Alaska DEC Division of Spill Prevention and Response

Contaminated Sites Program

Vapor Intrusion Assessment
Gaffney Road Area
Fairbanks, Alaska

Final Report

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Acronyms and Abbreviations

BTEX	benzene, toluene, ethylbenzene, xylenes
DCE	dichloroethene
DEC	Alaska Department of Environmental Conservation
EPA	Environmental Protection Agency
IDW	Investigation-derived waste
µg/m^3	micrograms per cubic meter
NHDES	New Hampshire Department of Environmental Services
NJDEP	New Jersey Department of Environmental Protection
NTP	Notice-to-proceed
NYDOH	New York Department of Health
OASIS	OASIS Environmental, Inc.
PCE	tetrachloroethene
PID	photo-ionization detector
RME	reasonable maximum exposure
SSD	sub-slab depressurization
TCE	trichloroethene

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1.0 INTRODUCTION

Under Notice-to-Proceed (NTP) 18-9028-13-17B, Alaska Department of Environmental Conservation (DEC) tasked OASIS Environmental, Inc. (OASIS) to conduct a vapor intrusion assessment of the West PCE Plume at the Gaffney Road area (hereafter "the site") located in Fairbanks, Alaska (see Figure 1). This report summarizes the results of two sampling events: October 2006 and February 2007.

1.1 Scope of Work

Based on Alaska DEC's request for proposal, the following objectives were developed for the project:

1) Establish current groundwater conditions related to previously documented contamination from chlorinated solvents;
2) Analyze the current state of natural attenuation based on observed geochemical parameters;
3) Determine the trend of cumulative concentration data for chlorinated solvents; and
4) Evaluate risk to human health from the vapor intrusion pathway.

The first three objectives relate to the groundwater assessment, which is covered under a separate report entitled *Groundwater Assessment, Gaffney Road Area*. This report addresses the fourth objective.

The October 2006 sampling event included a vapor intrusion assessment at Good News Bible and Book Store only. Based on the analytical results of this assessment, the NTP was modified so that the February 2007 vapor intrusion sampling included Meyeres Real Estate and Magoffin Law Firm in addition to Good News Bible and Book Store.

1.2 Project Organization

Several entities were involved in the execution of this project. OASIS was contracted by Alaska DEC. All other companies providing project support were subcontracted to OASIS.

- Owner – No involved responsible parties; Alaska DEC is funding the project.
- Third-Party Environmental Assessor – OASIS, 825 W 8th Ave, Suite 200, Anchorage, Alaska, 99501.
- Laboratory – Air Toxics Ltd, 180 Blue Ravine Road, Suite B, Folsom, California, 95630.

1.3 Vapor Intrusion Pathway

The following paragraphs are taken from Alaska DEC's *Evaluation of Vapor Intrusion Pathway at Contaminated Sites*, June 2004:

> Vapor intrusion is the migration of volatile chemicals from the subsurface into overlying buildings. Volatile chemicals in buried wastes and/or contaminated groundwater can emit vapors that may migrate through subsurface soils and into indoor air spaces of overlying buildings in ways similar to that of radon gas seeping into homes. This pathway may be important for buildings both with and without a basement.
>
> In extreme cases, vapors may accumulate in dwellings or occupied buildings to levels that pose near-term safety hazards (e.g., explosion), acute health effects, or aesthetic problems (e.g., odors). In these cases, it is relatively easy to

determine the pathway is complete and that remediation is necessary. Typically however, the chemical concentrations are low. In structures with low concentrations, the main concern is whether the chemicals may pose an unacceptable risk of chronic health effects due to long-term exposure. At these sites, determining whether the pathway is complete or not can be extremely complicated. The potential presence of background contaminants in households or commercial buildings (from the ambient air and/or emission sources in the building such as household solvents, gasoline, and cleaners) can make it difficult to interpret direct measurements. In addition, many soil and building characteristics can have a dramatic impact on the fate and transport of vapor migration.

1.4 Regulatory Framework

A regulatory framework for this project has been developed using the following regulations and guidance documents:

- Alaska DEC, *Evaluation of Vapor Intrusion Pathway at Contaminated Sites*, June 28, 2004,
- Alaska DEC, *Cumulative Risk Guidance*, November 7, 2002,
- Environmental Protection Agency (EPA), November 2002, *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*,
- New Hampshire Department of Environmental Services (NHDES), July 2006, Vapor Intrusion Guidance,
- New Jersey Department of Environmental Protection (NJDEP), October 2005, *Vapor Intrusion Guidance*,
- New York State Department of Health (NYDOH), October 2006, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York, Final*.

The contaminants of concern associated with this project are benzene and the following chlorinated alkenes: tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (DCE), trans-1,2-DCE, and vinyl chloride. The chlorinated alkenes historically have been detected in samples from the West PCE Plume at the Gaffney Road Area site, except for vinyl chloride which is a degradation compound of PCE, TCE, and DCE and an important compound for assessing potential degradation of the contaminant plumes.

Alaska DEC has not promulgated any regulatory benchmarks for the analysis of the vapor intrusion pathway. For this project, OASIS has included reasonable maximum exposures (RMEs) that were calculated for contaminants of concern using Alaska DEC's *Cumulative Risk Guidance* (2002). RMEs are long-term average concentrations for contaminants of concern that represent a risk level of 1 in 100,000. They have been calculated assuming a commercial setting (8 hours per day, 250 days per year, for 25 years).

In addition, EPA and some states have developed screening criteria for assessing site-specific concentrations. OASIS has included in this report EPA (2002) Target Indoor Air Concentrations at the 10^{-5} risk level; New York (NYDOH 2006) Air Guideline Values; New Jersey (NJDEP 2005) Rapid Action Levels; and New Hampshire (NHDES 2006) Commercial Indoor Air Screening Levels. The screening values generally combine documented groundwater, soil vapor, and indoor air concentrations to determine risk to human health. Variation between states and agencies occurs because of different risk factors, toxicities, and exposure assumptions used by

the states and agencies. The table below summarizes screening levels used in this report to assess site-specific data for the vapor intrusion pathway at the Gaffney Road Area site.

Analyte	Alaska DEC Reasonable Maximum Exposures (µg/m^3)	EPA Target Indoor Air Concentrations (µg/m^3)	New York Air Guideline Values (µg/m^3)	New Jersey Rapid Action Levels (µg/m^3)	New Hampshire Commercial Indoor Air Screening Levels (µg/m^3)
PCE	11.0	8.1	100	30	2.1
TCE	20.8	0.22	5	20	1.1
cis-1,2-DCE	---	88	---	66	---
trans-1,2-DCE	---	700	---	66	---
Vinyl chloride	---	2.8	---	7	2.8

In addition, the state of New York has developed decision matrices for additional actions based on the ratio between sub-slab soil vapor concentrations and indoor air concentrations of PCE and TCE. These matrices are found in Section 3.4.2 of NYDOH's (2006) *Guidance for Evaluating Soil Vapor Intrusion in the State of New York* and take into account both toxicity of compounds and general partitioning effects as soil vapor moves from the ground to indoor air. These decision matrices have been used in this assessment to assist in interpretation of analytical results for the vapor intrusion pathway.

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2.0 BACKGROUND

This section summarizes the environmental setting and previous investigations that have been performed at the Gaffney Road area site. The environmental setting is based on site-specific information from various regional reports by the United States Geological Survey (Glass, Lilly, and Meyer 1996), Ecology and Environment, Inc (E & E 1992, 1998, 1999a, 1999b, 2000a, 2000b, 2001, 2002a, 2002b, 2003, 2004, and 2005), and Dames and Moore (1993). Section 7 lists all referenced materials.

2.1 Environmental Setting

The site is situated on the collective floodplain of the Tanana and Chena Rivers. The surficial geology consists of unconsolidated silt, sand, and gravel of the Chena Alluvium of the Pleistocene and Holocene age. The Chena Alluvium is characterized by well-stratified layers of unconsolidated coarse sand and gravel interbedded with poorly stratified layers and lenses of unconsolidated silt and sandy silt. The poorly stratified sediments are present in sinuous swale and slough deposits, while the unconsolidated coarse sand and gravel are ubiquitous within the Tanana-Chena floodplain. Collectively, these unconsolidated deposits are more than 300 feet thick in the Tanana River and Chena River valleys (Péwé et al. 1976).

Discontinuous permafrost of generally low ice content is characteristic of Chena Alluvium sediments. However, swale and slough deposits commonly have moderate to high ice (permafrost) content as seams and lenses. The low ice content of the coarse sand and gravel deposits is present in pore spaces and/or very thin seams. Typically, the depth to permafrost is less in the finer-grained sediments of the swale and slough deposits, and the ice content is greater in the older swale and slough deposits than in the younger swale and slough deposits. Locally, both deposits are perennially frozen and, where present, permafrost ranges in depth from 2 feet to 40 feet below ground surface (bgs; Péwé et al. 1976).

The unconfined alluvial-plain Chena Alluvium aquifer is capable of yielding significant quantities of water in wells. The aquifer may exhibit seasonal confined conditions over localized areas from seasonal frosts. Also, where discontinuous permafrost is present, confined conditions may exist in subpermafrost groundwater within the alluvial plain aquifer (Péwé et al. 1976).

Recharge to the alluvial plain aquifer occurs from the Tanana and Chena rivers, with a relatively small amount resulting from infiltration of precipitation. Groundwater levels in the alluvial-plain aquifer respond relatively quickly to increases in the stages of the Tanana and Chena rivers. Wells completed in the alluvial-plain aquifer within 0.5 mile of either river show the greatest elevation increases because of increased river flow (Glass, Lilly, and Meyer 1996).

Data gathered during previous groundwater assessments at the site indicate that groundwater flow in the unconfined alluvial-plain aquifer is northwest with localized variations shifting the flow north or west. In general, the elevation of the water table in the alluvial-plain aquifer varies from 420 feet to 427 feet above mean sea level with an average horizontal gradient of 0.0008 feet per foot (E & E 1998, 1999a, 1999b, 2000a, 2000b, 2001, 2002a, 2002b, 2003, 2004, and 2005). These elevation data are consistent with those presented by the USGS for the regional aquifer (Glass, Lilly, and Meyer 1996).

2.2 Previous Investigations

Two previous sampling events at the Gaffney Road Area site included partial assessment of the vapor intrusion pathway. In February 2002, E&E (2002) collected indoor air samples from the Meyeres Real Estate building, located at the southwest corner of the intersection of Gaffney Road and Stacia Street, and from the Magoffin Law Firm building, located at the southeast corner of the intersection of Gaffney Road and Turner Street. Samples were set on the first and second floors at Meyeres Real Estate, and the basement and ground floor at Magoffin Law Firm. At each sample location, two 24-hour air samples were collected in summa canisters. One canister was analyzed for volatile organic compounds VOCs by EPA Method TO-14A, and the other canister was analyzed for chlorinated alkenes and benzene by EPA Method TO-15 SIM.

Table 1 includes the analytical results of the indoor air results from the February 2002 assessment. Analytical results showed that detectable concentrations of chlorinated alkenes were greater at Magoffin Law Firm than Meyeres Real Estate, while benzene concentrations were mostly equal for all sample locations.

The sample results from Magoffin Law Firm had significantly greater concentrations of PCE than samples from Meyeres Real Estate, which was interesting given that Meyeres Real Estate is closer to the documented source area near monitoring well MW-9. Benzene concentrations at all sample locations likely were a result of other indoor and outdoor air contaminants because benzene had not previously been detected in the West PCE Plume.

As a follow-up to the February 2002 air sampling, E&E (2003) performed a combined soil gas/indoor air assessment in October 2003 at both Meyeres Real Estate and Magoffin Law Firm. A soil gas probe was deployed at each corner of the two buildings, and two indoor air samples were collected from each building. At the Meyeres Real Estate building, one indoor air sample was deployed on the first floor and one was deployed on the second floor. At the Magoffin Law Firm, one indoor air sample was deployed in the basement and one was deployed on the first floor. The samples again were regulated to collect ambient air for 24 hours into evacuated summa canisters for the analysis of chlorinated alkenes and benzene by EPA method TO-15 SIM; however, because of laboratory error, only the samples from Meyeres Real Estate were analyzed by TO-15 SIM. The air samples from Magoffin Law Firm were analyzed by standard method EPA TO-15, which resulted in significantly greater reporting limits.

Table 2 includes the soil gas analytical results, and Table 3 includes the indoor air analytical results from the October 2003 assessment. Analytical results for the soil gas survey showed significantly higher concentrations of PCE around Magoffin Law Firm than Meyeres Real Estate. This finding supports concurrently collected indoor air samples, which had higher PCE concentrations for samples from Magoffin Law Firm than Meyeres Real Estate, and is similar to the February 2002 indoor air sampling results discussed above.

3.0 SAMPLING ACTIVITIES

This section presents a summary of field activities associated with the vapor intrusion assessment. A suite of three sub-slab air samples, one indoor air sample, and one outdoor air sample was collected at each sample location. For the October 2006 sample event, a suite of samples was collected at Good News Bible and Book Store only. Based on the analytical results of these samples from October 2006, Alaska DEC expanded the vapor intrusion assessment to include Meyeres Real Estate and Magoffin Law Firm. Figure 2 shows the locations of all three buildings included in the vapor intrusion assessment. Appendix 1 contains a copy of field notes, and Appendix 2 presents photographs depicting field activities.

3.1 Building Surveys

For both the October 2006 and February 2007 vapor intrusion assessments, OASIS performed a building survey with the owner of each building prior to conducting air sampling activities. The survey included a five-page questionnaire taken from *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance) (EPA 2002).* Appendix 3 contains a copy of the completed questionnaires. The results of the questionnaires indicate some potential for impact to indoor air from building activities. All three questionnaires document infrequent to regular use of aerosol deodorizers, infrequent use of insecticides, and infrequent to occasional use of disinfectants. These results may slightly under-represent reality as cleaners, disinfectants, and polishers likely are used on a weekly basis in all three businesses for regular housekeeping. In addition, the basement of Magoffin Law Firm contained a corner full of paints, adhesives, and solvents that are likely to have some impact on indoor air quality.

3.2 Air Sampling

For each building, OASIS deployed three sub-slab air samples, one indoor air sample, and one outdoor air sample. The three sample types together comprise an analytical strategy for defining the vapor intrusion pathway. Sub-slab samples indicate what soil vapors are present that may enter buildings and impact air quality. Indoor air samples show what vapors are present indoors either from subsurface sources, other indoor sources, or other background sources. Outdoor air samples show what background vapors are present in the area that may affect indoor air quality. The following subsections detail the procedures for sampling.

3.2.1 Sub-Slab Air Samples

Sub-slab air samples were located on the bottom floor of each building. For both Good News Bible and Book Store and Meyeres Real Estate, the bottom floor is the ground floor, while for Magoffin Law Firm, the bottom floor is the basement. OASIS selected three locations within each building to deploy sub-slab air samples. Figure 2 depicts the following locations:

- Good News Bible and Book Store – southwest corner of building, southeast corner of shop, and in the break room on the western side of the building.
- Meyeres Real Estate – southwest corner of building, southeast corner of building, and in the copy room on the western side of the building.
- Magoffin Law Firm – southwest corner of basement, northwest corner of basement, and northeast corner of basement.

The following process was used to prepare and collect samples at each location:

- If necessary, cut a 2-inch square on three sides of the carpet surface with a utility knife;

- Drill a hole into the concrete foundation using an electric hammer drill with a 1-inch drill bit to a depth of approximately 3 inches;
- Drill another hole inside the 3-inch hole using the hammer drill with a 3/8-inch drill bit until the concrete foundation was penetrated;
- Clean the hole with a damp paper towel to remove excess dust;
- Insert a stainless steel 7/8-inch washer into the hole so that the washer sits at the base of the hole created by the 1-inch drill bit;

- Insert the laboratory-provided stainless steel sample port attached to a stainless steel coupling so that the bottom of the coupling rests on the washer and the sample port extends through the washer into the subsurface;

- Use a concrete patch mix to seal the annular space between the outer wall of the 1-inch hole and the coupling;
- Allow the concrete patch to cure for 24-hours.

The concrete patch isolates subsurface vapors from indoor air so that infiltration does not occur in either direction. These sub-slab sample portals also are permanent so, if necessary, the same locations may be sampled again at a later date. Following installation, a hand-held vacuum cleaner was used to clean surrounding flooring.

After the concrete patch had cured for 24-hours, OASIS deployed sub-surface samples. Teflon tubing was used to connect the sample portal to one opening on a three-way sample T. Teflon tubing was connected to the other two openings: one of which continued to the regulator on the summa canister and the other was attached to a Swagelok® valve fitting. While the intake valve on the summa canister was still closed, the Swagelok® valve was opened and a photo-ionization detector (PID) was connected to the sample line to purge the entire Teflon tubing sample train of vapors. The PID remained connected until the estimated volume of vapor in the Teflon tubing was pulled based on the average pump speed of the PID. At this point, the Swagelok® valve was closed and the valve for the summa canister was opened to commence sub-slab sampling. Sub-slab samples were collected for 30 minutes. The rate of air flow for the regulators was pre-set at the laboratory. The samples were analyzed for chlorinated alkenes and benzene, toluene, ethylbenzene, and xylenes (BTEX) by EPA method TO-15.

Sub-slab replicate samples were collected at Good News Bible and Book Store in October 2006 and at Meyeres Real Estate in February 2007. This was accomplished by connecting another three-way sample T at the first summa canister so that a second summa canister could be connected to the sample train. This design allowed two summa canisters to be filled simultaneously from the same sub-slab sample portal.

3.2.2 Indoor Air Samples

Indoor air samples were located on the ground floor of each building. The sample locations were positioned in areas of frequent use by building occupants. The samples were elevated between three and five feet above the floor to capture the breathing zone for a seated individual. Figure 2 shows the locations of indoor air samples. In Good News Bible and Book Store, the indoor air sample was collected in the main retail area of the store. For the Meyeres Real Estate building, the indoor air sample was collected in the main office space of the Joint Pipeline Office. Lastly, for Magoffin Law Firm, the indoor air sample was collected in the living room/common area of the office.

The samples were deployed for eight hours with regulators pre-set at the laboratory. The run-time of eight hours is indicative of an 8-hour work-day. The samples were analyzed for chlorinated alkenes and BTEX by EPA method TO-15 SIM.

Indoor air replicate samples were collected at Magoffin Law Firm and Good News Bible and Book Store in February 2007. The replicate sample was accomplished by using Teflon tubing and a three-way sample T to simultaneously fill two summa canisters.

3.2.3 Outdoor Air Samples

Outdoor air samples were located on the south side of each building. The samples were elevated between three and five feet above the ground. Figure 2 shows the locations of outdoor air samples.

The samples were deployed for 24-hours with regulators pre-set at the laboratory. The samples were analyzed for chlorinated alkenes and BTEX by EPA method TO-15 SIM. The run-time of 24 hours is indicative of ambient conditions for an entire day.

3.3 Work Plan Deviations

The following deviations occurred from the proposed work plan (OASIS 2006):

- Sub-slab samples at Magoffin Law Firm were collected in canisters dedicated for analysis by EPA method TO-15 SIM instead of canisters dedicated for analysis by EPA method TO-15. Therefore, sample collection lasted for 8 hours, and analysis was by EPA method TO-15 SIM.
- The indoor air sample, and replicate sample, at Magoffin Law Firm were collected in canisters dedicated for analysis by EPA method TO-15 instead of canisters dedicated for analysis by EPA method TO-15 SIM. Therefore, sample collection lasted for 30 minutes and analysis was by EPA method TO-15, which resulted in higher than desired reporting limits for the indoor air sample.
- The replicate sample at Meyeres Real Estate was collected from a sub-slab sample location instead of an indoor location.

Corrective action was not necessary for any of these deviations because analytical results of the sub-slab and indoor air samples at Magoffin Law Firm all were above detection limits for PCE, the primary contaminant of concern. Therefore, analytical data were usable for reporting and interpretation.

3.4 Investigation-Derived Waste

Vapor intrusion assessment field activities generated minimal investigation-derived waste (IDW). Solid IDW included used PPE and sampling equipment, such as disposable nitrile gloves, Teflon tubing, and unused concrete patch mix. These items were contained in trash bags and disposed of at the Fairbanks landfill. No aqueous IDW was generated.

4.0 RESULTS

This section discusses field observations and analytical results of the vapor intrusion assessment. Appendix 4 contains a copy of the laboratory analytical reports.

4.1 Good News Book and Bible Store

Table 4 presents analytical results from air samples collected at Good News Bible and Book Store in October 2006 and February 2007. Figure 3 displays the analytical results.

Sub-slab soil vapor analytical results for both October 2006 and February 2007 had very high concentrations of PCE from the southwest corner of the building near monitoring well MW-9 and the documented source of PCE-contaminated soil. The sub-slab sample from the southeast corner of the store had an elevated concentration of PCE (2,400 micrograms per cubic meter [µg/m^3]) during October 2006, but the February 2007 result was significantly less (80 µg/m^3). The third sub-slab sample location in the store's break room had consistent results of 83 µg/m^3 and 72 µg/m^3 for the October and February sample events, respectively. BTEX was analyzed for only during the February 2007 sample event. No BTEX compounds were detected at the sample location in the southwest corner of the building, while total BTEX concentrations for the southeast corner and break room sample locations had similar low-level concentrations. BTEX compounds have only been detected inconsistently and at very low, estimated concentrations in nearby monitoring wells during previous sampling events. The absence of BTEX in the sub-slab samples from the southwest corner may potentially be related to use of hydrocarbons for biodegradation of elevated PCE groundwater concentrations in that area.

Indoor air sample results from October 2006 and February 2007 sample events had detected concentrations of both PCE and TCE, although concentrations in February were approximately 30 to 40 percent lower than concentrations in October. Concentrations of PCE exceed Alaska DEC RME, EPA target indoor air concentration, New Jersey rapid action level, and New Hampshire commercial indoor air screening level. In addition, based on New York's decision matrix for sub-slab/indoor air concentrations ratios, PCE concentrations warrant mitigating actions for potential exposures associated with the vapor intrusion pathway. These screening benchmarks are presented in Table 4 along with analytical results. TCE concentrations also exceed some of the screening benchmarks, but to a much lesser degree than PCE.

Outdoor air sample results had low concentrations of PCE (0.61 µg/m^3 and 2.4 µg/m^3) for both sample events. Therefore, "ambient" or "background" concentrations of PCE appear to have a minimal contributing effect to the concentrations of PCE detected in indoor air samples.

4.2 Meyeres Real Estate

Table 5 presents analytical results from air samples collected at Meyeres Real Estate in February 2007. Figure 3 shows the analytical results.

Sub-slab soil vapor analytical results had no detections above laboratory reporting limits for any chlorinated alkene. This result is somewhat surprising given the elevated PCE concentrations in sub-slab samples from Good News Bible and Book Store (Section 4.1) and Magoffin Law Firm (Section 4.3). BTEX compounds were detected at all sub-slab sample locations with total BTEX concentrations ranging from 40 µg/m^3 to 84 µg/m^3. The highest concentrations of BTEX compounds were from the sample located in the southeast corner of the building.

Both PCE and TCE were detected in the indoor air sample. The concentration of PCE did not exceed any of the screening levels. The concentration of TCE exceeded the EPA target indoor air concentration. The sub-slab/indoor air concentration ratios for both PCE and TCE indicate no further action is necessary based on New York screening criteria. No BTEX compounds

were detected in the indoor air sample; therefore, the partitioning effect of BTEX from sub-slab to indoor air is large enough that BTEX compounds detected in sub-slab soil vapor are not detectable in indoor air.

PCE was detected in the single outdoor air sample. The concentration (2.0 µg/m^3) was approximately equal to the indoor air sample result for PCE (1.8 µg/m^3); therefore, the indoor air sample result should be attributed to background conditions rather than a release through the vapor intrusion pathway, especially given that PCE was not detected in sub-slab soil vapor samples.

4.3 Magoffin Law Firm

Table 6 presents analytical results from air samples collected at Magoffin Law Firm in February 2007. Figure 3 shows the analytical results.

Sub-slab soil vapor analytical results had elevated concentrations of PCE (between 1,000 and 1,500 µg/m^3) in all three samples. TCE also was detected in all three samples, but at concentrations ranging from 2.5 µg/m^3 to 11 µg/m^3. Cis-1,2-DCE was detected at 7.6 µg/m^3 in the sample from the northwest corner, which is most downgradient in the corresponding groundwater plume. No BTEX compounds were detected in the sub-slab samples.

PCE was detected in the indoor air sample at a concentration that exceeded the Alaska DEC RME, EPA target indoor air concentration, New Jersey rapid action level, and New Hampshire commercial indoor air screening level. The sub-slab/indoor air concentration ratios warrant mitigating actions based on New York screening criteria. BTEX compounds also were detected in the indoor air sample from Magoffin Law Firm, although the absence of BTEX compounds in the sub-slab sample results suggests that the presence of BTEX is the result of other indoor sources rather than soil vapor intrusion. A plausible source of the BTEX is the collection of paints, adhesives, and solvents in the southeast corner of the basement documented during the building survey (Section 3.1). While these materials may likely have impacted indoor air quality for BTEX compounds, these materials likely are not biasing indoor air results for chlorinated alkenes because no BTEX compounds were detected in the sub-slab samples, which suggests that the sample train did not experience any infiltration from indoor air to sub-slab air.

PCE and TCE were detected in the outdoor air sample. The PCE concentration was high enough to possibly have some influence on the indoor air result. If the outdoor air concentration for PCE is subtracted from the indoor air concentration, then the indoor air concentration is less than the New Jersey rapid action level for PCE; however, the resulting PCE concentration is still greater than the Alaska DEC RME, EPA target indoor air concentration, and New Hampshire commercial indoor air screening level. In addition, the resulting PCE concentration still warrants mitigating actions based on New York screening criteria.

4.4 West PCE Plume Analysis

The vapor intrusion analytical data present an interesting scenario if used to interpret the state of the West PCE Plume. The elevated soil vapor concentrations beneath Good News Bible and Book Store are the result of the documented source area near monitoring well MW-9. The soil vapor concentrations beneath Magoffin Law Firm possibly are related to the high groundwater concentrations historically recorded in monitoring well TW-46. No unique source area has been defined near TW-46, and the source of the elevated groundwater concentrations in TW-46 generally has been grouped together with the source area at MW-9. However, the soil vapor data suggest that there may be a unique source area located near TW-46. The discriminating data for this hypothesis may be the current soil vapor results for Meyeres Real Estate. The absence of chlorinated alkene data in sub-slab samples from Meyeres Real Estate suggests that there may be a separation between elevated groundwater concentrations in MW-9 and TW-

46; otherwise, more uniform sub-slab soil vapor concentrations would be expected from Good News Bible and Book Store to Meyeres Real Estate to Magoffin Law Firm. The ratio of PCE to DCE in groundwater samples from MW-9 and TW-46 historically also have been quite different, which possibly indicates that biodegradation is at different stages because of differences in product type or time of release.

Another possible source of the elevated soil vapor concentrations beneath Magoffin Law Firm is the sanitary sewer line that runs in front of the law office under Turner Street. Soil gas samples collected in 1999 near the sewer line on Turner Street had elevated concentrations of PCE. Leaching from this wood-stave sewer line may be a source of the chlorinated alkenes detected in soil vapor samples from Magoffin Law Firm.

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5.0 QUALITY ASSURANCE REVIEW

The analytical results for all field, quality control, and laboratory quality assurance samples were evaluated. The data were reviewed to determine the integrity of the reported analytical results and ensure the data met data quality objectives. Appendix 5 presents a complete quality assurance review of the analytical data including Alaska DEC's *Laboratory Data Review Checklist*.

The following list provides a summary of data quality objectives as presented in the work plan:

- All work was performed by OASIS personnel who are qualified individuals as per 18 AAC 75.990(100).
- Completeness – 100% of samples submitted were analyzed.
- Accuracy – All surrogate recoveries were within method-specific limits.
- Precision – Collection of field replicate samples occurred at each building. Relative percent differences for replicate analyses were within the method-specific rate of 25% except for TCE results in samples 06GRA138SA and 06GRA139SA. These results have been flagged as estimated concentrations. The laboratory ran duplicate analyses on lab-selected samples. All relative percent differences were within 25%.
- Comparability – Samples were analyzed by the same analytical methods.
- Representativeness – Air sample collection rates were based on recommended times for the type of sample. Samples 07GRA104SA, 07GRA105SA, and 07GRA106SA were collected for eight hours instead of the proposed 30 minutes, which does not impact data usability. Samples 07GRA107IA and 07GRA108IA were collected for 30 minutes instead of 8 hours. This variation, which was detailed in Section 3.3, may impact the quality of the indoor air samples, but this variation is not possible to quantify. Sample 06GRA137OA was at ambient pressure when received at the laboratory, which likely indicates that leakage occurred sometime after sample collection. The single result (PCE) above reporting limits has been flagged as an estimated concentration. Trip blanks were analyzed for each building to assess potential cross-contamination. No compounds were detected in the trip blanks.

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6.0 CONCEPTUAL SITE MODEL

The following provides a preliminary human health conceptual site model for the Gaffney Road Area site. Appendix 6 contains a copy of Alaska DEC's Human Health Conceptual Site Model Flow Chart.

Elements of CSM	Site Specific Factors
Source	Groundwater Plume
Release Mechanism	Spill or discharge to soil and releases from wood-stave sanitary sewer lines
Impacted Media	Soil, groundwater, soil gas, air
Transport Mechanism	Migration or leaching to subsurface, Migration or leaching to groundwater, migration through groundwater, volatilization to air
Exposure Media	Soil, groundwater, air
Exposure Routes	Ingestion of soil and groundwater; direct contact with soil and groundwater; inhalation of outdoor air and indoor air
Receptors	Short-term workers, long-term workers, site visitors, potentially residents

Based on this model, the following pathways are considered complete at this time for contamination from petroleum hydrocarbons because they currently are complete or may become complete in the future:

Residential	Site Worker	Site Visitor	Subsistence
Ingestion of Soil	Ingestion of Soil	Ingestion of Soil	None
Ingestion of Groundwater	Ingestion of Groundwater	Ingestion of Groundwater	
Direct Contact with Soil	Direct Contact with Soil	Inhalation of Indoor Air	
Direct Contact with Groundwater	Direct Contact with Groundwater	Inhalation of Outdoor Air	
Inhalation of Indoor Air	Inhalation of Indoor Air		
Inhalation of Outdoor Air	Inhalation of Outdoor Air		

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7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

OASIS conducted a vapor intrusion assessment of the Gaffney Road Area site for Alaska DEC. The assessment included fall sampling at Good News Bible and Book Store and winter sampling at Good News Bible and Book Store, Meyeres Real Estate, and Magoffin Law Firm. The sampling program included the collection of three sub-slab soil vapor samples, one indoor air sample, and one outdoor air sample at each building for each sample event. The findings of the assessment are documented below:

- Good News Bible and Book Store has elevated concentrations of PCE and TCE in sub-slab soil vapor samples from the southwest corner of the building near a source of PCE-contaminated soil. The other two sub-slab sample locations also have elevated concentrations of PCE, but the concentrations are significantly less than the southwest corner. The indoor air sample shows that PCE is present in concentrations exceeding the Alaska DEC RME, and EPA and many state screening levels. Indoor air concentrations of TCE also are present, but at concentrations that only exceed EPA target indoor air concentrations. Analytical results of outdoor air samples demonstrate that background conditions are a minor contributor to indoor air concentrations. Given this weight of evidence, it appears that the vapor intrusion pathway is complete for Good News Bible and Book Store. In addition, when compared to New York screening criteria, the ratio of sub-slab/indoor air concentrations warrants mitigating action to minimize exposure to inhabitants.
- No chlorinated alkenes were detected in sub-slab soil vapor samples from Meyeres Real Estate, while low levels of BTEX compounds were detected at all three locations. Both PCE and TCE were detected at low concentrations in the indoor air sample; however, given that PCE and TCE were not detected in sub-slab samples and the outdoor air sample has a PCE concentration nearly equal to the indoor air result, indoor air concentrations of PCE and TCE likely are attributable to background conditions. Therefore, the vapor intrusion pathway appears incomplete at Meyeres Real Estate, but because of background conditions there is still some risk of exposure to chlorinated alkenes from indoor air.
- Magoffin Law Firm has high concentrations of PCE at all three sub-slab soil vapor sample locations. The indoor air sample shows that PCE is present in concentrations exceeding EPA and many state screening levels. Given that the outdoor air sample concentration of PCE is a fraction of the indoor air concentration, it appears that the vapor intrusion pathway is complete for Magoffin Law Firm. When compared to New York screening criteria, the ratio of sub-slab/indoor air concentrations for PCE warrants mitigating action to minimize exposure to building occupants. Indoor air concentrations also have low levels of BTEX compounds, but given the absence of BTEX compounds in sub-slab and outdoor analytical results, these detections appear to be the result of other indoor sources. Both TCE and cis-1,2-DCE were not detected in the indoor air sample.
- Past assessments have tended to group together the groundwater concentrations in monitoring wells MW-9 and TW-46 as originating from a single source. However, the elevated sub-slab soil vapor concentrations of PCE at Good News Bible and Book Store and Magoffin Law Firm combined with the absence of detectable concentrations of PCE in sub-slab soil vapor samples from Meyeres Real Estate suggest that there may be a divide in the West PCE Plume between the known source area near MW-9 and the historically high groundwater concentrations recorded in TW-46. Another possibility for

the elevated sub-slab soil vapor concentrations at Magoffin Law Firm is the wood-stave sanitary sewer buried beneath Turner Street in front of the law firm. Soil gas sample results from 1999 had elevated concentrations of PCE near the sewer line.

7.2 Recommendations

The vapor intrusion assessment of the West PCE Plume for the Gaffney Road Area site indicates that the vapor intrusion pathway is complete for occupants of Good News Bible and Book Store and Magoffin Law Firm; however, an accurate understanding of exposure to occupants of these buildings is not known because no sampling has been performed in the warm season to analyze the variability of vapor intrusion between seasons. Based on the need to better understand exposure for an entire year and also to begin to minimize exposure to building occupants, the following actions are recommended for the Gaffney Road Area site:

- Conduct another vapor intrusion assessment this summer using the same sample strategy. In addition, consider including a few additional buildings downgradient in the West PCE Plume to determine how far impact to indoor air quality may extend from the source area(s). Other buildings locations could include Wells Fargo Bank, Yukon Title, the church located at the corner of Turner Street and 11th Avenue, and the residence located on the west side of the church, behind monitoring well MW-16.
- Initiate remedial action for the known source of PCE-contaminated soil near monitoring well MW-9, as outlined in the recently submitted *Gaffney Road Area Groundwater Assessment* report.
- Conduct source characterization of the West PCE Plume, as outlined in the recommendations of the recently submitted *Gaffney Road Area Groundwater Assessment* report, to identify all sources of PCE.

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