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July 10, 2009

Ashley Holt, P.G., Manager
State Remediation Program
Division of Solid Waste Management
Tennessee Department of Environment and Conservation
5th Floor, L&C Tower
401 Church Street
Nashville, Tennessee 37243-1535

Re: Final Report of Soil Vapor Investigation – Daniels Drive Area
ELMCO Solvent Release Response Interim Action
Franklin, Tennessee
TriAD Project No. 07-ELM01-01

Dear Ms. Holt:

This letter constitutes the *Final Report of Soil Vapor Investigation – Daniels Drive Area*, related to the release of solvents from the Egyptian Lacquer Manufacturing Company (ELMCO) in Franklin, Tennessee. The soil vapor investigation was performed in January 2009 as one of a series of interim actions designed to investigate and remediate the solvent release. This report was prepared by TriAD Environmental Consultants, Inc. (TriAD) on behalf of ELMCO and through its attorneys Stites and Harbison, PLLC. It presents the findings of three separate data evaluations performed to determine whether the detected concentrations of soil vapor pose an unacceptable risk to the residents of Daniels Drive. These data evaluations were performed by TriAD, the Tennessee Department of Health (TDH), and Science Applications International Corporation (SAIC), a contractor working for the Tennessee Department of Environment and Conservation (TDEC). A description of the soil gas sampling and analysis efforts and the resulting data were presented in TriAD's *Preliminary Report of Daniels Drive Soil Gas Investigation* (Preliminary Report) dated March 23, 2009, which is incorporated into this report by reference. This final report also summarizes the series of events and decisions regarding the interpretation of the data, from the collection of the data in January 2009 to the preparation of the final report.

Event Summary

As noted in the Preliminary Report, soil vapor samples were collected on January 20 and 21, 2009, in accordance with the November 19, 2008, *Work Plan for Daniels Drive Soil Gas and Bedrock Profile Investigation*. Upon receipt of the

analytical reports, TriAD compared the data to risk-based guidance levels in the U.S. Environmental Protection Agency (EPA) Office of Solid Waste Emergency Response (OSWER) and Tennessee Division of Underground Storage Tanks (TDUST) guidance documents, as called for in the work plan. While performing these comparisons, TriAD concluded that 1) the measured soil vapors posed no short-term risk and were unlikely to pose long-term risk to local residents, and 2) there were differences in methodology between EPA and TDUST guidance that needed to be addressed in order to make a final conclusion.

In early March, TriAD discussed with the Tennessee Division of Solid Waste Management (TDSWM) the need to resolve the differences in the two guidance documents; however, rather than having a meeting, TDSWM requested that TriAD submit the raw data to them so that they could perform their own data evaluations. In response TriAD submitted the March 23 Preliminary Report. TriAD understands TDSWM requested that both TDH and SAIC evaluate the data with regard to potential risk to human health. At the request of TDSWM, TriAD put its final report preparation on hold pending the outcome of these reviews.

On April 20, 2009, Mr. Joe George of TDH notified Ashley Holt of TDSWM that the soil vapor samples were found to be within the acceptable risk range as defined in the OSWER guidance. His report is in Attachment A. Mr. George also recommended that TDEC "revisit" the issue of indoor air sampling at certain residences along Daniels Drive, although this action is not required by OSWER or TDUST.

On April 24, 2009, Ms. Samantha Pack of SAIC notified Ashley Holt of TDSWM in a draft memo that she had evaluated the soil vapor data using the OSWER guidance and that the soil vapors do not appear to pose a risk to human health, and that no additional characterization of the pathway is required. A copy of this draft memo is included in Attachment B.

On June 4, 2009, Ms. Pack provided a draft memo to Ms. Holt which stated that all sample results were below the most protective concentrations using TDUST guidance. A copy of this draft memo is included in Attachment B.

TriAD received the draft SAIC memos on June 1 and June 8, 2009. Mr. Chris Scott of TriAD spoke with Ms. Holt on June 8 to discuss a number of questions raised in the memos. On June 15, 2009, at Ms. Holt's request, Mr. Scott submitted those comments to Ms. Holt in writing.. Ms. Pack responded to the TriAD comments on June 30, 2009, and the responses were forwarded to TriAD on July 1, 2009. The responses to the comments are also included in Attachment B.

On July 7, 2009 ELMCO's counsel was advised by the TDSWM that TriAD should submit its report based upon the input from TDH and SAIC. TDSWM

would review the report based upon the draft memos and would not request SAIC to make a formal report.

Data Evaluation
The following sections describe the evaluations of the soil-vapor data that were performed by TriAD, TDH, and SAIC.

TriAD Evaluation
TriAD evaluated the data using both the OSWER (*Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils*, November 2002) and TDUST (*Technical Guidance Document-018* (TGD-018)) guidance documents. The OSWER guidance uses a tiered approach. Tier One involves determining whether the soil or groundwater contamination poses a *potential* risk to human health. The ELMCO solvent release posed a potential risk because the principal migration route between the ELMCO facility and Liberty Creek passes beneath the Daniels Drive residential area. Limited Indoor air sampling performed in April 2007 indicated no acute risks to residents, but the limited scope of this earlier investigation, the lapse of time, and the concerns about potential chronic risks made additional screening desirable.

Tier Two of the OSWER guidance involves the comparison of soil-vapor data to generic target concentrations for shallow (< 5 ft) and deep (> 5 ft) soil. A range of three generic scenarios are presented in the guidance, one each for cancer risk factors of 10^{-4}, 10^{-5}, and 10^{-6}. Data falling anywhere in this range is deemed within acceptable risk for human exposure. TriAD used the 10^{-5} risk factor because it is used by TDUST in screening for risk at sites contaminated with gasoline, which is similar in composition to the constituents released from ELMCO, including toluene, ethylbenzene, xylenes, and benzene. At this screening level, all but two of the 29 volatile organic compounds (VOCs) detected in the soil-vapor samples screen out; i.e., they are below the generic risk levels. Two VOCs, benzene and 1,3-butadiene, exceeded their screening levels; benzene in the shallow sample from SG-2 and 1,3-butadiene in the shallow sample from SG-2 and the deep sample from SG-1.

The benzene concentration in sample SG-2 was 38 ug/m^3, only slightly greater than the generic screening level of 31 ug/m^3 for the 10^{-5} risk factor. Using the 10^{-4} risk factor, which is within the acceptable range of risk under EPA risk-assessment guidance. the generic screening level becomes 310 ug/m^3, and the SG-2 benzene concentration of 38 ug/m^3 screens out.

1,3-Butadiene is a hydrocarbon chemical used primarily in making synthetic rubber and plastics, although small quantities are found in gasoline. It was not used by ELMCO and is not believed to be a constituent associated with the release of solvents from ELMCO. TriAD requested that TestAmerica laboratory review the data from soil samples collected from the contaminated soil in the cutter under Daniels Drive and from the soil source area at the ELMCO facility to

determine whether 1,3-butadiene, a chemical not normally reported in a soil VOC analysis, was present. (Soil laboratory reports are included in TriAD's July 2009 *Report of Bedrock Surface Data – Daniels Drive Area*.) TestAmerica reported that 1,3-butadiene was not present in any of the three soil samples analyzed. Therefore, although the origin of the 1,3-butadiene detected in the soil-vapor samples is not known, it is apparently not related to the solvent release from the ELMCO facility.

TriAD also evaluated the soil-vapor data using the TDUST guidance. Although it only includes petroleum fuel constituents, the TDUST guidance does include benzene, toluene, ethylbenzene, and xylenes, which are known constituents of the ELMCO solvent release. Using the look-up tables in the TDUST guidance, which assume a 10^{-5} risk factor, and applying a very protective assumption of only 0.1 feet of soil between the sampling point and the foundation floor, it was found that measured soil-vapor concentrations of these constituents were well below the screening levels.

TDH Evaluation

TDH used the OSWER guidance in their evaluation without reference to the TDUST guidance. In his memo, Mr. George noted that TriAD used the proper methodology for collecting soil-vapor samples though it was done in accordance with the TDUST methodology. TDH found, as did TriAD, that benzene in shallow sample SG-2 slightly exceeded the 10^{-5} risk factor screening level, but was well below the 10^{-4} risk factor screening level. It appears from his email that Mr. George was instructed by TDSWM to restrict his analysis to ELMCO-related VOCs and, therefore, did not evaluate 1,3-butadiene.

Mr. George stated that although the soil-vapor samples showed VOC concentrations within acceptable ranges and met the EPA protocol, he felt that it would be "advantageous for TDEC to revisit indoor air sampling to have an up-to-date assessment", and recommended homes with addresses ranging from 118 to 131 Daniels Drive as being of particular interest.

SAIC Evaluation

Ms. Pack of SAIC performed evaluations of the soil-vapor data using both the OSWER and TDUST guidance documents. The OSWER-based evaluation found exceedances of the 10^{-5} screening level for both benzene in SG-2 and 1,3-butadiene; however, she ruled out 1,3-butadiene as a chemical of concern at the ELMCO site. In her response to TriAD's comments, Ms. Pack noted that applying the risk factor of 10^{-4} (within the prescribed EPA range of risk), the measured benzene concentration screens out.

The only data anomaly identified by SAIC is the lack of detectable concentrations of VOCs in the deep (10 ft) sample from location SG-2. This fact was noted in TriAD's Preliminary Report because it was the only sample collected in which no VOCs were detected. TriAD does not know why this sample contained no

detectable VOCs. The sample train and canister appeared to function normally in the field. The sample either contained no VOCs, which seems unlikely given the concentrations detected in every other sample, or there was an error in the collection, handling, or analysis of the sample. In any case, SAIC did not recommend corrective action with regard to this anomaly. They found that "soil vapors do not appear to pose a risk to human health using the conservative EPA screening process, and that no additional characterization of this pathway is required."

Using the TDUST screening methodology, SAIC found that assuming only 0.01 feet of soil between the sampling point and the foundation floor (an order of magnitude less than was assumed by TriAD), there was no exceedance of the residential receptor standards.

Conclusions

Based on the evaluations of the soil-vapor data performed by TriAD, TDH, and SAIC, the detected concentrations of VOCs in soil vapor pose no unacceptable risk to human health. No further investigation of soil vapors or indoor air along Daniels Drive is necessary. The investigation complied with EPA and TDUST protocols.

ELMCO initially proceeded with indoor air sampling in April 2007 because of concerns that residents could be acutely exposed to solvent vapors during the period of heavy discharge of free-product solvent at Liberty Creek. The results indicated no significant risk. Since that time, ambient air sampling in the area around Liberty Creek and the south end of Daniels Drive was performed over several months, again finding no risk to residents. The subsurface flow of free-product solvent has also dramatically decreased over time, to the point that even deliberate efforts to induce free-product flow into the recovery sump near Liberty Creek are largely ineffective. Now, soil-vapor sampling has been performed in the neighborhood and the results evaluated by three organizations, two of which represent the State of Tennessee. No unacceptable risk was found using either federal or state screening methods, meaning that there is no basis to assume that indoor air would pose a risk to residents and there is no need to perform another indoor air investigation.

Indoor air samples, as recommended by Mr. George of TDH, are not appropriate unless a Tier Two investigation indicates there is an unacceptable risk. In the OSWER guidance, an indoor air investigation would be considered part of a Tier Three assessment needing contemporaneous sub-slab vapor sampling, a building inspection, occupant survey, background studies to account for ambient air contamination, and removal of all potential sources of indoor air emissions. In fact, interpretation of indoor air data is so problematic that the guidance states:

> "Collection of indoor air quality data without evidence to indicate the potential for vapor intrusion from subsurface sources can lead to

> confounding results. Indoor air quality can be influenced by 'background' levels of volatile chemicals (e.g., due to indoor and/or outdoor ambient sources). For example, consumer products typically found in the home (e.g., cleaners, fuels, paints, and glues) may serve as ancillary sources of indoor air contaminants. Additionally, ambient outdoor air in urban areas often contains detectable concentrations of many volatile chemicals. In either case, the resulting indoor air concentrations can be similar to or higher than levels that are calculated to pose an unacceptable chronic inhalation risk."

It is clear from this and other language in the OSWER guidance that EPA views indoor air sampling as a last resort effort, to be used when Tier One and Two results show that unacceptable risk may exist or when site conditions warrant.

Please contact us if you require additional information.

Sincerely,

TriAD Environmental Consultants, Inc.

T. Dwight Hinch
Senior Project Manager

Chris Scott, P.G.
Senior Hydrogeologist

Attachments

cc: Bill Penny, Stites and Harbison
Kerry Mattox, ELMCO

ATTACHMENT A

TDH MEMO

Chris Scott

From: Joseph George [Joseph.George@tn.gov]
Sent: Monday, April 20, 2009 10:15 AM
To: Ashley.A Holt
Cc: Bonnie Bashor; David.M Borowski
Subject: Re: Fwd: ELMCO - Preliminary Report of Daniels Drive Soil GasInvestigation

Ashley - I've taken a look at the results from TriAD's Daniels Drive soil-gas sampling investigation conducted in January 20-21, 2009 per your request. TriAD sampled at both 3 feet and 10 feet below ground surface
(bgs) at 4 locations and at 3 feet bgs at 3 locations. These sampling depths were patterned after the Tennessee Division of Underground Storage Tanks (TDUST) technical guidance document TGD-018.

As you have discussed with me, EPA Region 4 has instructed the SRP to evaluate sites according to EPA's 2002 OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). As outlined in this guidance, shallow soil-gas samples for indoor vapor intrusion determination should be collected no greater than 5 feet from the foundation of a building. It goes on to state that in general, samples taken less than 5 feet below the building foundation are not recommended unless the sample was taken from directly under the foundation slab or repeated sampling is performed to ensure a representative soil-gas value. While the TriAD shallow soil-gas samples were not collected according to the recommendations in the guidance, they still likely can be used to understand what individual vapor constituents may be migrating in the soil-gas.

As for deeper soil-gas samples, the guidance states they should be collected such that they represent a depth greater than 5 feet below the depth of the foundation. The deeper soil gas samples were collected from a depth of 10 feet bgs which corresponds to the recommendation in the guidance.

Following the steps outlined in the EPA VI guidance, the soil-gas concentrations of individual chemicals were compared to comparison value tables (Tables 2b and 2c). The tables were created given the calculations outlined in the guidance and represent both target shallow and deep soil-gas concentrations corresponding to target indoor air concentrations. All but one concentration of site-related compounds (acetone, toluene, benzene) identified in shallow and deep soil-gas sample results are within concentration range of 1 excess cancer in 1,000,000 (10-6) to 1 excess cancer in 100,000 (10-5). One shallow soil-gas sample (SG-2 at 3 feet bgs) had a concentration of benzene slightly above this range, but much less than the 1 excess cancer in 10,000 (10-4) comparison value. The excess cancer range from 10-4 to 10-6 is considered acceptable and protective of public health by EPA. Other compounds detected are also present in concentrations within this risk range. Since the investigation was focused on sampling and analysis of soil-gas, the results cannot be compared to any minimum risk level published by the Agency for Toxic Substances and Disease Registry
(ATSDR) and related to indoor air concentrations.

As you have stated, indoor air measurements were collected early on in the investigation. These recent soil-gas samples while within the acceptable risk range, were collected greater than 50 feet but less than 100 feet from each residence. They were collected through a relatively impervious surface material (asphalt) which may act similar to a floor slab in a basement.
However, these soil-gas concentrations and their subsequent target indoor air concentrations may not be representative of actual concentrations of the site-related compounds in the indoor air of homes along Daniels Drive. The Environmental Epidemiology Program feels it is advantageous for TDEC to revisit indoor air sampling to have an up-to-date assessment. Indoor air samples could be collected from the lowest living space in 10 to 12 homes within the suspected path of the contaminant plume in the cul-de-sac of Daniels Drive to understand if vapors are migrating into the homes. Homes having street addresses from 118 to 131 Daniels Drive would be of particular interest, since it appears the groundwater plume migrates beneath these homes.

If you have any questions, or would like to talk more about vapor intrusion, feel free to

contact me or David Borowski.

Joe George
Tennessee Department of Health
Environmental Epidemiology Program

>>> Ashley.A Holt 4/7/2009 1:04 PM >>>
Joe,

These are the results from the soil gas survey that was conducted by ELMCO (I gave it to you to look at when you were at our office). Would you mind giving it a more in-depth look? This was conducted because a contaminant plume migrates under a residential neighborhood and we wanted ELMCO to see if soil vapors were a potential pathway into the homes. I just need to know whether or not the results from this sampling indicate the need for
additional sampling inside the homes. Several of the homes have already had indoor air monitoring conducted and nothing was detected. Thanks again for all your help.

Ashley

ATTACHMENT B

SAIC MEMOS

SAIC
From Science to Solutions

INTERNAL MEMORANDUM
DRAFT

Date: April 23, 2009

To: J.J. Hollars, SAIC TDEC Program Manager

From: Samantha Pack, Sr. Human Health Risk Assessor

RE: REVIEW OF DANIELS DRIVE SOIL GAS DATA: ELMCO SOLVENT RELEASE RESPONSE INTERIM ACTION

The Tennessee Department of Environmental Conservation (TDEC) requested SAIC to review soil gas data collected January 20 and 21, 2009 along Daniels Drive in Franklin, TN. This letter presents our preliminary findings from the review.

GOALS OF THE REVEIW

The goal of this review is to evaluate the data in relation to the Environmental Protection Agency (EPA) OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway From Groundwater and Soils (subsurface Vapor Intrusion) (EPA, 2002).

This review does not attempt to evaluate the analytical quality of the data collected.

SUMMARY OF EPA GUIDANCE

The EPA guidance provides tools to conduct screening of data to determine if there is a potential for contaminant vapor intrusion to be a complete pathway at a site, and if contaminant levels could pose an unacceptable risk to humans. The goal of the screen is to determine 1) if the pathway is incomplete and no additional action is required, 2) if additional characterization is warranted, or 3) if an expedited mitigation action (e.g. ventilation) may be required. The ultimate use of the guidance is, "where appropriate, to support Current Human Exposures Under Control Environmental Indicator (EI) determination".

The screening approaches provided in the guidance are conservative, e.g. they overestimate the potential that vapor instruction could be an issue in a residential setting to ensure heath protectiveness under any setting.

The draft guidance promotes a tiered approach to understanding the conditions at a site:

- Tier 1 - Primary Screening uses general knowledge of the site, environmental media, and chemicals of potential concern, e.g. types of chemicals, receptors present, etc.
- Tier 2 - Secondary Screening compares limited site data, e.g. soil gas results, against target levels.

- Tier 3 - Site-Specific Assessment involves collecting confirmatory data at the receptor location.

The evaluation present in this review is a Tier 2 evaluation that involves screening recently collected soil gas data against the EPA recommended numerical criteria.

Site Data

Soil gas data were collected from seven locations along Daniels Drive in accordance with a Work Plan submitted and revised to the TDEC State Remediation Program (SRP) and in accordance with the TDUST Technical Guidance Document -018. At four locations two geoprobe borings were developed (one shallow – 3 ft bgs, and one deep – 10 ft bgs). At the three additional locations only shallow borings were developed. Soil samples were collected using laboratory-supplied SUMMA canisters.

Selected Criteria

EPA recommends the use of screening criteria corresponding to a 10^{-5} cancer risk target and a hazard quotient (HQ) = 1 and thus these values were used in this screening process. The selected values are listed in Table 2b of the guidance and represent:

- The target risk levels identified above.
- A default soil gas-to-indoor air attenuation factor of 0.1 for shallow soil gas.
- A default soil gas-to-indoor air attenuation factor of 0.01 for deeper soil gas.
- Standard EPA exposure and risk models and data sources for chemical properties and chemical toxicity.

DATA EVALUATION

Table 1 shows the soil gas data along with a comparison to the selected numeric criteria. Several of the chemicals detected in the soil gas do not have EPA screening criteria and are not covered in this assessment. Reasons for the lack of numeric criteria may include a lack of information on chemical toxicity or low Henry's Law Constant indicating low volatility.

One large anomaly is present in the dataset. The conceptual vapor transport model for this site assumes that contamination is present in the groundwater, volatilizes into the soil gases in the unsaturated soil zone, and migrates upwards to the ground surface or to and through a building foundation. Under this scenario soil gas concentrations in the deeper zone (10 ft bgs) should be higher than soil gas concentrations in the shallow zone (3 ft bgs) since the deeper zone is closer to the source and less attenuation has occurred. At location SG-2 concentrations are sufficiently higher in the shallow zone than the deeper zone, bringing into question 1) if a source other than groundwater is present in the area of the sample, or 2) if a data issues exists (e.g. were the shallow and deep samples inadvertently switched). There are two screening exceedances associated with this shallow sample, benzene and 1,3-butadience (which is not a chemical of potential concern in the Daniels Drive plume). Benzene at this location is close to the screening level (38 ug/m^3 vs.31 ug/m^3).

Aside from this anomaly there was only one detection above screening levels: 1,3-butadiene in SG-1. The extremely low screening level for this chemical results in any detection exceeding the criteria.

SUMMARY

Results from soil gas sampling along Daniels Drive indicate that soil vapors do not appear to pose a risk to human health using the conservative EPA screening process, and that no additional characterization of this pathway is required. This conclusion assumes that soil gas samples were properly placed above the high concentration points in the underlying groundwater plume.

Table 1. Comparison of EPA Screening Criteria and Soil Gas Data.

Analyte	Table 2B Criteria		SG-1				SG-2				SG-3				SG-4				SG-5		SG-6		SG-7	
	Shallow(a)	Deep(b)	3-Ft		10-Ft		3-Ft		10-Ft		3-Ft		10-Ft		3-Ft		10-Ft		3-Ft		3-Ft		3-Ft	
Acetone	3500	35000	67	no	220	no	220	no	< 5.9	ND	120	no	290	no	97	no	260	no	78	no	110	no	140	no
Benzene	31	310	11	no	93	no	38	yes	< 1.3	ND	7.7	no	48	no	15	no	64	no	17	no	24	no	16	no
2-Butanone			< 7.4		< 29		19		< 7.4		7.4		< 15		< 7.4		< 29		< 7.4		< 7.4		9.7	
1,3-Butadiene	0.9	8.7	< 8.9	ND	38	yes	9.3	yes	< 8.9	ND	< 8.9	ND	< 18	ND	< 8.9	ND	< 35	ND	< 8.9	ND	< 8.9	ND	< 8.9	ND
tert-Butyl alchohol			< 1.2		< 4.9		2.7		< 1.2		1.4		< 2.4		1.2		< 4.9		1.3		1.2		3	
Chlorobenzene	600.0	6000.0	7.9	no	40	no	29	no	< 1.8	ND	6.9	no	33	no	9.7	no	45	no	12	no	18	no	13	no
Chloroform	11.0	110.0	< 1.9	ND	25	no	< 1.9	ND	< 1.9	ND	< 1.9	ND	< 3.9	ND	< 1.9	ND	< 7.8	ND	< 1.9	ND	< 1.9	ND	< 1.9	ND
Chloromethane			7.4		< 3.3		2.3		< 0.83		2.3		< 1.7		2		< 3.3		8.9		3.3		1.9	
2-Chlorotoluene			< 2.1		< 8.2		< 2.1		< 2.1		< 2.1		< 4.1		< 2.1		< 8.2		< 2.1		< 2.1		2.6	
Cyclohexane			9		180		25		< 1.4		5.9		100		4.1		38		7.2		3.8		4.1	
1,2-Dichlorobenzene	2000	20000	< 2.4	ND	< 9.6	ND	2.9	no	< 2.4	ND	< 2.4	ND	< 4.8	ND	< 2.4	ND	< 9.6	ND	2.4	no	< 2.4	ND	2.8	no
1,4-Dichlorobenzene	8000	80000	3.5	no	< 9.6	ND	4.4	no	< 2.4	ND	< 2.4	ND	6.6	no	2.5	no	< 9.6	ND	4	no	< 2.4	ND	4.6	no
Dichlorodifluoromethane	2000	20000	2.8	no	< 7.9	ND	2.9	no	< 2	ND	2.8	no	< 4	ND	3	no	< 7.9	ND	2.9	no	2.8	no	3	no
Ethanol			72		34		38		< 2.4		28		43		23		38		26		62		26	
Ethylbenzene	220	2200	5.2	no	36	no	6.1	no	< 1.7	ND	< 1.7	ND	20	no	2	no	9.5	no	2	no	2	no	1.8	no
Heptane			11		180		31		< 1.6		8.6		94		4.9		41		7.4		4.9		5.3	
n-Hexane	2000	20000	14	no	350	no	46	no	< 4.4	ND	12	no	210	no	5.6	no	74	no	12	no	5.6	no	6.7	no
Isopropylbenzene	4000	40000	< 2	ND	12	no	< 2	ND	< 2	ND	< 2	ND	< 3.9	ND	< 2	ND	< 7.9	ND	< 2	ND	< 2	ND	< 2	ND
Methylene Chloride	240	2400	< 1.4	ND	< 5.6	ND	< 1.4	ND	< 1.4	ND	< 1.4	ND	< 2.8	ND	< 1.4	ND	< 5.6	ND	< 1.4	ND	3.4	no	< 1.4	ND
Methyl methacrylate			< 1.6	ND	< 6.6		< 1.6		< 1.6		< 1.6		34		< 1.6		< 6.6		< 1.6		< 1.6		< 1.6	
2-Propanol			< 4900	ND	740		490		< 6.1		440		610		320		540		440		610		490	
Propene			1.4		380		96		< 1.4		40		330		< 1.4		340		64		43		40	
Tetrachloroethene	81	810	31	no	110	no	5.6	no	< 2.7	ND	< 2.7	ND	20	no	< 2.7	ND	37	no	< 2.7	ND	< 2.7	ND	< 2.7	ND
Toluene	4000	40000	32	no	210	no	83	no	< 1.5	ND	16	no	110	no	29	no	110	no	32	no	45	no	30	no
1,1,1-Trichloroethane	2200	22000	NI 2.2	ND	65	no	< 2.2	ND	< 2.2	ND	< 2.2	ND	< 4.4	ND	< 2.2	ND	< 8.7	ND	< 2.2	ND	< 2.2	ND	< 2.2	ND
1,2,4-Trimethylbenzene	60	600	5.4	no	39	no	3.4	no	< 2	ND	< 2	ND	10	no	3	no	< 7.9	ND	< 2	ND	< 2	ND	< 2	ND
1,3,5-Trimethylbenzene	60	600	2.4	no	18	no	< 2	ND	< 2	ND	< 2	ND	6.9	no	< 2	ND	< 7.9	ND	< 2	ND	< 2	ND	< 2	ND
m&p Xylene			9.5		61		9.5		< 3.5		< 3.5		33		4.2		16		< 3.5		3.6		< 3.5	
o xylene			4.3		30		5.2		< 1.7		< 1.7		12		2		8.2		< 1.7		2.1		< 1.7	

All units in ug/m3

(a) Shallow soil gas criteria based on a soil gas-to-indoor air attentuation factor of 0.1.

(b) Deep soil gas criteria based on a soil gas-to-indoor air attentuation factor of 0.01.

"<" indicates chemical was not detected at reported limit.

"no" indicates chemical was detected below screening criteria; :yes" indicate chemical was detected above the screening criteria; "ND" indicates chemica was not detected in the sample.

SAIC
From Science to Solutions

INTERNAL MEMORANDUM
DRAFT

Date: June 4, 2009

To: J.J. Hollars, SAIC TDEC Program Manager

From: Samantha Pack, Sr. Human Health Risk Assessor

RE: REVIEW OF DANIELS DRIVE SOIL GAS DATA: ELMCO SOLVENT RELEASE RESPONSE INTERIM ACTION – COMPARISON TO TENNESSEE UST SOIL GAS LIMITS

The Tennessee Department of Environmental Conservation (TDEC) requested SAIC to review soil gas data collected January 20 and 21, 2009 along Daniels Drive in Franklin, TN. This memorandum presents a comparison of the soil gas results to the Tennessee Guidance Document 018 (TGD 018) soil gas action limits.

TDG 018 includes a model for developing "project-specific" action limits. The model calculates limits based on a soil vapor intrusion model and can be found at http://tennessee.gov/environment/ust/guidance/tgd018lt.xls. The only assumption in the model that can be varied by a specific project is the distance (in feet) from the crawlspace or basement, either vertically or horizontally. For this analysis we assume that there is almost zero distance (0.01 ft) from the soil gas sample location to the potential receptor. The basis for this assumption is that a typical crawl space foundation would be about 3-5 feet bgs and the shallow sample points were 3 feet bgs. A basement would be 9 – 10 feet bgs and the deeper sample points were 10 feet bgs. Table 1 and the attached Lookup Table show the soil gas action limits. Table 1 indicates that all sample results are well below the TGD 018 limits.

Table 1 Comparison of TDUST Criteria and Soil Gas Data

Analyte	TN Soil Gas Criteria (a)		SG-1		SG-2		SG-3		SG-4		SG-5	SG-6	SG-7
	Crawlspace	Basement/ slab	3-Ft	10-Ft	3-Ft	10-Ft	3-Ft	10-Ft	3-Ft	10-Ft	3-Ft	3-Ft	3-Ft
Benzene	191	731	11	93	38	< 1.3	7.7	48	15	64	17	24	16
Ethylbenzene	39326	73038	5.2	36	6.1	< 1.7	< 1.7	20	2	9.5	2	2	1.8
MTBE	88463	166240	< 1.4	< 5.8	< 1.4	< 1.4	< 1.4	< 2.9	< 1.4	< 5.8	< 1.4	< 1.4	< 1.4
Napthalene	5710	10576	< 2.1	< 8.4	< 2.1	< 2.1	< 2.1	< 4.2	< 2.1	< 8.4	< 2.1	< 2.1	< 2.1
Toluene	13442	25091	< 32	210	83	< 1.5	16	110	29	110	32	45	30
m&p Xylene	12247	22684	9.5	61	9.5	< 3.5	< 3.5	33	4.2	16	< 3.5	3.6	< 3.5
o xylene	12247	22684	4.3	30	5.2	< 1.7	< 1.7	12	2	8.2	< 1.7	2.1	< 1.7

All units in ug/m3

Criteria are derived from the Tennessee Gass Lookup Table in TDG 018

(a) the vertical distance between the subsurface exposure point and the sample location is assumed to be essentially zero (0.01 ft)

Tennessee Soil Gas Lookup Table

Enter the vertical distance (in feet) **from the crawlspace floor or slab to the sample point**, or the horizontal distance from the basement wall to the sample point.

0.01

Benzene Soil Gas Limits				
Receptor/Foundation Type	µg/m³	ppbv	ppmv	Sample Depth
Commercial (Slab)	8738	2685	2.68	0.01ft (0.003m)
Residential (Slab)	1244	382	0.38	
Commercial (Basement/Crawlspace)	821	252	0.25	
Residential (Basement/Crawlspace)	191	59	0.06	
Commercial (Basement/Slab)	5397	1658	1.66	
Residential (Basement/Slab)	731	225	0.22	

Toluene Soil Gas Limits				
Receptor/Foundation Type	µg/m³	ppbv	ppmv	Sample Depth
Commercial (Slab)	996173	306083	306.08	0.01ft (0.003m)
Residential (Slab)	84911	26090	26.09	
Commercial (Basement/Crawlspace)	101866	31299	31.30	
Residential (Basement/Crawlspace)	13442	4130	4.13	
Commercial (Basement/Slab)	648237	199177	199.18	
Residential (Basement/Slab)	25091	7709	7.71	

Ethylbenzene Soil Gas Limits				
Receptor/Foundation Type	µg/m³	ppbv	ppmv	Sample Depth
Commercial (Slab)	2628590	807658	807.66	0.01ft (0.003m)
Residential (Slab)	237924	73104	73.10	
Commercial (Basement/Crawlspace)	298506	91719	91.72	
Residential (Basement/Crawlspace)	39326	12083	12.08	
Commercial (Basement/Slab)	1817914	558570	558.57	
Residential (Basement/Slab)	73038	22442	22.44	

Xylenes Soil Gas Limits				
Receptor/Foundation Type	µg/m³	ppbv	ppmv	Sample Depth
Commercial (Slab)	779165	239405	239.41	0.01ft (0.003m)
Residential (Slab)	72460	22264	22.26	
Commercial (Basement/Crawlspace)	93060	28593	28.59	
Residential (Basement/Crawlspace)	12247	3763	3.76	
Commercial (Basement/Slab)	554053	170238	170.24	
Residential (Basement/Slab)	22684	6970	6.97	

MtBE Soil Gas Limits				
Receptor/Foundation Type	µg/m³	ppbv	ppmv	Sample Depth
Commercial (Slab)	7788208	2392997	2393.00	0.01ft (0.003m)
Residential (Slab)	594606	182698	182.70	
Commercial (Basement/Crawlspace)	670568	206038	206.04	
Residential (Basement/Crawlspace)	88463	27181	27.18	
Commercial (Basement/Slab)	4547344	1397212	1397.21	
Residential (Basement/Slab)	166240	51079	51.08	

Effective Diffusion Coefficient through Foundation Cracks						
D^{eff}_{crack} = D_{crack}*3600sec/hr/10000cm^2/m^2	Benzene	Toluene	Et.benzene	Xylenes	MtBE	Naphthalene
	0.003368628	0.003078827	0.002752818	0.002607944	0.003695169	0.002608392

Child		
	Dcrack	C_{indoor}(ug/m^3)
Benzene	0.009357299	3.52
Toluene	0.008552297	228
Et. Benz	0.007646716	601
Xylenes	0.007244289	178
MtBE	0.010264359	1780
Naph	0.007245534	83

Worker		
	Dcrack	C_{indoor}(ug/m^3)
Benzene	0.009357299	7.44
Toluene	0.008552297	848
Et. Benz	0.007646716	2237
Xylenes	0.007244289	663
MtBE	0.010264359	6633
Naph	0.007245534	309

Equation to CalculateTennessee Alpha Factors for Vapor Intrusion

$$\alpha = \frac{\left[\frac{D_T^{eff} A_B}{Q_B L_T}\right] \exp\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff} \eta A_B}\right)}{\exp\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff} \eta A_B}\right) + \left[\frac{D_T^{eff} A_B}{Q_B L_T}\right] + \left[\frac{D_T^{eff} A_B}{Q_{soil} L_T}\right]\left(\exp\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff} \eta A_B}\right) - 1\right)}$$

$$C_{indoor\ air} = \alpha_{SG} \times C_{soil\ gas}$$

Building Terms:

A_B is the area of the enclosed space that is in contact with soil [m^2]. This includes both floor and wall-space that contacts the subsurface.

Q_B is the building ventilation rate [m^3hr^{-1}], which is usually estimated to be the product of the enclosed-space volume (V_B [m^3]) and the indoor air exchange rate with outdoor air (E_B [hr^{-1}]).

L_T is the distance (depth) from the bottom of the foundation to the vapor source (for soil gas contamination) or water table (for groundwater contamination) [m].

η is the fraction of the enclosed space surface area open to vapor intrusion [unitless].

Subsurface Terms:

Q_{soil} is the pressure-driven soil gas flow rate into the building [L/min].

D_T^{eff} is the effective diffusion coefficient through the unsaturated zone (for soil gas contamination) or through both the capillary and unsaturated zones (for groundwater contamination).

D_{crack}^{eff} is the effective diffusion coefficient through the foundation cracks. It is assumed that the foundation cracks are dry, therefore D_{crack}^{eff} is set equal to D_T^{eff}.

Variables Used

$A_B = 1500ft^2(139.35m^2)$

$Q_B = (171.25m^3/hr)$(Residential)

$Q_B = (351.68m^3/hr)$(Commercial)

$V_B = 12000ft^3(339.79m^3)$(Residential)

$V_B = 15000ft^3(424.74m^3)$(Commercial)

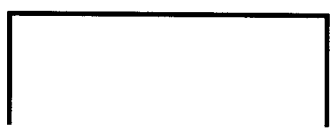
$E_B = 0.504/hr$(Residential)

$E_B = 0.828/hr$(Commercial)

L_T = Sample Depth(meters)

$\eta = 0.01$(Commercial/Slab)

η = 0.1(Residential/Slab)
η = 1(Commercial,Basement/Crawlspace)
η = 1(Residential,Basement/Crawlspace)
η = 0.1(Commercial,Basement/Slab)
η = 0.5(Residential,Basement/Slab)
Q_{soil} = 5L/min(0.3m^3/hr)
L_{crack} = 15cm(0.15m)



Comment Response to Review of Daniels Drive Soils Gas Data

Comment 1:

Samantha notes in her EPA screening memo that benzene slightly exceeds the screening level in one sample, but concludes no additional investigation is needed. Why? She does not explain why an exceedance is of no concern.

Response 1:

There are several reasons why further action may not be warranted based on the single benzene soil gas exceedence:

- There is a single exceedance above the screening level and the excedeence is negligible (38 vs. 31 $\mu g/m^3$).
- The selected screening level used is based on a target risk in the middle of the acceptable risk range, e.g. it is based on a 1E-05 risk, or the center of the 1E-06 to 1E-04 acceptable risk range. If the screening level was based on the 1E-04 risk it would be 310 $\mu g/m^3$ instead of 31 $\mu g/m^3$ and this detection would not be an exceedance. The use of the 1E-05 screen gives risk managers some leeway for decision-making.

Although this decision should be left to the risk managers, the combination of these two factors suggests that overall the benzene vapor intrusion pathway is not of primary concern.

Comment 2:

Samantha notes that 1,3-butadiene is not a constituent of concern at the site, but gives no reason why. We stated in the report that it is not a COC, but I think Samantha needs to either formally agree with our explanation or explain why TDEC has reached the same conclusion because 1,3-butadiene exceeds the EPA screening level.

Response 2:

1,3-butadiene is a chemical most-often associated with the synthetic rubber industry. It exists as either a colorless gas or a refrigerated liquid. The atmospheric half-life for 1,3-butadience is very short (4-6 hours) so in order for butadiene to be a sustained presence in the soil gas there would need to be a significant primary source of the chemical nearby.

The butadiene screening level is actually lower then the detection limit the lab was able to consistently attain which adds analytical uncertainty. The "exceedances" were within the range of the other results that were "non-detect". The 9.3 $\mu g/m^3$ detection is particularly questionable since it is lower then most non-detects in the study.

The low screening level is a result of a very high Henry's Law Constant (7.3E-02 atm-m3/mole) and a high inhalation unit risk used in the screening level development model. The selected screening level based on a 1E-05 risk allows risk managers some flexibility in determining a path forward.

We recommend that the State review any analytical QC information on this analyte and identify if there is a valid source for butadiene in the area.

Comment 3:

Samantha notes that the shallow and deep samples at SG-2 show counterintuitive results – i.e., the concentrations in the shallow sample are greater than those in the deep sample. We noted

this in our preliminary report because it appears the deep sample was invalid. But she does not accept our explanation – she only provides possible alternatives and makes no conclusions/recommendations about whether this is acceptable or whether additional data are needed.

Response 3:

SAIC does not see where the report indicates "the deep sample was invalid". We do see a statement: 'One sample, from SG-2 at 10 feet, contained no detected concentrations of VOC. The reason for this non-detection is unknown. The SUMMA canister and sampling train appeared to function properly in the field". If the deep sample was invalid we strike our comment that the situation is a conceptual model anomaly.

The SG-2 sample location is associated with both the slight exceedance of benzene and butadience and the question about the deeper sample results.

Comment 4:

A table based on the EPA OSWER guidance was included in Samantha's TDUST memo. This table apparently doesn't belong and would only raise more questions.

Response 4:

Agreed. This table will be removed.