

Health Consultation

Milton's Dry Cleaner Site

Vapor Intrusion Assessment
Fort Vancouver High School
Vancouver, Clark County, Washington

March 30, 2011

Prepared by

The Washington State Department of Health



Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in accordance with methodologies and guidelines developed by the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste sites and releases.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation and should not necessarily be relied upon if site conditions or land use changes in the future.

This report was supported by funds from a cooperative agreement with ATSDR. However, it has not been reviewed and cleared by ATSDR.

For additional information or questions regarding DOH or the contents of this health consultation, please call the health advisor who prepared this document:

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SUMMARY

INTRODUCTION

The Washington State Department of Health (DOH) conducted this health consultation at the request of the Washington State Department of Ecology (Ecology). The focus of this health consultation is the potential indoor air health threat posed by evaporating chlorinated solvents (e.g., tetrachloroethylene (also known as PCE) and trichloroethylene (commonly called TCE)) found in soil gas below Fort Vancouver High School. The source of the solvents may be the former Milton's Dry Cleaner property located approximately 3,500 feet northeast of the high school. Solvents in soil gas can travel through the soil and enter overlying buildings through cracks or other openings in the foundation. This is known as vapor intrusion. In communities where vapor intrusion is an issue, DOH works to ensure that the community has the best information possible about the potential health threat posed by these sites.

CONCLUSION 1

DOH concludes that the solvent contaminated soil gas found below the Fort Vancouver High School complex does not appear to pose a current indoor air health threat to students, teachers, or staff.

BASIS FOR DECISION

There is no clear evidence that the solvents found in the soil gas below the school complex are moving up through the foundation and entering indoor air.

CONCLUSION 2

DOH concludes that contaminated soil gas could pose an indoor air health threat in the future if the existing slab penetrations are not sealed, the building is not under positive pressure relative to sub-slab air pressure, or if new construction or remodeling occurs at the high school complex and steps are not taken to address the vapor intrusion pathway.

BASIS FOR DECISION

Buildings constructed in locations where contaminants in soil gas pose an indoor air health threat are at risk for vapor intrusion if steps (e.g., installation of a soil vapor vacuum system during construction) are not taken to cut off the pathway during construction.

NEXT STEPS

- Ecology is working with the former owners and operators of the Milton's Dry Cleaner site and the Vancouver School District to ensure that the health department's recommendations are followed:
 - The pressure inside and below the building will be monitored at an appropriate frequency to ensure that the high school complex is consistently under positive pressure relative to sub-slab air pressure. If the pressure inside the school becomes negative relative to sub-slab air pressure, steps will be taken to return it to positive pressure.
 - Steps will be taken to seal slab penetrations in the high school complex.
 - Soil gas testing below the school will continue bi-annually to ensure that the solvent levels are not increasing and posing a future indoor air health threat. If the levels increase significantly, indoor air will be retested.
 - If new construction or remodeling occurs at the high school complex in the future, steps will be taken to address the vapor intrusion pathway if it continues to be a pathway of concern.
- DOH and Clark County Public Health are available to assist the school or school district with chemical storage practices, if needed.
- DOH will provide copies of this health consultation report to Ecology, Clark County Health, Vancouver School District, the potentially liable parties for the Milton's Dry Cleaner's site, and the public.
- DOH will post this health consultation report on its web site to make it available to the general public.
- DOH will review future investigation plans and reports if requested by Ecology or the Vancouver School District.

FOR MORE INFORMATION

If you have concerns about your health as related to this site, please contact Barbara Trejo, Washington State Department of Health, at 1-877-486-7316.

Glossary

Acute	Occurring over a short time [compare with chronic].
Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Chronic	Occurring over a long time (more than 1 year) [compare with acute].
Contaminant	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dermal Contact	Contact with (touching) the skin (see route of exposure).
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].
Groundwater	Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].
Hazardous Substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see route of exposure].
Model Toxics Control Act (MTCA)	The hazardous waste cleanup law for Washington State.
Organic	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.
Remedial Investigation	The process of determining the type and extent of hazardous material contamination at a site.
Route of Exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
Volatile Organic Compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Purpose and Statement of Issues

The Washington State Department of Health (DOH) has prepared this health consultation at the request of the Washington State Department of Ecology (Ecology). The purpose of this health consultation is to address whether the levels of the chlorinated solvent tetrachloroethylene (a dry cleaning chemical, commonly known as PCE) and some of its breakdown products (e.g., trichloroethylene (TCE)) found in soil gas below the Fort Vancouver High School pose an indoor air health threat to students, teachers, and staff. Solvents in soil gas can travel through the soil and enter overlying buildings through cracks or other openings in the foundation. This is known as vapor intrusion.

The high school is located at 5700 East 18th Street in Vancouver, Clark County, Washington (Figure 1). It is hydraulically downgradient of the Milton's Dry Cleaner (Milton's) site where PCE was released to soil and groundwater in the past. Milton's is located at 6721 East Fourth Plain Boulevard, approximately 3,500 feet northeast of the high school.

Background

The Fort Vancouver High School is part of the Vancouver School District. It is an approximately 210,000 square foot, predominantly one-story, slab-on-grade complex (Figure 2). Approximately 1,500 students (grades 9 to 12) and 150 faculty and staff occupy the school during the school year.(1)

School hours are weekdays from 7:30 a.m. to 2:05 p.m. After school programs also use the high school complex during late afternoon and early evening hours. It is reported that maximum occupancy occurs during the approximately 7-hour school day and decreases to about 15 to 25 percent occupancy for an additional 4 to 6 hours during after school programs. The duration of the current school year is 164 days. Additionally, an approximately 15-day summer school program (typically in July) operates at the high school from 8:30 a.m. to 8:00 p.m. for a limited number of students and staff.(2)

The original high school building was constructed in 1970. The building footprint, at that time, covered approximately 190,000 square feet. A building renovation and classroom expansion project occurred in the late 1990s, which added approximately 30,000 square feet of new classroom space (Figure 1).(2)

Both the old and new sections of the high school are constructed on a concrete slab-on-grade foundation system. The concrete slab in the newer addition areas is reportedly about 4 inches thick and overlies a minimum of 6 inches of compacted granular fill, and a vapor barrier with an underlying sand bed. The concrete slab thickness in the older part of the school has not been reported. However, it is suspected that the older portion of the building likely does not have a vapor barrier as it was not required by the building code at the time of construction. Although the building does not have a basement, the sub-grade for the lower level of the gymnasium is approximately four feet below ground surface (bgs). An elevator system is located in the gym area.(2)

Geology/Hydrogeology

Borings drilled just north of the high school building in August 2008 suggest that the high school complex is underlain by a 4 to 6-foot layer of silty sand to sandy silt. This upper soil layer is reportedly underlain by silty sand, silty gravel, and a gravelly sand unit. The thickness of this unit is unknown. However, it was observed to 20 feet, which was the maximum depth of the borings advanced during the investigation. Shallow groundwater in the vicinity of the high school during that drilling was approximately 13.5 to 17.5 feet bgs.(2)

Environmental Investigations

August 2008 Groundwater and Soil Gas Investigation

PCE was reportedly found in shallow groundwater below the northeast portion of the high school property during the 2008 investigation (maximum concentration of 2.3 micrograms per liter ($\mu\text{g/l}$)); no TCE was reportedly detected.(1) During that same investigation, PCE, TCE, and low levels of some PCE breakdown products (e.g., 1,1-dichloroethene (1,1-DCE)) were detected at 5 feet bgs in soil gas just north of the high school complex. The highest levels of PCE (15 micrograms per cubic meter ($\mu\text{g/m}^3$)) and TCE ($12.9 \mu\text{g/m}^3$) were found near the northwest corner of the complex. PCE, TCE, and low levels of other PCE breakdown products were also found in soil gas immediately east of the Vancouver School District Maintenance Building ($1.3^{\text{J}} \mu\text{g/m}^3$ PCE and $9 \mu\text{g/m}^3$ TCE) and the high school tennis courts ($0.7^{\text{J}} \mu\text{g/m}^3$ PCE and $8.5 \mu\text{g/m}^3$ TCE). (3) The maintenance building and tennis courts are located northwest and west/southwest of the high school complex, respectively. These soil gas findings suggested that an indoor air threat might exist at the high school.

March 2010 Building Survey

In preparation for upcoming indoor air testing at the high school complex, a comprehensive building survey was conducted in March 2010 to determine whether any products that might contain PCE or its breakdown products were being stored in the complex. Several thousand consumer and school products containing volatile organic compounds (VOCs) were found during the survey. However, only three products were reportedly labeled as containing chlorinated solvents. These three products were removed from the school approximately two weeks before the sampling. It is important to note, however, that some of the products stored in the school were not labeled or were unavailable for inspection (e.g., located in locked cabinets), so it is possible that other products containing chlorinated solvents may have been in the school during indoor air sampling.(1)

March and April 2010 Indoor and Outdoor Barometric Pressure Testing

To better understand whether the soil gas below the high school posed an indoor air threat, a limited barometric pressure study was undertaken inside and outside the building in March and April 2010 to determine the pressure gradient between the school and outside air. The study confirmed the Vancouver School District's report that the high school complex is generally

^a J - indicates the chemical was positively identified but is only an approximate value. J-qualified results typically occur when chemicals are detected between the laboratory method detection limit and the reporting limit.

under a positive, although small, pressure because of the operation of the heating, ventilation, and air conditioning (HVAC) system.⁽¹⁾ This means that air would be flowing from inside the building to the outside and suggests that soil gas below the building would be unlikely to enter the building. However, because the pressure gradient was very small, some obvious openings in the floor slab were found, and only a limited pressure gradient study was conducted, Ecology requested that Milton's Dry Cleaner collect and analyze sub-slab soil gas samples as well as indoor and outdoor air samples for PCE and its breakdown products.

April 18, 2010, Sub-Slab Soil Gas, Outdoor Air, and Indoor Air Testing

On April 18, 2010, samples were collected and tested for PCE and its breakdown products. Samples collected included soil gas at four sub-slab locations, indoor air from ten rooms, three outdoor air samples near the school, and two air samples collected near air intake vents on the high school rooftop. Quality assurance and quality control criteria were met and the results were considered valid as reported.⁽¹⁾

Soil Gas

Four soil gas samples were collected below the floor slab of the high school complex (Figure 2). Three samples were collected below the slab in the western half of the complex (below Rooms 268, 370, and 439). The fourth sample was collected below the slab in the northeast quadrant of the high school (below Room 506). The samples were collected for about six minutes in Summa canisters and analyzed for PCE and nine breakdown products, including TCE, using the TO-15 analytical method. The results, which are higher than those found in soil gas just north of the high school complex at 5 feet bgs in August 2008, are summarized in Table 1.^b

PCE and TCE were the predominantly detected chemicals found in soil gas below the slab. However, reporting limits for the remaining PCE breakdown products were slightly elevated for three of the four samples so it is possible that low levels of other PCE breakdown products might exist in the soil gas.

PCE levels in soil gas ranged from 4.76J to 94.5 $\mu\text{g}/\text{m}^3$; TCE levels ranged from 1.53 to 365 $\mu\text{g}/\text{m}^3$. The highest levels were found below the slab in the western portion of the complex. The highest PCE level (94.5 $\mu\text{g}/\text{m}^3$) was found in soil gas below Room 268, which is a janitor's closet located in the southwest quadrant of the building next to Room 208. Soil gas below Room 268 also contained 176 $\mu\text{g}/\text{m}^3$ TCE and is the only location where low levels of the remaining tested breakdown products were found. The highest TCE level (365.5 $\mu\text{g}/\text{m}^3$) was found in soil gas below Room 439, which is a welding shop located in the northern portion of the northwest quadrant of the high school complex. The soil gas at that location also contained 82.1 $\mu\text{g}/\text{m}^3$ PCE.⁽¹⁾

^b This is not surprising because research has shown the contaminant levels in soil gas below buildings can be an order of magnitude or more higher than levels found adjacent to buildings.

Indoor Air

Indoor air from ten rooms was also tested for PCE and its breakdown products (Figure 2). The ten rooms included: 120, 245, 370, 390, 412, 437, 509, 600, 770, and near the elevator. The indoor air samples were collected in Summa canisters for approximately 8 hours (between 7:30 a.m. and 4:30 p.m.) and analyzed for PCE and nine breakdown products, including TCE, using the TO-15 analytical method. Six of the tested rooms had no visible evidence of slab penetrations such as areas where utility pipes enter the building. Indoor air samples were collected from the breathing space height at these locations. Four of the ten tested rooms had slab penetrations. The indoor air samples at those locations were collected at floor level or two feet above the floor. Table 2 provides details about the indoor air testing locations. Table 3 summarizes the indoor air results.(1)

PCE in indoor air ranged from 0.121J to 0.274 ug/m³. The highest indoor air level of PCE (0.274 ug/m³) was found in Room 245 (Media Center). TCE in indoor air ranged from 0.0302 to 1.33 ug/m³ with the highest indoor level found in Room 370 (Ceramics). These two rooms also contained low levels of 1,1,1-trichloroethane (1,1,1-TCA) and 1,2- dichloroethane (1,2-DCA).(1)

Outdoor Air

Outdoor air was tested at four locations for approximately 8 hours using Summa canisters (Figure 2). An additional outdoor air sample was collected in the breathing space near the school, but because of problems with the canister (the regulator reportedly failed), the sample was collected for only 1.5 hours. Two outdoor air samples were collected near intake vents on the roof. One was located near an intake vent above the Cafeteria Commons (Roof 1); the other was located near an intake vent above the Auditorium (Roof 2). The third outdoor air sample was collected southeast of the school complex; the fourth was collected north of the west driveway entrance. The third and fourth samples were collected three feet above the ground surface although they were intended to be collected in the breathing space. The non-roof samples do not represent upwind conditions throughout the testing.(1) Like indoor air samples, the outdoor air samples were analyzed for PCE and nine breakdown products, including TCE, using the TO-15 analytical method.

The four outdoor air sample results are summarized in Table 4. PCE ranged from 0.0952 to 0.161 µg/m³; TCE ranged from 0.0292 to 0.0781 µg/m³. Low levels of a few other PCE breakdown products were also detected (1,1 DCE; 1,1,1 TCA; and chloroethane).

Community Health Concerns

The Vancouver School District has expressed concerns that contaminants below the school might pose an indoor air health threat and have allowed the former owners/operators of the Milton's Dry Cleaner site access to the school so that appropriate testing can be conducted.

Discussion

When a building is underlain by volatile contaminants like PCE and TCE, the building's foundation can act as a barrier to the upward migration of contaminants if it is intact. Contaminants will then tend to accumulate below the building. However, if there are cracks or other openings in the foundation, the contaminants may migrate into indoor air. This is known as vapor intrusion.

The vapor intrusion pathway is a complex exposure pathway that requires evaluating multiple lines of evidence when determining whether it is likely that the pathway is complete (i.e., people have or are likely to come in contact with site-related contaminants) and poses a possible indoor air health threat. Some of these lines of evidence include:

- Foundation characteristics (e.g., cracks, utility penetrations through the slab).
- Heating, ventilation, and air conditioning (HVAC) system operation.
- Product use (e.g., cleaning products, paints, and solvents).
- Soil gas, indoor air, and outdoor air data.

Available information about the Fort Vancouver High School indicates that the school complex is underlain by a concrete slab. The slab, however, has some visible openings (e.g., utility penetrations, exposed soil in the rally room in the gymnasium) that could allow vapors to enter indoor air. However, based on information provided by the school about the HVAC system and barometric pressure testing results obtained prior to and during the indoor and outdoor air testing, it appears that the building is generally under a low positive pressure relative to outdoor air. This suggests that, although there are some openings in the slab, soil gas contaminants, like the PCE and TCE found during the April 2010 vapor investigation, would be unlikely to enter indoor air at the school complex because of pressure differences (i.e., air would flow from high (inside) pressure to low (outside) pressure). However, it should be noted that outdoor air and sub-slab pressures can differ.⁽⁴⁾ Assuming that outdoor air and sub-slab pressures are the same, if vapors did occasionally enter the high school complex during a short temporary pressure reversal, it is likely that they would quickly mix with indoor air and be difficult to distinguish from typical urban indoor air, which can be affected by outside air as well as products used inside buildings (e.g., cleaning products, paints, solvents, and school supplies).

The presence of volatile chemicals like PCE and TCE in urban outdoor and indoor air has been well established. Therefore, it is important to consider this fact when evaluating whether the vapor intrusion pathway is a completed exposure pathway at a site. To evaluate whether solvent vapor might be entering the school complex, DOH compared indoor air contaminant levels found in the ten tested rooms to contaminant levels found in outdoor air collected near the intake vents on the roof and soil gas found below the nearest slab location (Tables 5 through 9).^c Rooms 120, 245, 370, 412, 509, and 600 contained no visible slab penetrations. Rooms 390, 437, 770, and the elevator had visible slab penetrations.

^c DOH did not use the outdoor air results collected near the west driveway and at the southeast corner of the building because they were not collected in the breathing space and it appears that the samples were not consistently located upwind.

It was found that PCE, TCE, and the levels of other breakdown products when detected below the slab were always greater than indoor air levels. This was expected. Indoor air PCE, TCE, and levels of the other breakdown products in the rooms with and without slab penetrations were greater than outdoor air levels with a few exceptions (Table 10). This was also expected because products containing or potentially containing volatile chemicals were reported in all the tested rooms except rooms 600, 770, the elevator, and cafeteria. The remaining six tested rooms contained common office/school supplies and other chemical-containing products. Some of them, like Room 370 (Ceramics) and Room 437 (Metals and Machine Shop) had containers of paints and other volatile chemicals.(1) These products can release low levels of volatile chemicals into indoor air. Furniture and carpeting located throughout the school are also sources of volatile contaminants. The amount contributed by these sources, however, cannot be quantified.

Levels of PCE, TCE, and other breakdown products found in the rooms with visible slab penetrations were not significantly different than those found in rooms without penetrations. Additionally, rooms with the highest PCE (0.274 ug/m^3 in Room 245 (Media Center)) and TCE levels (1.33 ug/m^3 in Room 370 (Ceramics)) had no visible slab penetrations. Although these two rooms are in areas where the two contaminants were elevated in soil gas, the chemicals found in indoor air may be slightly elevated because of outdoor air and products used or stored in the rooms or the school. While it is possible a small amount could be coming from below the school, it does not seem likely because rooms with slab penetrations (e.g., Room 437 with PCE in soil gas at 82.1 ug/m^3 and the highest level of TCE found in soil gas (365 ug/m^3)) contain lower concentrations of these chemicals than Rooms 245 and 370.

The above findings suggest that the vapor intrusion pathway at the high school is not likely a current completed exposure pathway and therefore, does not pose an indoor air health threat to students, faculty, and staff. This may be a result of the HVAC system operation and the slab acting as a barrier to vapor migration. Although not likely a current exposure pathway, prudent public health steps should be taken to ensure that the vapor intrusion pathway does not pose a potential health threat in the future.

Children's Health Considerations

Children can be uniquely vulnerable to the hazardous effects of environmental contaminants, like solvents, when found in indoor air. When compared to adults, pound for pound of body weight, children breathe more air. This fact leads to an increased exposure to contaminants.

Because it appears that the vapor intrusion pathway is not a current pathway of concern at the high school, DOH does not expect that children will be exposed to contaminants found in the soil gas below the school. However, steps should be taken to prevent potential future exposures.

Conclusions

1. DOH concludes that the solvent-contaminated soil gas found below the Fort Vancouver High School complex does not appear to pose a current indoor air health threat to students, teachers, or staff. There is no clear evidence that solvents found in the soil gas below the school complex are moving up through the foundation and entering indoor air.

2. DOH concludes that contaminated soil gas could pose an indoor air health threat in the future if the existing slab penetrations are not sealed, the building is not under positive pressure relative to sub-slab air pressure, or if new construction or remodeling occurs at the high school complex and steps are not taken to address the vapor intrusion pathway.

Recommendations

1. The pressure inside and below the building should be monitored at an appropriate frequency to ensure that the high school complex is consistently under positive pressure relative to sub-slab air pressure. If the pressure inside the school becomes negative relative to sub-slab air pressure, steps should be taken to return it to positive pressure.
2. Steps should be taken to seal slab penetrations in the school complex.
3. If new construction or remodeling occurs at the high school complex in the future, steps should be taken to address the vapor intrusion pathway if it continues to be a potential pathway of concern.
4. Soil gas testing below the school should continue bi-annually to ensure that solvent levels are not increasing. If the levels increase significantly, indoor air should be retested.
5. Steps should be taken to store chemical-containing products in areas of the high school complex where they will not affect indoor air quality.

Public Health Action Plan

1. Ecology is working with the former owners and operators of the Milton's Dry Cleaner site and the Vancouver School District to ensure that the health department's recommendations are followed:
 - The pressure inside and below the high school complex will be monitored at an appropriate frequency to ensure that the building consistently remains under positive pressure relative to sub-slab air pressure. If the high school complex pressure becomes negative relative to sub-slab air pressure, steps will be taken to return it to positive pressure.
 - Steps will be taken to seal slab penetrations in the high school complex.
 - If new construction or remodeling occurs at the high school complex in the future, steps will be taken to address the vapor intrusion pathway (e.g., installation of a soil vapor vacuum system) if it continues to be a potential pathway of concern.
 - Soil gas testing below the school will continue bi-annually to ensure that solvent levels are not increasing and posing a future indoor air health threat. If the levels increase significantly, indoor air will be retested.
2. DOH and Clark County Health Department are available to assist the school or school district with chemical storage practices, if needed.
3. DOH will provide copies of this health consultation report to Ecology, Clark County Health, Vancouver School District, the potentially liable parties for the Milton's Dry Cleaners' site and the public.
4. DOH will post this health consultation report on its web site to make it available to the general public.
5. DOH will review future investigation plans and reports if requested by Ecology or the Vancouver School District.

Tables

Table 1: Fort Vancouver High School – April 18, 2010, Sub-Slab Soil Gas Results ($\mu\text{g}/\text{m}^3$)

Sample Location	Location Description	Units	PCE		TCE		1,1 DCE		cis1,2 DCE		trans1,2 DCE	
Room 268	Below janitor closet	$\mu\text{g}/\text{m}^3$	94.5		176		0.968	J	1.21	J	0.686	J
Room 370	Below ceramic arts	$\mu\text{g}/\text{m}^3$	41.7		73.7		9.40	U	9.40	U	9.40	U
Room 439	Below welding shop	$\mu\text{g}/\text{m}^3$	82.1		365		7.78	U	2.06	J	7.78	U
Room 506	Below electrical	$\mu\text{g}/\text{m}^3$	4.76	J	1.53		7.74	U	7.74	U	7.74	U

Sample Location	Location Description	Units	Vinyl chloride		1,1,1 TCA		1,1 DCA		1,2 DCA		Chloroethane	
Room 268	Below janitor closet	$\mu\text{g}/\text{m}^3$	0.6760	J	4.61	J	0.782	J	0.659	J	0.644	J
Room 370	Below ceramic arts	$\mu\text{g}/\text{m}^3$	6.06	U	3.55	J	9.59	U	9.59	U	6.25	U
Room 439	Below welding shop	$\mu\text{g}/\text{m}^3$	5.02	U	9.32	J	7.95	U	7.95	U	5.18	U
Room 506	Below electrical	$\mu\text{g}/\text{m}^3$	4.99	U	10.7	U	7.90	U	7.90	U	5.15	U

$\mu\text{g}/\text{m}^3$ – microgram per cubic meter J – estimated value U – undetected at the reporting limit

PCE – tetrachloroethylene; TCE- trichloroethylene; 1,1 DCE – 1,1-Dichloroethene; cis 1,2 DCE - cis1,2-Dichloroethene; trans1,2 DCE - trans 1,2-Dichloroethene; 1,1,1 TCA - 1,1,1-Trichloroethane; 1,1 DCA – 1,1 Dichloroethane; 1,2 DCA – 1,2 Dichloroethane

Table 2: Fort Vancouver High School – April 18, 2010, Indoor Air Sampling Location Information (1)

Room Number	Description	Visible Sub-slab Penetrations	Nearest Soil Gas Location	Nearest Rooftop Air Location
<i>Rooms without Sub-slab Penetrations</i>				
120	Administrative Area	None	268, 506	Roof 1
245	Media Center	None	268	Roof 2
370	Ceramics Art Room	None	370	Roof 2
412	Computer Technology	None	370, 439	Roof 2
509	Science Building	None	506	Roof 1
600	Cafeteria Commons	None	268, 506	Roof 1
<i>Rooms with Sub-slab Penetrations</i>				
390	Band Auxiliary Room –	Yes - Utility conduit openings	370	Roof 2
437	Chemical Storage Room	Yes – fire suppression valve piping	439	Roof 2
770	Rally Room	Yes - ~ 4 ft ² area of exposed soil	506	Roof 1
Elevator	Elevator	Unknown	506	Roof 1

ft² - feet squared

Table 3: Fort Vancouver High School – April 18, 2010, Indoor Air Results

Sample Location	Location Description	Units	PCE		TCE		1,1 DCE		cis1,2 DCE		trans1,2 DCE	
Rooms without Sub-slab Penetrations												
120	Administrative Area	µg/m³	0.166	J	0.119	J	0.131	U	0.131	U	0.131	U
245	Media Center	µg/m³	0.274		0.157		0.0799	U	0.0799	U	0.0799	U
370	Ceramics Art	µg/m³	0.201	J	1.33		0.325	U	0.325	U	0.325	U
412	Computer Technology	µg/m³	0.121	J	0.0516	J	0.302	U	0.302	U	0.302	U
509	Science Building	µg/m³	0.176	J	0.0776	J	0.266	U	0.266	U	0.266	U
600	Cafeteria Commons	µg/m³	0.137		0.0302	J	0.0601	U	0.0601	U	0.0601	U
Rooms with Sub-slab Penetrations												
390	Band Auxiliary Room	µg/m³	0.233	J	0.688	U	0.269	J	0.508	U	0.508	U
437	Chemical Storage Room	µg/m³	0.145		0.128		0.0496	J	0.0657	U	0.0657	U
770	Rally Room	µg/m³	0.123	J	0.317		0.142	U	0.142	U	0.142	U
Elevator	Gymnasium	µg/m³	0.143		0.0787	J	0.0625	U	0.0625	U	0.0625	U

µg/m³ – microgram per cubic meter J – estimated value U – undetected at the reporting limit

PCE – tetrachloroethylene; TCE- trichloroethylene; 1,1 DCE – 1,1-Dichloroethene; cis 1,2 DCE - cis1,2-Dichloroethene; trans1,2 DCE - trans 1,2-Dichloroethene

Table 3 (continued): Fort Vancouver High School – April 18, 2010, Indoor Air Results

Sample Location	Location Description	Units	Vinyl chloride		1,1,1 TCA		1,1 DCA		1,2 DCA		Chloroethane	
Rooms without Sub-slab Penetrations												
120	Administrative Area	μg/m ³	0.0842	U	0.0710	J	0.133	U	0.0786	J	0.0553	J
245	Media Center	μg/m ³	0.0515	U	0.0638	J	0.0815	U	0.0811	J	0.0531	U
370	Ceramics Art Room	μg/m ³	0.209	U	0.184	J	0.331	U	0.0865	J	0.216	U
412	Computer Technology	μg/m ³	0.195	U	0.0949	J	0.309	U	0.0910	J	0.201	U
509	Science Building	μg/m ³	0.172	U	0.0860	J	0.272	U	0.0906	J	0.177	U
600	Cafeteria Commons	μg/m ³	0.0387	U	0.0527	J	0.0613	U	0.0807		0.0553	
Rooms with Sub-slab Penetrations												
390	Band Auxiliary Room	μg/m ³	0.328	U	0.159	J	0.519	U	0.519	U	0.338	U
437	Chemical Storage Room	μg/m ³	0.0424	U	0.644		0.0671	U	0.0762		0.0413	J
770	Rally Room	μg/m ³	0.0918	U	0.0677	J	0.145	U	0.0782	J	0.0948	U
Elevator	Gymnasium	μg/m ³	0.0403	U	0.0660	J	0.0638	U	0.0778		0.0620	

$\mu\text{g}/\text{m}^3$ – microgram per cubic meter J – estimated value U – undetected at the reporting limit
1,1,1 TCA - 1,1,1-Trichloroethane; 1,1 DCA – 1,1 Dichloroethane; 1,2 DCA – 1,2 Dichloroethane

Table 4: Fort Vancouver High School – April 18, 2010, Outdoor Air Results

Sample Location	Location Description	Units	PCE		TCE		1,1 DCE		cis1,2 DCE		trans1,2 DCE	
Near the School												
Air 1	10 feet from SE building corner	µg/m³	0.0952	J	0.0368	J	0.0154	J	0.0605	U	0.0605	U
Air 3	Entrance Stapleton Road	µg/m³	0.161		0.0298	J	0.0208	J	0.0657	U	0.0657	U
Rooftop												
Roof 1	Above Room 600 - Cafeteria	µg/m³	0.099	J	0.0781	J	0.0661	U	0.0661	U	0.0661	U
Roof 2	Above Room 300 - Auditorium	µg/m³	0.0959	J	0.0292	J	0.0641	U	0.0641	U	0.0641	U

Sample Location	Location Description	Units	Vinyl chloride	1,1,1 TCA	1,1 DCA	1,2 DCA	Chloroethane					
Near the School												
Air 1	10 feet from SE building corner	µg/m³	0.0390	U	0.0418	J	0.0618	U	0.0811		0.0314	J
Air 3	Entrance Stapleton Road	µg/m³	0.0424	U	0.0955		0.0671	U	0.0696		0.0438	U
Rooftop												
Roof 1	Above Room 600 - Cafeteria	µg/m³	0.0426	U	0.0544	J	0.0675	U	0.0766		0.0277	J
Roof 2	Above Room 300 - Auditorium	µg/m³	0.0413	U	0.0544	J	0.0655	U	0.0762		0.0427	U

SE - southeast

µg/m³ – microgram per cubic meter J – estimated value U – undetected at the reporting limit PCE – tetrachloroethylene; TCE- trichloroethylene; 1,1 DCE – 1,1-Dichloroethene; cis 1,2 DCE - cis1,2-Dichloroethene; trans1,2 DCE - trans 1,2-Dichloroethene; 1,1,1 TCA - 1,1,1-Trichloroethane; 1,1 DCA – 1,1 Dichloroethane; 1,2 DCA – 1,2 Dichloroethane

Table 5: Fort Vancouver High School – Indoor Air, Soil Gas, and Outdoor Air Comparisons – Rooms 120 and 245 (no slab penetrations)

Sample Location	Location Description	Units	PCE		TCE		1,1 DCE		cis1,2 DCE		trans1,2 DCE	
Room 120 - Administration												
Indoor Air		µg/m³	0.166	J	0.119	J	0.131	U	0.131	U	0.131	U
Sub-slab	Below Room 268	µg/m³	94.5		176		0.968	J	1.21	J	0.686	J
Sub-slab	Below Room 506	µg/m³	4.76	J	1.53		7.74	U	7.74	U	7.74	U
Roof 1	Above Room 600 - Cafeteria	µg/m³	0.099	J	0.0781	J	0.0661	U	0.0661	U	0.0661	U
Room 245 - Media Center												
Indoor Air		µg/m³	0.274		0.157		0.0799	U	0.0799	U	0.0799	U
Sub-slab	Below Room 268	µg/m³	94.5		176		0.968	J	1.21	J	0.686	J
Roof 2	Above Room 300 - Auditorium	µg/m³	0.0959	J	0.0292	J	0.0641	U	0.0641	U	0.0641	U

Sample Location	Location Description	Units	Vinyl chloride		1,1,1 TCA		1,1 DCA		1,2 DCA		Chloroethane	
Room 120 - Administration												
Indoor Air		µg/m³	0.0842	U	0.0710	J	0.133	U	0.0786	J	0.0553	J
Sub-slab	Below Room 268	µg/m³	0.6760	J	4.61	J	0.782	J	0.659	J	0.644	J
Sub-slab	Below Room 506	µg/m³	4.99	U	10.7	U	7.90	U	7.90	U	5.15	U
Roof 1	Above Room 600 - Cafeteria	µg/m³	0.0426	U	0.0544	J	0.0675	U	0.0766		0.0277	J
Room 245- Media Center												
Indoor Air		µg/m³	0.0515	U	0.0638	J	0.0815	U	0.0811	J	0.0531	U
Sub-slab	Below Room 268	µg/m³	0.6760	J	4.61	J	0.782	J	0.659	J	0.644	J
Roof 2	Above Room 300 - Auditorium	µg/m³	0.0413	U	0.0544	J	0.0655	U	0.0762		0.0427	U

µg/m³ – microgram per cubic meter J – estimated value U – undetected at the reporting limit PCE – tetrachloroethylene; TCE- trichloroethylene; 1,1 DCE – 1,1-Dichloroethene; cis 1,2 DCE - cis1,2-Dichloroethene; trans1,2 DCE - trans 1,2-Dichloroethene; 1,1,1 TCA - 1,1,1-Trichloroethane; 1,1 DCA – 1,1 Dichloroethane; 1,2 DCA – 1,2 Dichloroethane

Table 6: Fort Vancouver High School – Indoor Air, Soil Gas, and Outdoor Air Comparisons – Rooms 370 and 412 (no slab penetrations)

Sample Location	Location Description	Units	PCE		TCE		1,1 DCE		cis1,2 DCE		trans1,2 DCE	
Room 370 – Ceramics Art Room												
Indoor Air		µg/m³	0.201	J	1.33		0.325	U	0.325	U	0.325	U
Sub-slab	Below Room 370	µg/m³	41.7		73.7		9.40	U	9.40	U	9.40	U
Roof 2	Above Room 300 - Auditorium	µg/m³	0.0959	J	0.0292	J	0.0641	U	0.0641	U	0.0641	U
Room 412 – Computer Technology												
Indoor Air		µg/m³	0.121	J	0.0516	J	0.302	U	0.302	U	0.302	U
Sub-slab	Below Room 370	µg/m³	41.7		73.7		9.40	U	9.40	U	9.40	U
Sub-slab	Below Room 439	µg/m³	82.1		365		7.78	U	2.06	J	7.78	U
Roof 2	Above Room 300 - Auditorium	µg/m³	0.0959	J	0.0292	J	0.0641	U	0.0641	U	0.0641	U

Sample Location	Location Description	Units	Vinyl chloride		1,1,1 TCA		1,1 DCA		1,2 DCA		Chloroethane	
Room 370 – Ceramics Art Room												
Indoor Air		µg/m³	0.209	U	0.184	J	0.331	U	0.0865	J	0.216	U
Sub-slab	Below Room 370	µg/m³	6.06	U	3.55	J	9.59	U	9.59	U	6.25	U
Roof 2	Above Room 300 - Auditorium	µg/m³	0.0413	U	0.0544	J	0.0655	U	0.0762		0.0427	U
Room 412 – Computer Technology												
Indoor Air		µg/m³	0.195	U	0.0949	J	0.309	U	0.0910	J	0.201	U
Sub-slab	Below Room 370	µg/m³	6.06	U	3.55	J	9.59	U	9.59	U	6.25	U
Sub-slab	Below Room 439	µg/m³	5.02	U	9.32	J	7.95	U	7.95	U	5.18	U
Roof 2	Above Room 300 - Auditorium	µg/m³	0.0413	U	0.0544	J	0.0655	U	0.0762		0.0427	U

µg/m³ – microgram per cubic meter J – estimated value U – undetected at the reporting limit PCE – tetrachloroethylene; TCE- trichloroethylene; 1,1 DCE – 1,1-Dichloroethene; cis 1,2 DCE - cis1,2-Dichloroethene; trans1,2 DCE - trans 1,2-Dichloroethene; 1,1,1 TCA - 1,1,1-Trichloroethane; 1,1 DCA – 1,1 Dichloroethane; 1,2 DCA – 1,2 Dichloroethane

Table 7: Fort Vancouver High School – Indoor Air, Soil Gas, and Outdoor Air Comparisons – Rooms 509 and 600 (no slab penetrations)

Sample Location	Location Description	Units	PCE		TCE		1,1 DCE		cis1,2 DCE		trans1,2 DCE	
Room 509 – Science Building												
Indoor Air		µg/m ³	0.176	J	0.0776	J	0.266	U	0.266	U	0.266	U
Sub-slab	Below Room 506	µg/m ³	4.76	J	1.53		7.74	U	7.74	U	7.74	U
Roof 1	Above Room 600 - Cafeteria	µg/m ³	0.099	J	0.0781	J	0.0661	U	0.0661	U	0.0661	U
Room 600 – Cafeteria Commons												
Indoor Air		µg/m ³	0.137		0.0302	J	0.0601	U	0.0601	U	0.0601	U
Sub-slab	Below Room 268	µg/m ³	94.5		176		0.968	J	1.21	J	0.686	J
Sub-slab	Below Room 506	µg/m ³	4.76	J	1.53		7.74	U	7.74	U	7.74	U
Roof 1	Above Room 600 - Cafeteria	µg/m ³	0.099	J	0.0781	J	0.0661	U	0.0661	U	0.0661	U

Sample Location	Location Description	Units	Vinyl chloride		1,1,1 TCA		1,1 DCA		1,2 DCA		Chloroethane	
Room 509 – Science Building												
Indoor Air		µg/m ³	0.172	U	0.0860	J	0.272	U	0.0906	J	0.177	U
Sub-slab	Below Room 506	µg/m ³	4.99	U	10.7	U	7.90	U	7.90	U	5.15	U
Roof 1	Above Room 600 - Cafeteria	µg/m ³	0.0426	U	0.0544	J	0.0675	U	0.0766		0.0277	J
Room 600 – Cafeteria Commons												
Indoor Air		µg/m ³	0.0387	U	0.0527	J	0.0613	U	0.0807		0.0553	
Sub-slab	Below Room 268	µg/m ³	0.6760	J	4.61	J	0.782	J	0.659	J	0.644	J
Sub-slab	Below Room 506	µg/m ³	4.99	U	10.7	U	7.90	U	7.90	U	5.15	U
Roof 1	Above Room 600 - Cafeteria	µg/m ³	0.0426	U	0.0544	J	0.0675	U	0.0766		0.0277	J

µg/m³ – microgram per cubic meter J – estimated value U – undetected at the reporting limit PCE – tetrachloroethylene; TCE- trichloroethylene; 1,1 DCE – 1,1-Dichloroethene; cis 1,2 DCE - cis1,2-Dichloroethene; trans1,2 DCE - trans 1,2-Dichloroethene; 1,1,1 TCA - 1,1,1-Trichloroethane; 1,1 DCA – 1,1 Dichloroethane; 1,2 DCA – 1,2 Dichloroethane

Table 8: Fort Vancouver High School – Indoor Air, Soil Gas, and Outdoor Air Comparisons – Rooms 390 and 437 (slab penetrations)

Sample Location	Location Description	Units	PCE		TCE		1,1 DCE		cis1,2 DCE		trans1,2 DCE	
Room 390 - Auxiliary Room near Band/Chorus Area												
Indoor Air		µg/m³	0.233	J	0.688	U	0.269	J	0.508	U	0.508	U
Sub-slab	Below Room 370	µg/m³	41.7		73.7		9.40	U	9.40	U	9.40	U
Roof 2	Above Room 300 - Auditorium	µg/m³	0.0959	J	0.0292	J	0.0641	U	0.0641	U	0.0641	U
Room 437 - Chemical Storage Room												
Indoor Air		µg/m³	0.145		0.128		0.0496	J	0.0657	U	0.0657	U
Sub-slab	Below Room 439	µg/m³	82.1		365		7.78	U	2.06	J	7.78	U
Roof 2	Above Room 300 - Auditorium	µg/m³	0.0959	J	0.0292	J	0.0641	U	0.0641	U	0.0641	U

Sample Location	Location Description	Units	Vinyl chloride		1,1,1 TCA		1,1 DCA		1,2 DCA		Chloroethane	
Room 390 - Auxiliary Room near Band/Chorus Area												
Indoor Air		µg/m ³	0.328	U	0.159	J	0.519	U	0.519	U	0.338	U
Sub-slab	Below Room 370	µg/m ³	6.06	U	3.55	J	9.59	U	9.59	U	6.25	U
Roof 2	Above Room 300 - Auditorium	µg/m ³	0.0413	U	0.0544	J	0.0655	U	0.0762		0.0427	U
Room 437 - Chemical Storage Room												
Indoor Air		µg/m ³	0.0424	U	0.644		0.0671	U	0.0762		0.0413	J
Sub-slab	Below Room 439	µg/m ³	5.02	U	9.32	J	7.95	U	7.95	U	5.18	U
Roof 2	Above Room 300 - Auditorium	µg/m ³	0.0413	U	0.0544	J	0.0655	U	0.0762		0.0427	U

µg/m³ – microgram per cubic meter J – estimated value U – undetected at the reporting limit PCE – tetrachloroethylene; TCE- trichloroethylene; 1,1 DCE – 1,1-Dichloroethene; cis 1,2 DCE - cis1,2-Dichloroethene; trans1,2 DCE - trans 1,2-Dichloroethene; 1,1,1 TCA - 1,1,1-Trichloroethane; 1,1 DCA – 1,1 Dichloroethane; 1,2 DCA – 1,2 Dichloroethane

Table 9: Fort Vancouver High School – Indoor Air, Soil Gas, and Outdoor Air Comparisons – Room 770 and Elevator (slab penetrations)

Sample Location	Location Description	Units	PCE		TCE		1,1 DCE		cis1,2 DCE		trans1,2 DCE	
Room 770 – Rally Room												
Indoor Air		µg/m³	0.123	J	0.317		0.142	U	0.142	U	0.142	U
Sub-slab	Below Room 506	µg/m³	4.76	J	1.53		7.74	U	7.74	U	7.74	U
Roof 1	Above Room 600 - Cafeteria	µg/m³	0.099	J	0.0781	J	0.0661	U	0.0661	U	0.0661	U
Elevator – Near Gymnasium												
Indoor Air		µg/m³	0.143		0.0787	J	0.0625	U	0.0625	U	0.0625	U
Sub-slab	Below Room 506	µg/m³	4.76	J	1.53		7.74	U	7.74	U	7.74	U
Roof 1	Above Room 600 - Cafeteria	µg/m³	0.099	J	0.0781	J	0.0661	U	0.0661	U	0.0661	U

Sample Location	Location Description	Units	Vinyl chloride		1,1,1 TCA		1,1 DCA		1,2 DCA		Chloroethane	
Room 770 – Rally Room												
Indoor Air		µg/m³	0.0918	U	0.0677	J	0.145	U	0.0782	J	0.0948	U
Sub-slab	Below Room 506	µg/m³	4.99	U	10.7	U	7.90	U	7.90	U	5.15	U
Roof 1	Above Room 600 - Cafeteria	µg/m³	0.0426	U	0.0544	J	0.0675	U	0.0766		0.0277	J
Elevator – Near Gymnasium												
Indoor Air		µg/m³	0.0403	U	0.0660	J	0.0638	U	0.0778		0.0620	
Sub-slab	Below Room 506	µg/m³	4.99	U	10.7	U	7.90	U	7.90	U	5.15	U
Roof 1	Above Room 600 - Cafeteria	µg/m³	0.0426	U	0.0544	J	0.0675	U	0.0766		0.0277	J

µg/m³ – microgram per cubic meter J – estimated value U – undetected at the reporting limit PCE – tetrachloroethylene; TCE- trichloroethylene; 1,1 DCE – 1,1-Dichloroethene; cis 1,2 DCE - cis1,2-Dichloroethene; trans1,2 DCE - trans 1,2-Dichloroethene; 1,1,1 TCA - 1,1,1-Trichloroethane; 1,1 DCA – 1,1 Dichloroethane; 1,2 DCA – 1,2 Dichloroethane

Table 10: Fort Vancouver High School – Indoor and Outdoor Sources

Room Number	Description	Indoor Levels > Outdoor Levels?	Indoor Sources of Solvents Found in Rooms?
<i>Rooms without Sub-slab Penetrations</i>			
120	Administrative Area	Yes	Yes
245	Media Center	Yes	Yes
370	Ceramics Art Room	Yes	Yes
412	Computer Technology	Yes (except TCE)	No
509	Science Building	Yes (except TCE)	Yes
600	Cafeteria Commons	Yes (except TCE; 1,1,1-TCA; 1,1-DCA)	No
<i>Rooms with Sub-slab Penetrations</i>			
390	Auxiliary room – band/chorus area	Yes	No
437	Chemical storage– metals/machine shop	Yes	Yes
770	Rally room in the gymnasium	Yes	No
Elevator	Elevator – in gymnasium area	Yes (except 1,2-DCA)	No

TCE- trichloroethylene; 1,1,1 TCA - 1,1,1-Trichloroethane; 1,1 DCA – 1,1 Dichloroethane; 1,2 DCA – 1,2 Dichloroethane

Figures

Figure 1: Vicinity Map – Milton's Dry Cleaners (5)

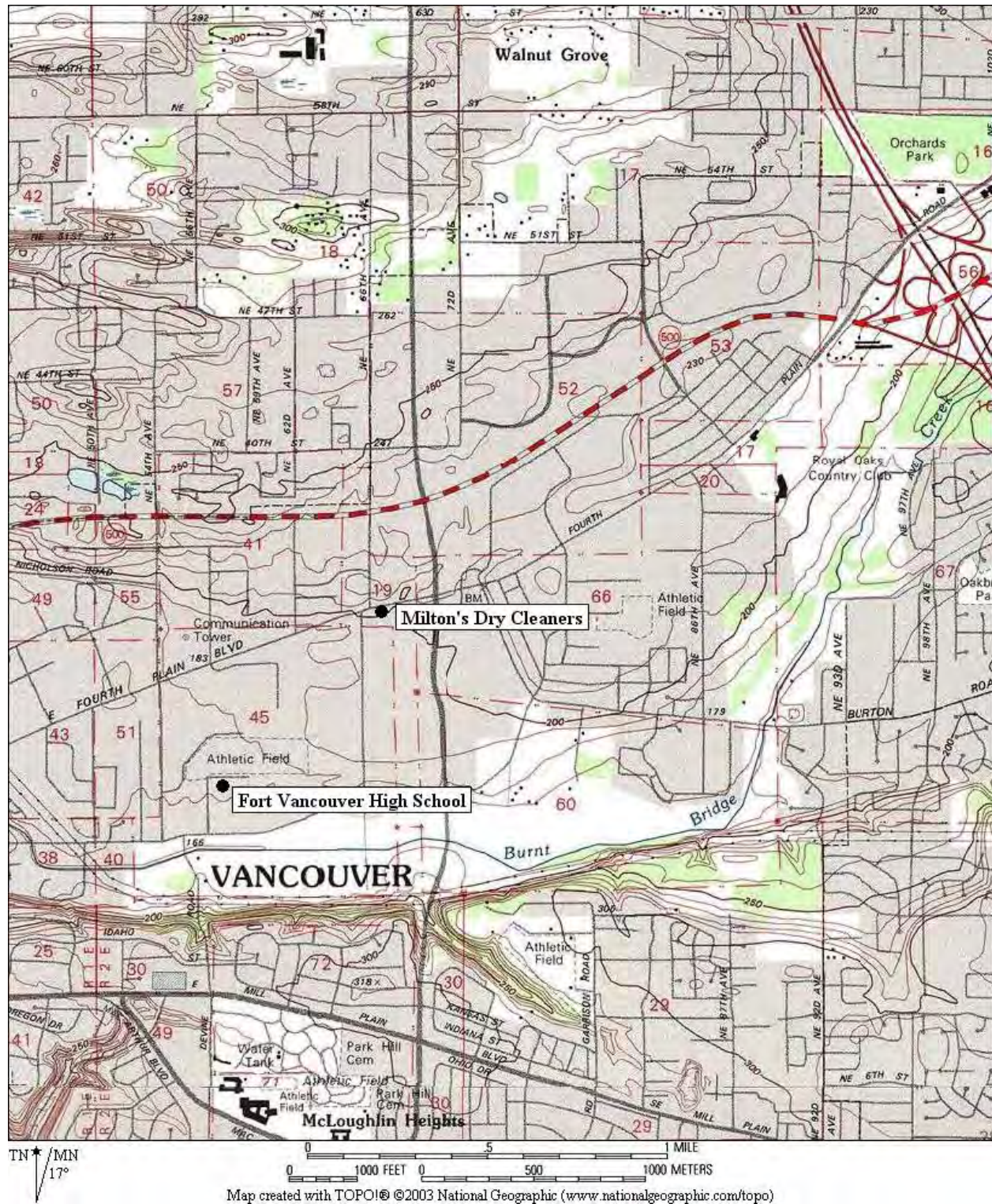
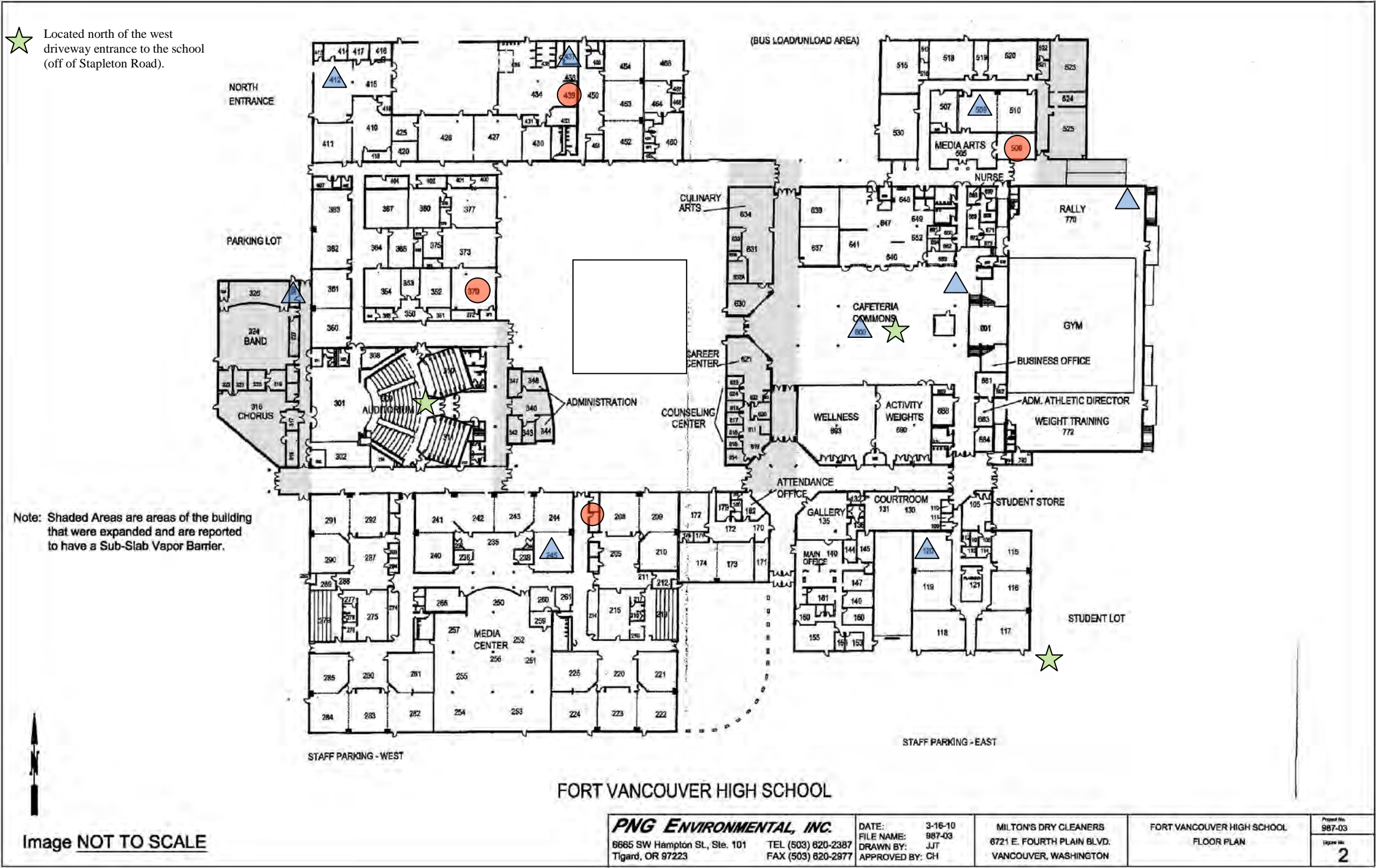


Figure 2: Fort Vancouver High School – April 18, 2010 Soil Gas, Indoor Air and Outdoor Air Testing Locations



○ Soil Gas Sample ▲ Indoor Air Sample ★ Outdoor, including Rooftop, Air Samples

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