TCE concentration contours in groundwater for AOC 8 are shown on Figure 11 of the 2006 *Supplemental Groundwater Data Report*.

Groundwater analytical data for overburden monitoring wells and direct-push samples from 1994 to 2005 were reviewed and compared to screening levels presented in Table 1 of NJDEP's Vapor Intrusion Guidance (October 2005, updated March 2007) to characterize the COPCs in Groundwater AOC 8. Table 5-1 provides these data for all VOCs that have historically been detected in any of the groundwater samples collected from within the bounds of Groundwater AOC 8. The historic contaminants of concern in Groundwater AOC 8 were TCE, PCE, benzene, and vinyl chloride as shown in Table 5-1.

The July 2008 Groundwater RAWP recommended proposed MNA as the remedial action for Groundwater AOCs 8C, and 8D. Preparation of a RAWP for Groundwater AOC 8A/B will be based on further investigation (associated with Area 18E) and additional IAQ results.

Because of the concentrations of VOCs that have been detected in Groundwater AOC 8A/B, IAQ sampling has been conducted at several buildings within 100 ft of the groundwater plume (further discussed below).

5.1.2 Sub-slab Soil Gas

From December 2008 through May 2009, the USACE collected sub-slab soil gas samples at five buildings (Buildings 10, 18, 200, 205, and 209) on EPA Property within 100 ft of Groundwater AOCs 8A and 8B. However, EPA Building 200 is on a quarterly sampling schedule and was sampled during three events, December 2008, March 2009, and May 2009. All other buildings were sampled only once during the March 2009 winter event. The table below summarizes the number of sub-slab soil gas samples collected during each sampling event at each building.

Building	Number of Sub-slab Soil Gas Samples	Sampling Date	Sampling Round
Building 10	2	10 March 2009	Tenth Round
Building 18	2	12 March 2009	Ninth Round
Building 200	1	12 December 2008	Twelfth Round
	1	13 March 2009	Thirteenth Round
	1	29 May 2009	Fourteenth Round
Building 205	3	12 March 2009	Eleventh Round
Building 209	6	10March 2009	Eighth Round

Results of the sub-slab soil gas analyses for VOCs below buildings in the vicinity of Groundwater AOC 8 are discussed in the following building-specific subsections of this report, and are provided in Tables 5-2 through 5-21. Shaded values in the tables indicate concentrations exceeding the NJDEP VIG residential screening levels whereas bolded and shaded values indicate concentrations exceeding NJDEP VIG non-residential sub-slab soil gas screening levels.

5.1.3 Building Survey

Prior to collection of indoor air samples, a *NJDEP Building Survey and Sampling Form* was completed for each building from/under which samples were being collected. No products or

chemicals were observed during the building inspections that could be considered a potential VOC emissions source. The *Indoor Air Building Survey and Sampling Forms* are included on the CD attached to this report. However, Buildings 205 and 209 have had recent renovations within the vicinity of several sub-slab soil gas sampling ports.

5.1.4 Indoor Air

From December 2008 to May 2009 the USACE collected indoor air samples and sub-slab soil gas samples at five buildings (Buildings 10, 18, 200, 205, and 209) located on EPA Property within 100 ft of Groundwater AOCs 8A/8B. Again, Building 200 was sampled during three separate sampling events, while all other buildings were sampled during one event (March 2009). The table below summarizes the number of indoor air samples collected during each sampling event at each building.

Building	Number of Indoor Air Samples	Ambient Air Samples	Sampling Date	Sampling Round
Building 10	2	0	9 March 2009	Ninth Round
Building 18	2	1	11 March 2009	Ninth Round
Building 200	2	1	11 December 2008	Twelfth Round
	2	1	12 March 2009	Thirteenth Round
	2	1	28 May 2009	Fourteenth
Building 205	5	0	11 March 2009	Eleventh Round
Building 209	6	1	9 March 2009	Eighth Round

Results of the indoor air analyses for VOCs in buildings falling within Groundwater AOC 8 are discussed building by building in the following subsections of this report. Shaded compounds and values indicate exceedances of the NJDEP VIG screening levels.

5.1.5 Meteorological Data

Meteorological data utilized during each sampling event was obtained from the National Climatic Data Center for Newark Liberty International Airport. The meteorological data collected during the sampling of the Groundwater AOC 8 buildings is summarized below. See the attached CD for the complete meteorological data.

Building	Dates Sampled	Temperature Range Min-Max (°F)	Barometric Pressure Station Average (Inches)	Precipitation (Inches)	Relative Humidity Average (%)
Building 10	9-10 March 2009	38-51	30.13	0.04	73.42
Building 18	11-13 March 2009	27-58	30.28	0.00	49.12
Building 200	11-12 December 2008	33-46	29.78	1.45	83.05
	12-13 March 2009	27-47	30.41	0.00	37.09
	28-29 May 2009	55-76	29.81	0.15	83.13
Building 205	11-12 March 2009	32-58	30.21	0.00	52.35
Building 209	9-10 March 2009	38-51	30.13	0.04	73.42

5.2 EPA BUILDING 10

EPA Building 10 is located within the western portion of Groundwater AOC 8 and up-gradient of Building 205. Building 10 is a two-story brick building built on a concrete slab on grade, located within the Groundwater AOC 8A/B plume. The building consists of office space and is surrounded by a parking lot with a small landscaped and lawn area. This building has never been identified as an area of investigation or a former DOD occupancy requiring investigation.

Nine previous sampling events were conducted by USACE at EPA Building 10 in January 2005 through September 2008. Current investigation activities include sub-slab soil gas and indoor air samples collected during the March 2009 winter sampling event.

5.2.1 Prior Investigations

Four sub-slab soil gas samples were collected at Building 10 by the EPA in December 2004. TCE was detected at concentrations ranging from 29 to 161 µg/m^3 in the sub-slab soil gas. In January 2005, the EPA took indoor air readings with the TAGA, and the TCE concentrations ranged from "not detected" to 1.07 µg/m^3 (EPA, January 2005). Based on EPA's sub-slab soil gas and indoor air trace atmospheric gas analyzer (TAGA) results indicating the presence of TCE at concentrations exceeding its screening benchmark, USACE re-sampled the sub-slab soil gas point at which the highest TCE concentration was detected (1-010-SG-03). At location 1-010-SG-03, benzene, chloroform and TCE were detected in exceedance of the EPA Table 2C-SSG screening benchmarks. Of these, TCE exhibited the highest magnitude of the exceedances; the TCE concentration at location 1-010-SG-03 was 69 times the screening benchmark.

The soil and groundwater analytical results, collected as part of the Area 18E investigation, in close proximity (less than 100 ft) to Building 10, indicated the presence of TCE in both soil and groundwater. TCE was detected in soil within a localized area up to 3.5 ft below ground surface (bgs) at concentrations up to 17 mg/kg. TCE was detected in groundwater at concentrations to 5.9 µg/L. The data suggest that soil may be a potential source of TCE concentrations in soil gas beneath and within Building 10.

Given that TCE was also detected in the indoor air within the building during the EPA investigation, there appeared to be a potential vapor intrusion pathway in this building. The USEPA installed a sub-slab depressurization system at Building 10.

Sub-slab soil gas and indoor air were subsequently sampled by Weston for USACE in January 2006. The results of that investigation indicated the possibility of a vapor intrusion pathway as PCE was detected in one of the two sub-slab soil gas samples and one of the two indoor air samples exceeding NJDEP VIG screening levels. During that sampling event, benzene and MTBE were also detected in one of two indoor air samples at concentrations greater than NJDEP VIG screening levels; however, the presence of these compounds were attributed to non-DOD sources, likely related to use of gasoline in the vicinity of Building 10.

Sampling events performed by both Weston and Shaw from January 2007 through September 2008 detected both PCE and TCE in the sub-slab during various sampling events. The maximum TCE concentration detected during this period was 116.08 ug/m^3 during the September 2008 sampling event. The highest PCE sub-slab soil gas concentration detected during this period was 180 ug/m^3 detected during the January 2007 sampling event. During this same period (January 2007 through September 2008) both PCE and TCE were not detected at concentrations exceeding NJDEP VIG screening levels and thus showing an incomplete pathway to indoor air.

5.2.2 Current Investigation

Two sub-slab soil gas and two indoor air samples were collected from 10 through 11 March 2009. Sub-slab soil gas and indoor air sample locations for EPA Building 10 are shown on Figure 5-1.

The following table summarizes the samples collected under the current investigation.

Matrix	Number of Samples	Parameters/Method	Dates Sampled
Sub-slab Soil Gas	2	VOCs/TO-15	10 March 2009
Indoor Air	2	VOCs/TO-15	9 March 2009
Background	0	VOCs/TO-15	-

5.2.3 Sub-slab Soil Gas Results

Both TCE and PCE were not detected in the sub-slab at concentration exceeding NJDEP VIG soil gas screening levels during the March 2009 winter sampling event. Only methylene chloride was detected in the soil gas at concentration exceeding NJDEP VIG screening levels. However, methylene chloride is considered a non-DOD constituent and was not detected in the groundwater associated with AOC 8A/B plume. All other VOCs were either not detected or were detected at concentrations lower than their respective NJDEP VIG soil gas screening levels.

A summary of the detection frequency and concentration range of compounds detected in sub-slab soil gas is provided on Table 5-2. The complete sub-slab soil gas results for the current investigation are shown on Table 5-4. The following table contains a summary of the sub-slab soil gas exceeding NJDEP VIG screening levels.

	NJDEP VIG Table 1 Non-Residential Sub-slab Soil Gas Screening Criteria and Exceedances			NJDEP VIG Table 1 Residential Sub-slab Soil Gas Screening Criteria and Exceedances		
Compound	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
Methylene Chloride (March 2009)	1 of 2	4655.2	430	1 of 2	4655.2	190

5.2.4 Building Survey

Shaw conducted initial inspections of Building 10 for each sampling event to confirm no significant changes in building activates between sampling events. For each inspection an *Indoor Air Building Survey and Sampling Form* was completed during each subsequent sampling event in order to identify and evaluate site conditions that could impact the sample results, including any possible indoor air emission sources that could generate target VOCs in the building. Building 10 is an office building, and other than daily cleaning products or coping toner, there were no chemicals observed that are considered significant potential VOC sources during the initial and subsequent sampling events. The Indoor Air Building Survey and Sampling Form are included on the CD attached to this report.

5.2.5 Indoor Air Sampling Results

Both PCE and TCE were not detected at levels exceeding NJDEP VIG indoor air screening levels for the March 2009 winter sampling event. No other VOCs were detected in indoor air in exceedance of their respective VIG Generic screening guidelines.

A summary of the detection frequency and concentration range of compounds detected in indoor air is provided on Table 5-3. The complete indoor air sampling results for the current investigations are shown on Table 5-5.

5.2.6 Integrated Discussion of Results

Since the installation of the sub-slab remediation system, PCE or TCE have been detected in indoor air below NJDEP VIG screening levels for the past eight sampling events. During the most recent sampling event (March 2009) PCE and TCE were not detected in sub-slab soil gas exceeding NJDEP VIG screening levels. Methylene chloride was detected in indoor air at levels exceeding NJDEP VIG screening levels. However, this VOC was not detected in the groundwater plume associated with AOC 8 and is considered a non-DOD compound of concern. In addition, it is not being detected in indoor air and is not considered a threat. Continued semi-annual monitoring of the sub-slab remediation system will continue.

5.2.7 Conclusions and Recommendations

Due to installation of a remedial system, VOCs have not been migrating into the indoor air at concentrations of concern. Semi-annual monitoring of the remedial system has proven that the system is operating properly. It is recommended that the monitoring at this frequency continue with an annual reevaluation in 2010.

5.3 EPA BUILDING 18

EPA Building 18 is located near the border of Area 18E. Building 18 is a two-story brick building built on a concrete slab on grade, located within the Groundwater AOC 8A/B plume. The building consists of office space and is surrounded by a parking lot with a small landscaped and lawn area.

Eight previous sampling events were conducted by USACE at EPA Building 18 starting in February 2006 through September 2008. Current investigation activities included sub-slab soil gas and indoor air sample collection during March 2009.

5.3.1 Prior Investigations

Five sub-slab soil gas samples were collected at Building 18 by the EPA in December 2004. TCE concentrations ranged from not detected to 1,021 µg/m^3. In January 2005, the EPA took TAGA readings indicating that indoor air TCE concentrations ranged from 0.75 to 6.99 µg/m^3 (EPA, January 2005). As stated in the work plan submitted to the NJDEP by the USACE on 20 January 2005 (Weston, January 2005), location 018-05 (highest TCE concentration) was to be re-sampled, but could not be because the sampling point had been abandoned (filled in with clay) prior to the USACE's investigation.

During the 18E investigation, TCE was detected in both soil and groundwater exceeding its NJDEP criterion within 100 feet of the building. TCE was detected in soil north of Building 18 exceeding the NJDEP MSSCC in five samples collected at the sample interval of 1.5 to 2.0 ft bgs and in one sample collected at 3.5 to 4.0 ft bgs. It should be noted the soil samples collected from the two closest borings did not have any VOC exceedances. The samples collected from these borings were collected at depths ranging from 1.5 to 5.0 ft bgs. TCE was detected in the shallow groundwater sample, collected from a location completed immediately north of Building 18, at a concentration of 37 µg/L (Weston, June 2005a).

The USEPA data suggested a complete vapor intrusion pathway existed at Building 18. USACE was unable to verify the USEPA's sub-slab soil gas results during this field program. However USACE re-sampled both sub-slab soil gas and indoor air to confirm prior USEPA results in January 2006.

Weston collected a round of sub-slab soil gas and indoor air samples in January 2006. The results of this investigation did not support the presence of a vapor intrusion pathway as no VOCs were detected in sub-slab soil gas or indoor air samples in exceedance of the NJDEP VIG screening levels.

However, sampling continue after January 2006 with sampling events in June 2006, September 2006, January 2007, April 2007, August 2007, June 2008 and September 2008. TCE and PCE were detected in the sub-slab soil gas above NJDEP VIG screening levels during different sampling events. However, sampling events in June 2006, August 2007 and September 2008 did not detected PCE or TCE above NJDEP VIG screening levels. PCE has never been detected in indoor air samples greater than NJDEP VIG screening levels. TCE was detected only once (June 2008) in indoor air samples greater than the NJDEP VIG screening levels. Because PCE and TCE continue to be detected in the sub-slab soil gas above NJDEP VIG screening levels, monitoring of Building 18 continues.

5.3.2 Current Investigation

Two sub-slab soil gas and two indoor air samples were collected from March 12 through March 13, 2009. Sub-slab soil gas and indoor air sample locations for EPA Building 18 are shown on Figure 5-2.

The following table summarizes the samples collected under the current investigation.

Matrix	Number of Samples	Parameters/Method	Dates Sampled
Sub-slab Soil Gas	2	VOCs/TO-15	12 March 2009
Indoor Air	2	VOCs/TO-15	11 March 2009
Background	1	VOCs/TO-15	12 March 2009

5.3.3 Sub-slab Soil Gas Results

Only one sampling point detected TCE above the NJDEP VIG screening levels for soil gas. PCE was not detected above its NJDEP VIG screening level during this sampling event. Benzene was the only other VOC detected in soil gas exceeding NJDEP VIG screening levels.

A summary of the detection frequency and concentration range of compounds detected in sub-slab soil gas is provided on Table 5-6. The complete sub-slab soil gas results for the current investigation are shown on Table 5-8. The following table contains a summary of the sub-slab soil gas that exceeded its NJDEP VIG screening levels.

	NJDEP VIG Table 1 Non-Residential Sub-slab Soil Gas Screening Criteria and Exceedances			NJDEP VIG Table 1 Residential Sub-slab Soil Gas Screening Criteria and Exceedances		
Compound	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
Benzene (March 2009)	1 of 2	40.57	26	1 of 2	40.57	16
TCE (March 2009)	1 of 2	235.93	27	1 of 2	235.93	27

5.3.4 Building Survey

Shaw completed the *Indoor Air Building Survey and Sampling Form* during each subsequent sampling event in order to identify and evaluate site conditions that could impact the sample results, including any possible indoor air emission sources that could generate target VOCs in the building. Building 18 is primarily an office building and did contain daily cleaning products in small quantities. Otherwise, there were no chemicals observed that are considered significant potential VOC sources during the initial and subsequent sampling events. The Indoor Air Building Survey and Sampling Forms are included on the CD attached to this report.

5.3.5 Indoor Air Sampling

TCE and PCE were not detected above NJDEP VIG screening levels during the March 2009 winter sampling event. Methylene chloride was detected in two samples above NJDEP VIG indoor air screening levels; one exceeding both non-residential and residential screening levels (Sample 018-04 at 136.16 ug/m^3) and above the residential screening level (Sample 018-05 at

6.46 ug/m^3). Methylene chloride was not detected in groundwater above NJDEP Groundwater Screening Levels for the plume associated with AOC-8. It is considered to be associated with non-DOD activities. The indoor air and background air results are shown on Table 5-9.

5.3.6 Integrated Discussion of Results

Volatile organic compounds are periodically detected in sub-slab soil gas. Since the installation of the sub-slab remediation system, VOC exceedances have been limited to methylene chloride, which has not been detected in groundwater above benchmark concentrations. Only once has TCE been detected in indoor air above NJDEP VIG screening levels (June 2008). Continued monitoring of the sub-slab remediation system will continue on a semi-annual basis.

5.3.7 Conclusions and Recommendations

Due to installation of a remedial system, VOCs have not been consistently migrating into the building at concentrations of concern. Previous monitoring of the remedial system has proven that the system is operating properly. It is recommended that the monitoring continue at the same semi-annual frequency. USACE will reevaluate the monitoring performed on an annual basis.

5.4 EPA BUILDING 200

EPA Building 200 is a single-story brick building built on a concrete slab on grade, located within the Groundwater AOC 8A/B plume. The building consists of office space and is surrounded by a parking lot with a small landscaped and lawn area. The building is currently used as a medical facility (nurse's station).

Thirteen previous rounds of sub-slab soil gas sampling were conducted at EPA Building 200 in January 2005 through October 2008, and twelve previous rounds of indoor air sampling were conducted in January 2006 through October 2008. Current investigation activities included sub-slab soil gas and indoor air sample collection during December 2008, March 2009, and May 2009. Building 200 is the only remaining building sampled on a quarterly basis.

5.4.1 Prior Investigations

The EPA installed three sub-slab soil gas monitoring points in Building 200 during December 2004; the TCE concentrations ranged from 86 to 29,019 µg/m^3. In January 2005, the EPA took TAGA indoor air readings; the TCE concentrations ranged from 20.42 to 59.11 µg/m^3 (EPA, January 2005). Based on EPA's December 2004 sub-slab soil gas and January 2005 indoor air TAGA results, USACE decided to re-sample the sub-slab soil gas monitoring point in Building 200 (200-02) where the highest TCE concentration was detected. Carbon tetrachloride, chloroform, and TCE were detected in exceedance of the EPA Table 2C-SSG screening benchmark in sample 1-200-SG-02. Of these, TCE exhibited the greatest magnitude of exceedance; the TCE concentration at location 1-200-SG-02 was 210 µg/m^3.

TCE was also detected in groundwater exceeding the NJDEP Class IIA GWQS and EPA Table 2C-GW criteria at Building 200. The maximum TCE concentration in soil gas (210 µg/m^3) cannot be fully explained by the maximum groundwater TCE concentration of 120 µg/L (location EPA200-02) detected at this building. TCE was detected in soil at concentrations as high as 9.5 mg/kg below the slab (location EPA200-06), indicating that subsurface soil contamination may be a source for a significant amount of the TCE detected in soil gas. EPA-installed monitoring point 200-02, where the highest TCE concentration was detected in the EPA-collected samples, is approximately 25 feet away from boring location EPA200-06 (Weston, June 2005a).

Results indicated that a complete vapor intrusion pathway from sub-slab soil gas to indoor air existed for Building 200. Based on the results, a sub-slab venting/depressurization system was installed by the EPA.

Weston collected a round of sub-slab soil gas samples in January 2005, and two subsequent rounds of sub-slab soil gas and indoor air samples in January and March 2006. The results of the earlier phases of investigation suggested the presence of a vapor intrusion pathway, since TCE was detected in sub-slab soil gas and indoor air samples in exceedance of the NJDEP VIG screening levels.

Additional rounds of sampling through October 2008 continue to show sporadic concentrations of TCE above NJDEP VIG screening levels. However, the concentration of TCE never exceeds the screening levels no greater than 1.4 ug/m^3. In addition, TCE has not been detected in sub-slab soil gas above NJDEP VIG screening levels since November 2007.

5.4.2 Current Investigation

One sub-slab soil gas and two indoor air samples were collected during the three sampling events presented in Report #5 (December 2008, March 2009 and May 2009). Sub-slab soil gas and indoor air sample locations for EPA Building 200 are shown on Figure 5-3. The sub-slab soil gas point was sampled in the office area, by the nurse's desk. The indoor air samples were collected at the nurse's desk and the bookcase by the patient's rooms. One background sample was collected during each sampling round.

The following table summarizes the samples collected under the current investigation:

Matrix	Number of Samples	Parameters/Method	Dates Sampled
Sub-slab Soil Gas	1	VOCs/TO-15	12 December 2008
	1	VOCs/TO-15	13 March 2009
	1	VOCs/TO-15	29 May 2009
Indoor Air	2	VOCs/TO-15	11 December 2008
	2	VOCs/TO-15	12 March 2009
	2	VOCs/TO-15	28 May 2009
Background	0	VOCs/TO-15	-
	1	VOCs/TO-15	12 March 2009
	1	VOCs/TO-15	28 May 2009

5.4.3 Sub-slab Soil Gas Results

TCE has been detected consistently in sub-slab soil gas in exceeding NJDEP VIG screening levels during sampling events up to November 2007. However, TCE was not detected above the NJDEP VIG screening levels for soil gas during the last five sampling events, starting in June 2008 and continuing through May 2009. Methylene chloride was the only other VOC detected in sub soil gas greater than the NJDEP VIG screening levels. It was detected above the NJDEP VIG screening levels during the March 2009 sampling event. It exceeded USEPA Generic screening levels in May 2009, but not the NJDEP VIG screening levels. The elevated levels of methylene chloride cannot be explained as this compound was not detected in groundwater. No other VOCs were detected in exceedance of their NJDEP VIG screening guidelines during the sampling events.

A summary of the detection frequency and concentration range of compounds detected in sub-slab soil gas is provided on Table 5-10. The complete sub-slab soil gas results for the current investigation are shown on Table 5-12. The following table contains a summary of the sub-slab soil gas exceeding NJDEP VIG screening levels.

	NJDEP VIG Table 1 Non-Residential Sub-slab Soil Gas Screening Criteria and Exceedances			NJDEP VIG Table 1 Residential Sub-slab Soil Gas Screening Criteria and Exceedances		
Compound	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
Methylene chloride	1 of 3	13,896	430	1 of 3	13,896	190

5.4.4 Building Survey

Building 200 is currently used as the Health Center for the EPA facility. Shaw completed *Indoor Air Building Survey and Sampling Form* during each subsequent sampling event in order to identify and evaluate site conditions that could impact the sample results, including any possible indoor air emission sources that could generate target VOCs in the building. There were no chemicals observed that are considered significant potential VOC sources during the initial and subsequent sampling events. However, because this is a medical facility, small quantities of chemicals may exist for medical purposes. The Indoor Air Building Survey and Sampling Forms are included on the CD attached to this report.

5.4.5 Indoor Air Sampling Results

PCE was detected in one indoor air sample above NJDEP VIG indoor air screening levels (December 2008 at 73.24 µg/m^3). In addition, 1,4-dichlorobenzene was also detected slightly above the NJDEP VIG screening levels during a different sampling event (March 2009 at 3.61 µg/m^3). No other VOCs were detected above their respective NJDEP VIG screening levels.

A summary of the detection frequency and concentration range of compounds detected in indoor air is provided on Table 5-11. The complete indoor air sampling results for the current investigations are shown on Table 5-13. The following table contains a summary of the indoor air exceeding NJDEP VIG screening levels.

	NJDEP VIG Table 1 Non-Residential Indoor Air Screening Criteria and Exceedances			**NJDEP VIG Table 1 Residential Indoor Air Screening Criteria and Exceedances**		
Compound	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
PCE (December 2008)	1 of 1	73.24	3.0	1 of 1	73.24	3.0
1,4-dichlorobenzene (March 2009)	1 of 1	3.61	3.0	1 of 1	3.61	3.0

Based on the most current results, the quarterly sampling should be reduced to semi-annual sampling.

5.4.6 Integrated Discussion of Results

Previous sub-slab and indoor air sampling results corroborated that a complete vapor intrusion pathway existed from groundwater to soil gas to indoor air at Building 200. However, data from the last five sampling events show a significant decreasing trend in sub-slab soil gas concentrations for PCE and TCE. Both constituents have not been detected above NJDEP VIG screening levels since November 2007. Another significant trend is that PCE has not been detected in either the indoor air or sub-slab soil gas in concentrations above NJDEP VIG screening levels since March 2006. TCE was detected in indoor air above NJDEP VIG screening levels during the December 2008 fall sampling event. Methylene chloride has also been detected in the sub-slab soil gas above NJDEP VIG screening levels, but its elevated concentration cannot be explained as it does not exist in the ground water above benchmark criteria.

It appears that the sub-slab venting/depressurization system installed by the building owner is operating properly. The USACE has agreed to monitor Building 200 on a quarterly frequency to ensure the effectiveness of the system.

5.4.7 Conclusions and Recommendations

Data from the last five sampling events show a significant decrease of concentrations of TCE and PCE in indoor air. PCE has not been detected in either the indoor air or sub-slab soil gas at concentrations above NJDEP VIG screening levels since March 2006. It appears that the sub-slab venting/depressurization system installed by the building owner is operating properly. The USACE recommends continue quarterly sampling with the option to reduce the frequency of sampling to semi-annual.

5.5 EPA BUILDING 205

EPA Building 205 is a single-story brick building built on a concrete slab on grade, located within the Groundwater AOC 8A/B plume. The building consists of office space and is surrounded by a parking lot with a small landscaped and lawn area. It contains USEPA offices and warehouse space.

Ten previous rounds of sub-slab soil gas sampling events were conducted by USACE at EPA Building 205 from January 2005 through September 2008, and nine previous rounds of indoor air sampling were conducted in January 2006 through April September 2008. Current investigation activities included sub-slab soil gas and indoor air sample collection during the March 2009 winter sampling event.

5.5.1 Prior Investigations

In December 2004, the EPA installed 19 sub-slab soil gas monitoring points; the TCE concentrations ranged from "Not Detected" to 27,407 µg/m^3. In January 2005, the EPA decided to collect indoor air TAGA readings; the TCE concentrations ranged from "Not Detected" to 204 µg/m^3 (EPA, January 2005).

USACE collected two sub-slab soil gas samples in Building 205 in January 2005. Benzene, carbon tetrachloride, chloroform, and TCE were detected in sample 1-205-SG-11 on the west side of the building and carbon tetrachloride, chloroform, and TCE were detected in sample 1-205-SG-12 on the east side of the building exceeding their EPA Table 2C-SSG screening benchmarks.

The sub-slab soil gas results from January 2005 corroborated EPA's December 2004 sub-slab soil gas results including the concentrations of TCE detected in the sub-slab soil gas. In addition, TCE concentrations were detected in the indoor air during the EPA investigation. The TCE concentrations in sub-slab soil gas suggest soil gas is the source of the TCE concentrations detected by EPA in their indoor air investigation.

Weston collected a subsequent round of sub-slab soil gas coupled with indoor air samples in January 2006. The results of this investigation did not suggested the presence of a vapor intrusion pathway as TCE was detected in sub-slab soil gas exceeding the NJDEP VIG screening levels but not in indoor air.

The maximum TCE concentration detected in sub-slab soil gas (2,800 µg/m^3, detected during the January 2005 sampling event) cannot be explained by the maximum groundwater TCE concentration of 7 µg/L detected near this building. TCE was detected in soil beneath the building slab at a concentration as high as 14 mg/kg, indicating that contamination in subsurface soil may be a source for a significant amount of the TCE detected in sub-slab soil gas (Weston, June 2005a).

From November 2007 through September 2008, TCE, benzene and methylene chloride were detected in indoor air above NJDEP VIG screening levels. However, TCE was only detected in the September 2008 sampling event slightly above the NJDEP indoor screening level at a concentration of 3.87 µg/m$^{3.}$ In addition, TCE was not detected in the sub-slab soil gas above NJDEP VIG screening levels during two consecutive sampling events (June 2008 and September 2008).

5.5.2 Current Investigation

Three sub-slab soil gas and five indoor air samples were collected from March 11, 2009 through March 12, 2009. Indoor air and sub-slab samples were collected in the Training Center, Bay A, Bay B (indoor air samples only), and Small Conference Room. Due to recent construction activities, sub-slab soil gas samples were not collected in Bay B. Sub-slab soil gas and indoor air sample locations for EPA Building 205 are shown on Figure 5-4.

The following table summarizes the samples collected under the current investigation.

Matrix	Number of Samples	Parameters/Method	Dates Sampled
Sub-slab Soil Gas	3	VOCs/TO-15	12 March 2009
Indoor Air	5	VOCs/TO-15	11 March 2009

5.5.3 Sub-slab Soil Gas Results

During the March 2009 winter sampling event, only three sub-slab samples were collected. During the March 2009 sampling event Building 205 was being renovated and two sub-slab sampling ports (SG-11 and SG-12) were covered with a fresh layer of concrete. Both TCE and PCE were not detected above NJDEP VIG screening levels during the March 2009 winter sampling event. This is a decreasing trend as the recent four sampling events (August 2007 through September 2008) only detected TCE once in sub-slab soil gas greater then NJDEP VIG Soil Gas Screening Levels. Except for methylene chloride, no other VOC was detected above NJDEP VIG Soil Gas Screening Levels in the March 2009 winter sampling event. Methylene chloride was detected at an elevated concentration in only one sub-slab soil gas sampling port (1,205.49 µg/m^3 at SG-15). This elevated concentration cannot be explained as methylene chloride was not a compound detected in previous groundwater samples.

A summary of the detection frequency and concentration range of compounds detected in sub-slab soil gas is provided on Table 5-14. The complete sub-slab soil gas results for the current investigation are shown on Table 5-16. The following table contains a summary of the sub-slab soil gas exceeding NJDEP VIG screening levels.

	NJDEP VIG Table 1 Non-Residential Sub-slab Soil Gas Screening Criteria and Exceedances			NJDEP VIG Table 1 Residential Sub-slab Soil Gas Screening Criteria and Exceedances		
Compound	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Maximum Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
Methylene Chloride (March 2009)	1 of 3	1205.49	430	1 of 3	1205.49	190

The sample locations are depicted and TCE exceedances are noted in red font on Figure 5-4.

5.5.4 Building Survey

This building is located within Groundwater AOC 8 and part of investigation Area 18F (former warehouses). Building 205 was constructed by the U.S. Army in 1918 and once included pits, degreaser tanks, stills, dip tanks, transformers, floor drain, and utility lines (Weston, 1997). Shaw completed the *Indoor Air Building Survey and Sampling Form* during each subsequent

sampling event in order to identify and evaluate site conditions that could impact the sample results, including any possible indoor air emission sources that could generate target VOCs in the building. There were no chemicals observed that are considered significant potential VOC sources during the initial and subsequent sampling events. However, Building 205 has recently completed a renovation of its back warehouse prior to this sampling event. The Indoor Air Building Survey and Sampling Forms are included on the CD attached to this report.

5.5.5 Indoor Air Sampling Results

The only VOC detected above NJDEP VIG screening levels during the March 2009 winter sampling event was methylene chloride. Methylene chloride was detected in two of the five samples collected. However, it did not exceed the non-residential screening levels. No other VOC was detected above their respective NJDEP VIG screening levels during the March 2009 winter sampling event.

A summary of the detection frequency and concentration range of compounds detected in indoor air is provided on Table 5-15. The complete indoor air sampling results for the current investigations are shown on Table 5-17. The following table contains a summary of the indoor air exceeding NJDEP VIG screening levels.

	NJDEP VIG Table 1 Non-Residential Indoor Air Screening Criteria and Exceedances			**NJDEP VIG Table 1 Residential Indoor Air Screening Criteria and Exceedances**		
Compound	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
Methylene Chloride (March 2009)	0 of 5	-	9	2 of 5	4.2-6.77	4

5.5.6 Integrated Discussion of Results

TCE and PCE concentrations in sub-slab soil gas have been steadily decreasing since January 2006. The last three sampling rounds (June and September 2008, and March 2009) did not detect TCE or PCE in the soil gas above NJDEP VIG screening levels. In addition, only one sample (September 2008) of TCE has been detected in indoor air above NJDEP VIG screening levels in Building 205 since the USACE began their investigation, indicating that the remedial system is functioning effectively. It was not detected in indoor air during the March 2009 winter sampling event. Methylene chloride was the only constituent detected in both indoor air and sub-slab soil gas samples at a concentration exceeding their individual NJDEP VIG screening levels, but it is important to note that this compound has not been detected in any of the sub-slab soil gas samples collected during previous sampling events. Also, the elevated concentration cannot be explained as methylene chloride was not a compound detected in previous groundwater samples.

Otherwise, the decreasing trend of TCE and PCE results confirm that the remedial system is operating effectively. As previously recommended, monitoring of sub-slab soil gas and indoor air should be continued on a semi-annual basis to ensure the effectiveness of the remedial system.

5.5.7 Conclusions and Recommendations

The sub-slab soil gas results of this investigation were consistent with previous investigations indicating that TCE and PCE levels in the sub-slab soil gas continue to decrease in concentration. During the March 2009 winter sampling event, TCE and PCE were not detected in indoor and sub-slab soil gas samples exceeding NJDEP VIG screening levels. This confirms that the sub-slab depressurization remediation system that was installed is functioning effectively in preventing/reducing migration of sub-slab soil gas contaminants into the air within the building.

Methylene chloride was detected in sub-soil and indoor air exceeding NJDEP VIG screening levels. However, the elevated concentration cannot be explained as methylene chloride was not a compound detected in previous groundwater samples. Continued monitoring on a semi-annual basis is recommended. USACE will reevaluate the monitoring frequency on an annual basis.

5.6 EPA BUILDING 209

EPA Building 209 is a single-story brick building built on a concrete slab on grade, located to the west of the Groundwater AOC 8A/B plume. The building consists of office space and is surrounded by a parking lot with a small landscaped and lawn area.

Seven previous sampling events were conducted by USACE at EPA Building 209 from January 2006, through September 2008. Current investigation activities included sub-slab soil gas and indoor air sample collected during the March 2009 winter sampling event.

5.6.1 Prior Investigations

Weston and Shaw collected several round of sub-slab soil gas and indoor air samples from January 2006 through September 2008. The results of previous investigations did not suggest the presence of a complete vapor intrusion pathway since, while TCE was detected in sub-slab soil gas exceeding NJDEP VIG screening levels, it has not detected consistently in indoor air. In seven previous sampling events, PCE and TCE were only detected in indoor air above NJDEP VIG screening level during one sampling event (June 2008).

5.6.2 Current Investigation

Six sub-slab soil gas points were sampled in the newly furbished cage areas (Randy Braun/MAB's cage and Lockheed Martin's cage), Griffen's service warehouse, the kitchen/office area, extraction lab and the microscopy lab on March 11, 2009.

Matrix	Number of Samples	Parameters/Method	Dates Sampled
Sub-slab Soil Gas	6	VOCs/TO-15	10 March 2009
Indoor Air	6	VOCs/TO-15	9 March 2009
Background	1	VOCs/TO-15	9 March 2009

5.6.3 Sub-slab Soil Gas Results

During the March 2009 winter sampling event three VOCs (methylene chloride, chloroform, and PCE) exceeded their respective NJDEP VIG Soil Gas Screening Levels. PCE was detected in exceedance of the VIG screening levels during the last three sampling events (March 2009 and June and September 2008). Chloroform was detected above NJDEP VIG screening levels in all previous sampling events dating back to August 2007. Methylene chloride has never been detected above NJDEP VIG sub slab screening levels during the previous seven sampling events dating back to January 2006. Methylene chloride was detected above NJDEP VIG screening levels for sub soil gas in all six samples at elevated concentrations. However, the elevated concentration cannot be explained as methylene chloride was not a compound detected in previous groundwater samples.

A summary of the detection frequency and concentration range of compounds detected in sub-slab soil gas is provided on Table 5-18. The complete sub-slab soil gas results for the current investigation are shown on Table 5-20. The following table contains a summary of the sub-slab soil gas exceeding NJDEP VIG screening levels.

	NJDEP VIG Table 1 Non-Residential Sub-slab Soil Gas Screening Criteria and Exceedances			NJDEP VIG Table 1 Residential Sub-slab Soil Gas Screening Criteria and Exceedances		
Compound	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
Chloroform (March 2009)	3 of 5	24.32-29.06	24	3 of 5	24.32-29.06	24
Methylene Chloride (March 2009)	6 of 6	1010.94-4689.94	430	6 of 6	1010.94-4689.94	190
PCE (March 2009)	1 of 6	57.03	36	1 of 6	57.03	34

No other VOCs were detected at concentrations exceeding the NJDEP VIG screening levels. The sample locations are depicted and TCE and PCE exceedances are noted in red on Figure 5-5.

5.6.4 Building Survey

Building 209 is currently used as office space and lab areas for the EPA facility. Shaw completed the *Indoor Air Building Survey and Sampling Form* during each subsequent sampling event in order to identify and evaluate site conditions that could impact the sample results, including any possible indoor air emission sources that could generate target VOCs in the building. There were no visible chemicals observed that are considered significant potential VOC sources during the initial and subsequent sampling events. However, the not all areas of the warehouse cage areas are accessible and the exact use of chemicals in the laboratory area at any given time is unknown. The Indoor Air Building Survey and Sampling Forms are included on the CD attached to this report, as are the MSDS forms obtained for chemicals present due to tenant activities in Building 209.

5.6.5 Indoor Air Sampling Results

During the March 2009 winter sampling event TCE and PCE were not detected in ambient air samples. Benzene and methylene chloride were the only two VOC's exceeding VIG generic screening levels during this event. However, methylene chloride is not a COPC because it has not been detected in groundwater. Also, methylene chloride exceeding NJDEP VIG indoor air screening levels in one ambient air sample. Methylene chloride has also exceeded NJDEP VIG screening levels in ambient air samples during previous sampling events. Benzene may be related to gasoline use around the building. Similar to methylene chloride, benzene was detected at similar concentrations in previous ambient samples. The compounds that exceeded the NJDEP VIG screening levels are shown in the table below:

	NJDEP VIG Table 1 Non-Residential Indoor Air Screening Criteria and Exceedances			NJDEP VIG Table 1 Residential Indoor Air Screening Criteria and Exceedances		
Compound	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*	**No. of Samples Exceeding**	**Range in Concentration Exceeding** *(ug/m^3)*	**Criterion** *(ug/m^3)*
Benzene (March 2009)	4 of 7	2.4-10.41	2	4 of 7	2.4-10.41	2
Methylene chloride (March 2009)	2 of 7	33-57.32	9	5 of 7	4.83-57.32	4

A summary of the frequency of detections and ranges of detected concentrations are presented on Table 5-19. The complete indoor air and background air results for the current investigation are shown on Table 5-21. The PCE and TCE sample results for indoor air are shown on Figure 5-5.

5.6.6 Integrated Discussion of Results

The only VOCs detected in indoor air within Building 209 during this investigation were non-DOD related compounds (benzene and methylene chloride). While PCE, and chloroform were both detected in groundwater and sub-slab soil gas at concentrations greater than NJDEP VIG screening levels, neither compound was detected in indoor air at concentrations above its respective NJDEP VIG screening level.

5.6.7 Conclusions and Recommendations

Although PCE and chloroform were detected at concentrations exceeding their respective NJDEP VIG screening levels in sub-slab soil gas, they were not detected in the indoor air samples at concentrations exceeding the NJDEP VIG screening levels. Benzene and methylene chloride were detected in indoor air samples at concentrations above their NJDEP VIG screening levels, but these compounds are attributed to non-DOD activities. TCE concentrations in both soil gas and indoor air continue to remain below NJDEP VIG screening levels. Continued semi-annual monitoring of Building 209 is recommended.

SECTION 6.0
REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). *Minimal Risk Levels (MRLs), Inhalation*. January 2003.

Dames & Moore. *Archival Search Report, Former Raritan Arsenal, Edison, New Jersey*. July 1993

Hodgson, A.T., Garbesi, K., Sextro, R.G., and Daisey, J. *Soil-gas contamination and entry of volatile organic compounds into a house near a landfill.* 1992. Journal of the Air and Waste Management Association 42: 277-283.

National Institute for Occupational Safety and Health (NIOSH). *Pocket Guide to Chemical Hazards*. Occupational Safety and Health Administration Permissible Exposure Limits (PELs). U.S. Department of Health and Human Services. February 2004.

New Jersey Department of Environmental Protection. *Indoor Air VOC Sampling Analysis Requirements*, Site Remediation Program. April 2003.

New Jersey Department of Environmental Protection, Site Remediation Program. *Draft Guidance for Soil Gas Sampling*. 2004.

New Jersey Department of Environmental Protection, Site Remediation Program. *Draft Vapor Intrusion Guidance Document.* October 2005 with updates in March 2006, May 2006, and March 2007.

U.S. Army Corps of Engineers. *Approach for Evaluating Potential Indoor Air Quality Impacts, Former Raritan Arsenal, Edison, NJ.* 21 September 2004.

U.S. Environmental Protection Agency. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air: Method TO-15, Second Edition, Cincinnati, OH, EPA 625/R-96/010b.* January 1999.

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response (OSWER). *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils*. November 2002.

U.S. Environmental Protection Agency Region III. *EPA Region III Risk-Based Concentrations (RBC) Table.* Updated 8 October 2004.

U.S. Environmental Protection Agency. *Draft Vapor Investigation Binder*, distributed at the 13 January 2005 meeting.

U. S. Environmental Protection Agency. Trace Atmospheric Gas Analyzer (TAGA). March 2006. Online.Internet. http://www.epa.gov/earth1r6/6lab/taga.htm

Weston Solutions, Inc. *Final Site-Wide Hydrogeology Report, Former Raritan Arsenal Phase 2 Remedial Investigation.* June 1996.

Weston Solutions, Inc. *Former Raritan Arsenal Phase II Supplemental Record Review/Site Investigation Report.* December 1997.

Weston Solutions, Inc. *Draft Final Groundwater Natural Attenuation Report, Former Raritan Arsenal.* July 2002.

Weston Solutions, Inc. *Indoor Air Monitoring Work Plan for Building 165*. 3 October 2003.

Weston Solutions, Inc. *Draft Proposed Indoor Air, Sub-slab Soil Gas and Soil Sampling at Campus Plaza 1, 2, 3, 4, 5, 7, 8, 25-27 Campus Drive and 20 Northfield Avenue, Former Raritan Arsenal*. 4 October 2004.

Weston Solutions, Inc. *Draft Proposed Indoor Air and Sub-slab Soil Gas Sampling, Buildings 10, 18, 200, 205, and the Guard Shack.* 20 January 2005.

Weston Solutions. *Draft Indoor Air Quality Evaluation (Steps One through Four), Former Raritan Arsenal.* February 2005.

Weston Solutions, Inc. *Groundwater AOC 8 – EPA Building Investigation, for Soil, Groundwater and Sub-slab Soil Gas*. June 2005a.

Weston Solutions, Inc. *Final Supplemental Remedial Investigation Report Area 18C – Ramp Area and Building 151/165*. June 2005b.

Weston Solutions, Inc. *Final Supplemental Groundwater Data Report.* September 2006.

Weston Solutions, Inc. *Indoor Air Quality Semi-Annual Report.* November 2005.

Weston Solutions, Inc. *Proposed Work Plan for Sub-slab Soil Gas, Indoor Air and Sub-slab Soil Sampling; Groundwater AOC 4A and 4B Sampling Work Plan.* 23 January 2006.

Weston Solutions, Inc. *Proposed Work Plan for Sub-slab Soil Gas, Indoor Air and Sub-slab Soil Sampling; Addendum to Groundwater AOC 6A, 6B and 6C Sampling Work Plan.* 23 January 2006.

Weston Solutions, Inc. *Indoor Air Quality Semi-Annual Report #2.* September 2006.

Weston Solutions, Inc. *Indoor Air Quality Semi-Annual Report #3.* July 2008.