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Fremont State Street Center, LLC
c/o SummerHill Homes LLC
3000 Executive Parkway, Suite 450
San Ramon, CA 94583

November 9, 2016

Alameda County Environmental Health
1131 Harbor Bay Parkway
Alameda, CA 94502
Attention: Mr. Mark Detterman, PG, CEG

Subject: **Revised Human Health Risk Evaluation of Subsurface Data**
39155 and 39183 State Street, Fremont, California

Dear Mr. Detterman:

Submitted herewith for your review is the *Revised Human Health Risk Evaluation of Subsurface Data, 39155 and 39183 State Street, Fremont, California* prepared by The Source Group, Inc., a division of Apex Companies LLC dated November 7, 2016.

I declare, under penalty of perjury, that the information and/or recommendations contained in the attached document are true and correct to the best of my knowledge.

Very truly yours,

Katia Kamangar

Katia Kamangar
Executive Vice President

APEX
Apex Companies, LLC
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November 7, 2016

Ms. Denise Cunningham
SummerHill Homes
3000 Executive Pkwy, Suite 450
San Ramon, CA 94583

Subject: Revised Human Health Risk Evaluation of Subsurface Data
39155 and 39183 State Street, Fremont, California

Dear Ms. Cunningham:

The Source Group, Inc. (SGI), a division of Apex Companies, LLC, has reviewed the data collected during previous site investigations for the property at 39155 and 39183 State Street in Fremont, California (the Site). The data was reviewed with a focus on aspects of the investigations that may influence human health. Apex's review included the following reports prepared by PES Environmental, Inc. (PES) and previously submitted to Alameda County Environmental Health (ACEH):

- *Report of Results, Subsurface Investigation, 39155 and 39183 State Street, Fremont, California*, dated February 12, 2015 (PES, 2015);
- *Vapor Mitigation System, Basis of Design Report, State Street Center, Fremont, California*, dated March 24, 2016 (PES, 2016b); and
- *Addendum – Contour Maps, Vapor Mitigation System Design Drawings and Specifications, State Street Center, Fremont, California*, dated July 7, 2016 (PES, 2016c).

The *Human Health Risk Evaluation of Subsurface Data* report, dated August 12, 2016, was submitted to and reviewed by ACEH. Based on comments from ACEH on the risk evaluation, this *Revised Human Health Risk Evaluation of Subsurface Data* was prepared to incorporate the following:

- A sensitivity analysis on the soil characteristics used as inputs in the vapor intrusion model (Attachment A);
- A letter from Mr. Ross Steenson of the California Regional Water Quality Control Board (RWQCB) supporting the use of loamy sand in the vapor intrusion model and supporting benzene concentrations above the published or site-specific screening levels, with the presence of low total petroleum hydrocarbon concentrations in soil and sufficient oxygen in the vadose zone (Attachment B);
- Evaluation of the adequacy of previous pesticide sampling and analysis in soil; and
- Evaluation of potential vinyl chloride impacts by including site-specific screening levels for vinyl chloride.

SITE LAND USE

The Site is approximately 6 acres in size and was formerly occupied by a Nob Hill grocery store and Payless drug store building. This building was demolished in 2001. The southern corner of the Site formerly included a building (Nation's Giant Hamburgers) with associated parking and landscape areas, which were removed in 2016. Currently, the Site is vacant and all pavements have been removed. The planned redevelopment of the Site includes grading and soil excavation for utilities and construction of a mixed use residential and retail project with 157 residential dwelling units and approximately 21,000 square feet of retail area. As described by PES (2016b), approximately 50 percent of the residences will be on-grade townhomes, the rest are podium townhomes and flats. The northwestern portion of the Site will include subgrade parking lots beneath the commercial retail/residential buildings. The two commercial retail/residential buildings (Building A and Building B) will include elevator shafts that extend into the subsurface. The surrounding area will contain roadways with associated landscaping.

DATA EVALUATION

As discussed in the above referenced reports prepared by PES, soil and soil vapor data were collected during previous investigations. Soil samples were analyzed for organochlorine pesticides (OCPs), lead, arsenic, and volatile organic compounds (VOCs) and/or total petroleum hydrocarbons (TPH). Soil vapor samples were analyzed for VOCs. During previous investigations, PES attempted to collect groundwater samples by advancing soil borings until the drill rig hit refusal at approximately 45 feet below ground surface (bgs). Consequently, no groundwater samples were collected at the Site.

Nine borings were completed by PES on the approximately 6 acre site for the purpose of soil sampling for pesticide analysis (i.e., organochlorine pesticides ([OCPs], arsenic, and lead). Samples were collected from 1 to 2 feet bgs and 3 to 4 feet bgs from each boring, which generally corresponds to the tilling zone of the former agricultural use of the property. For each boring the shallow soil sample was analyzed, and if detections above screening levels were identified, then the deeper soil sample was also analyzed. Fifteen soil samples were analyzed for OCPs. Nine soil samples were analyzed for arsenic and lead. Six of the borings (B1, B3, B5, B6, B7, and B8) were sited at representative locations across the property that correspond to future residential building footprints; two borings were located within the footprints of the podium Buildings A and B (B11 and B12); one boring B13 was located within the future Memorial Street. DTSC sampling guidance for agricultural properties (DTSC, 2008) recommends for a 6 acre site, a total of 12 borings and the analysis of 4 composite samples for OCPs and four discrete samples for arsenic. Although a lower number of borings were completed (9), the total number of samples analyzed for OCPs was 15, with 9 of the samples collected from the shallow soil zone, where typically the highest concentrations of pesticides are found on former agricultural properties. The total number of arsenic samples was 9. More than double the number of samples specified in the DTSC sampling guidance were analyzed and all of the OCP samples were discrete samples, which are not susceptible to the potential dilution that can be encountered with composite samples. Consequently, there was adequate and sufficient testing of pesticide residues for this former agricultural site.

The results from the soil and soil vapor investigations were compared with San Francisco Bay Regional Water Quality Control Board ESLs (SFRWQCB, 2016). These ESLs represent conservative screening values below which adverse effects on human health are not expected to occur. The ESLs are currently available for resident and commercial/industrial worker receptors potentially exposed to chemicals via inhalation of vapor in indoor air exposure pathways, and for the resident, commercial/industrial worker, and construction worker receptors potentially exposed to chemicals via direct contact exposure pathways (i.e., ingestion, dermal contact, and inhalation of dust/vapor in outdoor air). The risk-based ESLs correspond to an excess cancer risk of 1×10^{-6} or a hazard quotient of 1, based on standardized equations (SFRWQCB, 2016) that combine exposure assumptions with agency-derived toxicity data.

Soil ESLs

The SFRWQCB soil ESLs include a broad scope of screening levels. The SFRWQCB Tier 1 soil ESLs represent the lowest value of the risk-based and non-risk-based screening levels. The non-risk-based soil ESLs address the following environmental protection goals:

- Protection against leaching to groundwater;
- Protection of gross contamination; and
- Protection against adverse nuisance conditions (i.e., taste and odor thresholds).

The soil ESLs for protection against leaching to groundwater are not appropriate for use at the Site. The potential for chemicals to leach from soil depends on the physical and chemical properties of the chemicals, the chemical concentration, soil type, pH (for metals), and other Site-specific conditions. For example, chemicals with high water solubilities tend to leach more readily than chemicals with lower solubilities. In addition, a chemical's Koc is important for assessing the degree of chemical sorption to soil particles; chemicals with a high sorption potential do not tend to leach as readily (i.e., metals and pesticides). Site-specific conditions are also important for assessing whether leaching may occur, such as soil type (leaching occurs more readily in sandy soils than in clayey or silty soils), amount of rainfall, gradient, etc. Based on the boring logs provided in the Geotechnical Investigation prepared by Rockridge Geotechnical (Rockridge, 2015), the soil type in the vadose zone to 30 feet bgs is predominately silts and clays (Attachment C). In addition, other competing migration pathways can affect the tendency of a chemical to leach. Based on the following reasons the leaching of contaminants in the vadose zone into groundwater was not considered a significant exposure pathway:

- Metals and pesticides in soil are expected to adsorb to soil particles (especially clay), become immobile, and not leach;
- Limited VOC concentrations detected in soil within the vadose zone of the onsite area. Acetone was the only VOC detected in near surface soil at 1 to 2 feet bgs; and
- Groundwater was not encountered at recently investigated depths of 45 feet bgs (PES, 2015). Based on boring logs the upper 30 feet of vadose zone beneath the Site is predominately silts and clays, which will limit the leaching potential of any constituents detected on-site.

Therefore, the soil ESLs for protection against leaching to groundwater were not considered in the selection of appropriate soil ESLs for the Site.

In general, gross contamination levels and nuisance levels are greater than the risk-based levels and are not expected to drive any risk management decisions. However, protection against adverse nuisance conditions (i.e., taste and odor) was considered in the selection of appropriate soil ESLs.

Unlike most compounds, the soil screening levels for arsenic and lead are not derived from typical standardized equations. At many sites, the presence of arsenic in soil is due to naturally occurring background concentrations. Therefore, a regional background level of 11 milligrams per kilogram (mg/kg; Duvergé, 2011) is used as the appropriate soil screening level for arsenic. The soil screening level for lead is based on a blood lead model developed by the Office of Health Hazard Assessment (OEHHA) and the Department of Toxic Substances Control (DTSC) leadspread model (SFRWQCB, 2016; DTSC, 2016). The residential soil screening level for lead is 80 mg/kg, based on exposure to a child resident. The commercial soil screening level for lead is 320 mg/kg, based on exposure to a pregnant adult worker.

SFRWQCB soil ESLs for the construction worker receptor are included in the event any construction or redevelopment occurs at the Site. The following table summarizes the appropriate SFRWQCB soil ESLs for chemicals detected at the Site:

Chemical	**SFRWQCB Soil ESL**		
	Residential	**Commercial**	**Construction**
Arsenic	11 mg/kg		
Lead	80 mg/kg	320 mg/kg	160 mg/kg
Endrin	2,700 µg/kg	2,700 µg/kg	2,700 µg/kg
Dichlorodiphenyldichloroethane (DDD)	2,700 µg/kg	12,000 µg/kg	81,000 µg/kg
Dichlorodiphenyldichloroethene (DDE)	1,900 µg/kg	8,500 µg/kg	57,000 µg/kg
Dichlorodiphenyltrichloroethane (DDT)	1,900 µg/kg	4,300 µg/kg	4,300 µg/kg
Dieldrin	38 µg/kg	170 µg/kg	1,100 µg/kg
Heptachlor Epoxide	67 µg/kg	300 µg/kg	1,900 µg/kg
Alpha-Chlordane	480 µg/kg	2,200 µg/kg	14,000 µg/kg
Acetone	500,000 µg/kg	1,000,000 µg/kg	1,000,000 µg/kg
TPH as diesel (TPH-d)	230 mg/kg	1,000 mg/kg	880 mg/kg
TPH as motor oil (TPH-mo)	5,100 mg/kg	5,100 mg/kg	5,100 mg/kg

mg/kg = milligram per kilogram
µg/kg = microgram per kilogram

Soil Vapor ESLs

The SFRWQCB soil vapor ESLs are calculated by dividing the indoor air screening level by the DTSC default attenuation factors of 0.002 and 0.001 for existing residential and commercial building type, respectively (SFRWQCB, 2016; DTSC, 2011). The SFRWQCB soil vapor ESLs for residential and commercial land use are presented in the table below.

Soil Vapor Site-Specific Screening Levels (SLs)

Although the DTSC default attenuation factors are designated for use with current and future building scenarios, these attenuation factors do not specifically take into account subsurface soil conditions and may be conservative for sites with less permeable vadose zone conditions (i.e., silts and clays). Most of the onsite soil vapor samples were collected at approximately 5 feet bgs, with the exception of four soil vapor samples collected at 25 feet bgs (approximate depth of future elevator shafts). Nine offsite soil vapor samples were collected at 9 feet bgs (approximate depth of existing sewer lateral in State Street). Based on the geotechnical investigation conducted by Rockridge (2015), soil within the vadose zone is generally silts and clays (Attachment C). Rockridge (2015) describes the subsurface conditions as:

> …the Site is blanketed by stiff to hard clay with varying sand content that extends to depths ranging from approximately 5 to 11-1/2 feet bgs…Beneath the surficial clay layer are heterogeneous alluvial deposits consisting of loose to very dense silty sand, medium dense to

very dense sand with varying gravel content, medium dense clayey sand, stiff to very stiff, non-plastic sandy silt, and stiff to very stiff clay with varying sand content.

With Site conditions more reflective of less permeable silts and clays, the SFRWQCB soil vapor ESLs based on DTSC default attenuation factors (based on coarser grained soils) likely further overestimate the migration and transport from soil vapor to indoor air for this Site (i.e., DTSC default attenuation factors result in higher estimated indoor air concentrations than indoor air concentrations based on site-specific attenuation factors that reflect less permeable soils). Therefore, the DTSC modified version of the Johnson and Ettinger (1991; J/E) model (DTSC, 2014) was used to estimate Site-specific screening levels (SLs) that take into account Site-specific geotechnical data.

Using DTSC default soil properties for loamy sand and sandy clay loam, Site-specific SLs were estimated for the residential and commercial exposure scenarios for VOCs detected at the Site and 5 additional VOCs not detected above the reporting limits in soil vapor (carbon tetrachloride, 1,2-dichloroethane, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, and vinyl chloride). Assuming the vadose zone consists of loamy sand, Tables 1 and 2 present the Site-specific SLs for residential and commercial exposure scenarios, respectively. Assuming the vadose zone consists of sandy clay loam, Tables 3 and 4 present the Site-specific SLs for residential and commercial exposure scenarios, respectively. The methods used to develop the Site-specific SLs for loamy sand soil and sandy clay loam soil are described in Attachments A and D, respectively. The following table summarizes the SFRWQCB soil vapor ESLs and Site-specific SLs for VOCs detected at the Site:

Chemical	**SFRWQCB Soil Vapor ESL**		**Site-Specific SLs* Loamy Sand**		**Site-Specific SLs* Sandy Clay Loam**	
	Residential (µg/m³)	**Commercial** (µg/m³)	**Residential** (µg/m³)	**Commercial** (µg/m³)	**Residential** (µg/m³)	**Commercial** (µg/m³)
Tetrachloroethene (PCE)	240	2,100	500	4,400	960	8,400
Benzene	48	420	76	660	130	1,100
Toluene	160,000	1,300,000	260,000	2,200,000	460,000	3,800,000
Ethylbenzene	560	4,900	1,000	8,800	1,800	16,000
m,p-Xylene	52,000	440,000	93,000	780,000	170,000	1,400,000
o-Xylene	52,000	440,000	93,000	780,000	170,000	1,400,000
Trichlorofluoromethane (Freon 11)	Not available	Not available	670,000	5,600,000	1,200,000	10,000,000
Dichlorodifluoromethane (Freon 12)	Not available	Not available	88,000	740,000	150,000	1,300,000
Chloroform	61	530	100	900	180	1,600
Carbon Tetrachloride	33	290	66	580	120	1,100
1,2-Dichloroethane	54	470	86	750	150	1,300
1,1,2-Trichloroethane	88	770	160	1,400	290	2,500
1,1,2,2-Tetrachloroethane	24	210	53	460	100	880
Vinyl Chloride	4.7	160	26	230	42	370

µg/m³ = microgram per cubic meter
* = Site-specific screening levels represent rounded values to two significant figures, consistent with SFRWQCB ESLs.

SCREENING LEVEL RISK EVALUATION

The screening level risk evaluation is based on the soil and soil vapor data from previous Site investigations as summarized by PES in the *Vapor Mitigation System, Basis of Design Report, State Street Center, Fremont, California*, dated March 24, 2016 (PES, 2016b).

Soil

Arsenic and lead were detected in 10 of 10 soil samples collected at approximately 1 to 2 feet bgs. The maximum detected arsenic concentration of 8.2 mg/kg in soil sample B6-1.0-2.0 is below the San Francisco Bay regional background value of 11 mg/kg (Duvergé, 2011). Therefore, arsenic does not pose a potential risk to human health beyond background levels. The maximum detected lead concentration of 13 mg/kg is below the SFRWQCB soil ESLs for all receptors; therefore, lead does not pose a potential risk to human health at the Site.

Organochlorine pesticides were detected in 10 of 16 soil samples collected at approximately 1 to 2 feet bgs or 3 to 4 feet bgs. The maximum detected concentrations of the seven pesticides detected in soil were below their respective SFRWQCB soil ESLs for all receptors; therefore, pesticides do not pose a potential risk to human health at the Site.

Acetone was the only VOC detected in soil. It was detected in 2 of 21 soil samples collected at approximately 1 to 2 feet bgs or 3 to 4 feet bgs. No VOCs were detected in the deep soil sample (B50) collected at approximately 9 to 10 feet bgs. The maximum detected acetone concentration of 130 µg/kg is below the SFRWQCB soil ESLs for all receptors; therefore, acetone does not pose a potential risk to human health at the Site.

TPH as gasoline (TPH-g), TPH as diesel (TPH-d), and TPH as motor oil (TPH-mo) were analyzed by the laboratory with and without silica gel cleanup (SGC). In accordance with SFRWQCB (2016) guidance, the results from the extractable TPH analyses without SGC were compared with the SFRWQCB ESL. TPH-g was not detected above the laboratory reporting limit. The maximum detected concentrations of TPH-d (190 mg/kg) and TPH-mo (1,400 mg/kg) are below their respective SFRWQCB soil ESLs for all receptors; therefore, TPH does not pose a potential risk to human health at the Site.

Soil Vapor

This screening level risk evaluation is based on comparison of soil vapor data with Site-specific SLs, where the vadose zone is assumed to be sandy clay loam.

During previous onsite soil vapor investigations, nine VOCs were detected in soil vapor collected at approximately 5 feet bgs. Of these nine VOCs, only PCE and benzene were detected at concentrations above their respective Site-specific SL. PCE was detected at concentrations above the residential Site-specific SL of 960 $\mu g/m^3$ at four soil vapor sample locations (B21, B30, B55, and B56), which were located in the northeast portion of the Site adjacent to State Street. Soil vapor sample B21 was collected in December 2014, sample B30 was collected in January 2015, and samples B55 and B56 were collected in February 2016 immediately adjacent to locations of B21 and B30. Only PCE was detected at concentrations above the commercial Site-specific SL of 8,400 $\mu g/m^3$ at only one soil vapor sample location (B21). However, subsequent soil vapor sampling near this location at soil vapor location B56 only detected PCE at 1,300 $\mu g/m^3$. Benzene was detected at concentrations above the residential Site-specific SL at only two soil vapor sample locations (B4 and B47), which were located in the southern portion of the Site. Soil vapor sample B4 was collected in October 2014 and sample B47 was collected in September 2015 near the locations of B4. Benzene was not detected at concentrations above the commercial Site-specific SL.

During the September 2015 soil vapor investigation, oxygen concentrations were measured in five soil gas samples collected from borings B44 through B47, and B50. The oxygen results ranged from 14 to 21 percent oxygen by volume. These results were presented in the memorandum titled *Report of Results, Supplemental Subsurface Investigation*, dated October 20, 2015. In accordance with the letter prepared by Mr. Ross Steenson of the RWQCB (Attachment B) and the Low-Threat Underground Storage Tank Case Closure Policy (LTCP; State

Water Resource Control Board [SWRCB], 2012), if a bioattenuation zone is present, allowable benzene concentrations can exceed ESLs and Site-specific SLs. According to the LTCP (SWRCB, 2012), general criterion for a bioattenuation zone include the following:

(1) A minimum of five vertical feet of soil from surface to soil vapor measurement – Soil vapor samples in benzene impacted area in the southern portion of the Site (B4, B44 through B47) were collected at five feet bgs.

(2) TPH (TPH-g + TPH-d) less than 100 mg/kg in at least two depths within the five-foot zone – TPH in soil was analyzed by the laboratory at two depths (approximately 1 to 2 feet bgs and 3 to 4 feet bgs) in borings B44 through B47. TPH-g was not detected above the laboratory reporting limit. TPH-d (without SGC) was detected in all eight soil samples. TPH-d was detected in only two of the eight soil samples at concentrations slightly above 100 mg/kg. TPH-d concentrations, at approximately 1 to 2 feet bgs, in samples B44 and B47 were 190 mg/kg and 170 mg/kg, respectively. TPH-d concentrations in the remaining six soil samples, including the deeper soil samples are borings B44 and B47, ranged from 25 mg/kg to 59 mg/kg. Although TPH-d concentrations in two shallow soil samples were greater than 100 mg/kg, this localized area of benzene impacts in the southern portion of the Site was planned for excavation (PES, 2016a). The planned excavation was implemented in July and August 2016. The remedial excavation and subsequent confirmation sampling of this area documented that the soil conditions are well below appropriate screening levels (PES, 2016d).

(3) Oxygen content greater than 4% at the bottom of the five-foot zone – Oxygen content was measured in soil vapor samples in benzene impacted area in the southern portion of the Site (B4, B44 through B47) at a depth of five feet.

The data at this Site generally meet the criterion for a bioattenuation zone. As a result, application of a 1,000-fold bioattenuation factor is acceptable and increases the ESLs and Site-specific SLs by three orders of magnitude. Screening levels for benzene in soil vapor with a bioattenuation zone are presented in the table below. Although 48,000 μg/m^3 is a potentially acceptable soil vapor screening level for benzene in a residential scenario, to be conservative, 1,000 μg/m^3 was arbitrarily selected as a soil vapor screening level for benzene at this Site. In the RWQCB letter (Attachment B), Mr. Ross Steenson states, "…if a site has benzene soil gas concentrations less than 1,000 μg/m^3, sufficient oxygen, and low to non-detect concentrations of TPH [total petroleum hydrocarbons] in the upper five feet of soil, these conditions indicate benzene in soil gas poses no significant risk for a residential scenario (unrestricted)."

Chemical	**SFRWQCB Soil Vapor ESL**		**Site-Specific SLs* Loamy Sand**		**Site-Specific SLs* Sandy Clay Loam**	
	Residential (μg/m^3)	**Commercial** (μg/m^3)	**Residential** (μg/m^3)	**Commercial** (μg/m^3)	**Residential** (μg/m^3)	**Commercial** (μg/m^3)
Benzene	48	420	76	660	130	1,100
Benzene -TPH <100 mg/kg -Oxygen > 4% -bioattenuation factor of 1,000	48,000	420,000	76,000	660,000	130,000	1,100,000
Benzene -RWQCB (Attachment B)	**1,000**					

TPH concentrations in soil are low to non-detect and the maximum detected benzene concentration is 710 µg/m^3 in soil vapor sample B47, which had 15 percent oxygen by volume. Based on the above criterion and recommendations from RWQCB (Attachment B), benzene concentrations at the Site do not pose risk to future residential receptors for the proposed development.

During the February 2016 investigation (PES, 2016b), soil vapor borings B57 through B60 were advanced within the footprint of the planned elevator shafts in Buildings A and B. Soil vapor samples B57 through B60 were collected at approximately 25 feet bgs, which is approximately 5 feet below the proposed future elevator sump bottom. Currently available vapor intrusion models do not allow for the evaluation of multi-story building or elevator exposure scenarios. Therefore, this HHRA conservatively assumes that the future onsite resident and commercial worker receptors are located 5 feet above any detected VOC concentrations. No VOCs were detected at concentrations above the commercial Site-specific SLs. Only chloroform was detected at a concentration above the residential Site-specific SL at only one soil vapor sample location (B59), which is located in the northern portion of the Site. Chloroform was detected at a concentration of 190 µg/m^3, which is only slightly above the Site-specific SL of 180 µg/m^3 and well below the commercial Site-specific SL of 1,600 µg/m^3. In the duplicate sample, chloroform was detected at 180 µg/m^3, which is equal to the Site-specific SL. Using the same DTSC modified version of the J/E model (DTSC, 2014) that was used to estimate the Site-specific SLs (as described in Attachment E) for a residential exposure scenario (24 hours per day and 350 days per year for 26 years), with a soil vapor concentration of 190 µg/m^3 and an assumed soil vapor sampling depth below grade of 152 centimeters bgs (5 feet bgs), the hazard quotient (HQ) estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is equal to 1×10^{-6}, which is the most stringent end of CalEPA's risk management range of 1×10^{-6} to 1×10^{-4} (Attachment F). Generally, an excess cancer risk equal to or below 1×10^{-6} is acceptable for unrestricted or residential land use. Although an elevator shaft may represent a preferential pathway for vapors, exposure parameters in an elevator exposure scenario (e.g., 0.5 hours per day for 26 years) would be significantly less than the exposure parameters assumed for a long-term receptor (8 hours per day for 25 years for commercial worker receptor and 24 hours per day for 26 years for resident receptor). Therefore, chloroform in soil vapor volatilizing into indoor air within an elevator shaft does not pose a potential risk to human health at the Site.

During previous offsite soil vapor investigations, samples were collected along the existing sewer lateral in State Street. The offsite soil vapor samples were collected from approximately 9 feet bgs (approximate depth of sewer lateral). No structures are anticipated over the offsite soil vapor sample locations, since they are located within State Street and the sidewalk between the Site and State Street. However, for discussion purposes, the detected VOC concentrations were compared with Site-specific SLs. Only PCE was detected at concentrations above the residential Site-specific SL of 960 µg/m^3 at six offsite soil vapor sample locations. PCE was detected at concentrations above the commercial Site-specific SL of 8,400 µg/m^3 at two offsite soil vapor sample locations. The highest PCE concentrations were detected in the offsite soil vapor samples; however, PCE concentrations in soil vapor decrease as the offsite PCE plume migrates onto the northern portion of the Site (PES, 2016c).

EVALUATION OF POTENTIAL VAPOR IMPACTS IN OUTDOOR AIR

Inhalation of VOCs in outdoor air is generally negligible due to dispersion; therefore, inhalation of VOCs in outdoor air is generally not considered a significant exposure pathway. However, the planned redevelopment of the Site includes a limited open area that will be covered with a paver system. The planned paver system will be approximately 5,000 square feet and is adjacent to the PCE plume in soil vapor (See Plate 1 of PES memorandum titled *Basis for Site Remedy*, dated August 19, 2016). At the request of ACEH, inhalation of VOCs in outdoor air for the future onsite resident and commercial worker receptors at the Site was evaluated for the open area covered with a paver system. Currently available fate and transport models do not allow for the evaluation of vapor emissions through a paver system. Therefore, this outdoor air evaluation conservatively assumes that the future onsite receptors are located directly above maximum detected VOC concentrations detected onsite without any barrier on the ground surface. The methodology for fate and transport modeling used to estimate exposure point concentrations (EPCs) in outdoor air resulting from volatilization of VOCs from subsurface sources is provided in Attachment E. The model-derived outdoor air EPCs were used to estimate noncancer adverse health effects and excess cancer risks from assumed exposure to VOCs migrating from soil vapor to outdoor air. The outdoor air EPCs are presented in Table E1 of Attachment E. Although the proposed development may also include commercial/retail workers, the estimated risks for these occupational receptors would be even less than the estimated risks for a resident receptor. Consequently, this evaluation was conducted to estimate potential human health risks from VOCs in outdoor air for future onsite resident receptor.

Consistent with U.S. Environmental Protection Agency (USEPA, 1989; 1991) guidelines, the following general equations were used to estimate excess cancer risks and noncancer adverse health effects (expressed as a HQ):

For carcinogens: $$Risk = \frac{EPC_{outdoor\ air} x EF x ED x ET x IUR}{AT_c}$$

For noncarcinogens: $$HQ = \frac{EPC_{outdoor\ air} x EF x ED x ET x \frac{1}{RfC}}{AT_n}$$

Where:

$EPC_{outdoor\ air}$	=	*Chemical concentration in outdoor air ($EPC_{outdoor\ air}$; μg/m^3).*
EF	=	*Exposure frequency (350 days/year).*
ED	=	*Exposure duration (26 years).*
ET	=	*Exposure time (24 hours/day).*
AT	=	*Averaging time (hours).*
		For noncarcinogenic effects (hours), AT = ED x 365 days/year x 24 hours/day.
		For carcinogenic effects, AT (hours) = 70 years x 365 days/year x 24 hours/day.
IUR	=	*Inhalation unit risk for carcinogenic chemicals (μg/m^3)$^{-1}$.*
RfC	=	*Inhalation reference concentration for noncarcinogenic chemicals (μg/m^3).*

The noncancer hazard quotient (HQ) and excess cancer risk for VOCs in outdoor air were estimated by using the exposure factors presented above and toxicity values presented in Table 5 in the equations above. Exposure to multiple chemicals were evaluated by summing the HQs and excess cancer risks for each chemical, resulting in a hazard index (HI) and total excess cancer risk, respectively. Risk characterization of inhalation of VOCs volatilizing from soil vapor into outdoor air for the future onsite resident receptor is presented in Table 6. The spreadsheet containing the results of the fate and transport emission rate and box model is presented in Table E1 of Attachment E.

USEPA guidance on risk and exposure levels considered protective of human health is presented to provide context for interpretation of the HI and excess cancer risk estimates presented below. Hazard indices are compared to the USEPA and California Environmental Protection Agency (CalEPA) recommended target HI of one (USEPA, 1989). Excess cancer risks are compared to the CalEPA's risk management range of one-in-one-million (1×10^{-6}) to one-in-ten thousand (1×10^{-4}). The CalEPA threshold value of 1×10^{-6} represents the lower end (most stringent) of the CalEPA's risk management range and is the point of departure for risk management decisions for all receptors. The USEPA target excess cancer risk represent the incremental probability of an individual developing cancer over a lifetime as a result of chemical exposure. This probability is considered an excess cancer risk because the incidence of cancer from all sources other than chemicals associated with a site (i.e., background) are substantial.

Resident Exposure Pathway	HI	Excess Cancer Risk
Inhalation of VOCs Volatilizing from Soil Vapor into Outdoor Air	0.0007	3×10^{-8}

Site data indicate that the maximum detected VOC concentrations were located in different areas of the Site. However, this evaluation assumes the future onsite resident receptor resides over co-located maximum detected VOC concentrations in soil vapor. Therefore, the results of this evaluation overestimate actual risk.

Based on the maximum detected soil vapor concentrations onsite, the HI estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is below 1×10^{-6}, which is the most stringent end of CalEPA's risk management range of 1×10^{-6} to 1×10^{-4}. Generally, an excess cancer risk equal to or below 1×10^{-6} is acceptable for unrestricted or residential land use. Therefore, VOCs in soil vapor volatilizing into outdoor air do not pose a potential risk to human health at the Site.

SUMMARY AND CONCLUSIONS

The following summarizes the results of the human health risk evaluation for the Site:

- No metals, pesticides, VOCs, or TPH were detected at concentrations above the SFRWQCB soil ESLs for all receptors. Therefore, no adverse effects on human health are expected to occur from exposure to any residual impacts in soil.
- Near the northeast boundary of the Site adjacent to State Street, PCE was detected at concentrations above the residential Site-specific SL of 960 $\mu g/m^3$ at four soil vapor sample locations (B21, B30, B55, and B56). PCE was detected at concentrations above the commercial Site-specific SL of 8,400 $\mu g/m^3$ at only one soil vapor sample location (B21). However, subsequent soil vapor sampling near this location at soil vapor location B56 only detected PCE at 1,300 $\mu g/m^3$. Based on offsite soil vapor investigation data, the PCE concentrations detected in the northern portion of the Site are associated with an offsite source. Isoconcentration contour maps for PCE (PES, 2016c) indicate the soil vapor concentrations decrease as the offsite PCE plume migrates onto the northern portion of the Site (PES, 2016c). PCE is not detected in soil vapor in the central and southern portions of the Site.
- In the southern portion of the Site, near the former Nation's Giant Hamburgers building, benzene was detected at 510 $\mu g/m^3$ in soil vapor sample B4 and 710 $\mu g/m^3$ in soil vapor sample B47. These concentrations are above the residential Site-specific SL. Benzene concentrations in soil vapor are localized in the area immediately adjacent to soil vapor sample B4. Benzene was not detected above the commercial Site-specific SL in any soil vapor sample. Due to the presence of low to non-detect TPH concentrations in soil and high oxygen content in the vadose zone in the vicinity of sample locations B4 and B47, the benzene concentrations at the Site do not pose risk to future residential receptors for the proposed development (Attachment B).
- In the evaluation of soil vapor beneath the planned elevator shafts, only chloroform was detected at a concentration above the residential Site-specific SL. Chloroform was only detected at one soil vapor sample (B59), located in footprint of the planned elevator shaft in the northwestern portion of the Site. Chloroform was detected in sample B59 and duplicate sample at concentrations of 190 $\mu g/m^3$ and 180 $\mu g/m^3$, respectively. These concentrations are equal to or slightly above the Site-specific SL of 180 $\mu g/m^3$, and well below the commercial Site-specific SL of 1,600 $\mu g/m^3$. Although an elevator shaft may represent a preferential pathway for vapors, exposure parameters in an elevator exposure scenario (e.g., 0.5 hours per day for 26 years) would be significantly less than exposure parameters assumed in the development of the Site-specific SLs for a long-term receptor (8 hours per day for 25 years for

commercial worker receptor and 24 hours per day for 26 years for resident receptor). Regardless of the inherent conservativeness in assuming a long-term residential exposure for the elevator shaft scenario, using a soil vapor concentration of 190 $\mu g/m^3$ and an assumed soil vapor sampling depth below grade of 152 centimeters bgs (5 feet bgs), the resulting HQ estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is equal to 1×10^{-6}, which is the most stringent end of CalEPA's risk management range of 1×10^{-6} to 1×10^{-4}. Therefore, chloroform in soil vapor volatilizing into indoor air within an elevator shaft does not pose a potential risk to human health at the Site.

- Planned redevelopment of the Site, includes limited open area that will be covered with a paver system; therefore, inhalation of VOCs in outdoor air for the future onsite resident and commercial worker receptors at the Site was considered for these open areas. Without a regulatory-approved model for this scenario, this outdoor air evaluation conservatively assumes that the future onsite receptors are located directly above maximum detected VOC concentrations in soil vapor without any barrier on the ground surface (i.e. pavers). Additionally, although the VOCs impacts at the Site are not co-located, this model assumes the VOCs are co-located beneath the future onsite receptor. Regardless of the inherent conservativeness of this evaluation, the resulting HI estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is below 1×10^{-6}, which is the most stringent end of CalEPA's risk management range of 1×10^{-6} to 1×10^{-4}. Therefore, VOCs in soil vapor volatilizing into outdoor air do not pose a potential risk to human health at the Site.

The site remedy for the PCE, benzene, and chloroform impacted areas of the Site have been proposed to ACEH (PES, 2016a,b) to further reduce any potential risks to future onsite resident and commercial receptors.

Sincerely,
The Source Group, Inc.

Ivy Inouye
Senior Toxicologist

cc: Mr. Tom Graf, GrafCon
Mr. Carl J. Michelsen, PES Environmental, Inc.

Tables

Table 1 – Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Residential Exposure Scenario – Soil Classification as Loamy Sand

Table 2 – Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Commercial Exposure Scenario – Soil Classification as Loamy Sand

Table 3 - Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Residential Exposure Scenario – Soil Classification as Sandy Clay Loam

Table 4 - Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Commercial Exposure Scenario – Soil Classification as Sandy Clay Loam

Table 5 – Inhalation Toxicity Values

Table 6 – Risk Characterization for the Future Onsite Resident Receptor, Inhalation of Volatile Organic Compounds Volatilizing from Soil Vapor into Outdoor Air

Attachments

Attachment A – Vapor Intrusion Model Sensitivity Analysis

Attachment B – RWQCB Letter

Attachment C – Soil Geotechnical Data

Attachment D – Site-Specific Screening Levels for Soil Vapor

Attachment E – Fate and Transport for Vapor Emissions from Soil Vapor into Outdoor and Indoor Air

Table E1 – Estimation of Outdoor Air Concentrations from Volatile Organic Compounds Volatilizing from Soil Vapor

Attachment E1 - DTSC J/E Model for Subsurface Vapor Intrusion into Buildings for the Residential Exposure Scenario, Loamy Sand

Attachment E2 - DTSC J/E Model for Subsurface Vapor Intrusion into Buildings for the Commercial Exposure Scenario, Loamy Sand

Attachment E3 - DTSC J/E Model for Subsurface Vapor Intrusion into Buildings for the Residential Exposure Scenario, Sandy Clay Loam

Attachment E4 - DTSC J/E Model for Subsurface Vapor Intrusion into Buildings for the Commercial Exposure Scenario, Sandy Clay Loam

Attachment F – Fate and Transport for Vapor Emissions of Chloroform from Soil Vapor into Indoor Air (Elevator Shaft Scenario) - DTSC J/E Model for Subsurface Vapor Intrusion into Buildings for the Residential Exposure Scenario

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TABLES

Table 1
Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Residential Exposure Scenario - Soil Classification as Loamy Sand
39155 and 39183 State Street
Fremont, California

Volatile Organic Compounds (VOCs) Detected in Soil Vapor	Soil Vapor	Indoor Air[2]		Cancer Risk	Noncancer Hazard Index	Site-Specific Screening Level (SL)		
	$EPC_{soil\ vapor}$[1] (µg/m^3)	Soil Vapor to Indoor Air Attenuation Factor (unitless)	$EPC_{indoor\ air}$ (µg/m^3)	(unitless)	(unitless)	Soil Vapor SL Based on Carcinogenic Effects[3] (µg/m^3)	Soil Vapor SL Based on Nonarcinogenic Effects[4] (µg/m^3)	Lowest Soil Vapor SL[5] (µg/m^3)
Tetrachloroethene	8,500	9.4E-04	7.95E+00	1.7E-05	2.2E-01	509	39,022	509
Benzene	710	1.3E-03	9.10E-01	9.4E-06	2.9E-01	76	2,440	76
Toluene	1,500	1.2E-03	1.79E+00	NA	5.7E-03	NA	261,650	261,650
Ethylbenzene	280	1.1E-03	3.13E-01	2.8E-07	3.0E-04	1,005	933,292	1,005
m,p-Xylene	1,100	1.1E-03	1.23E+00	NA	1.2E-02	NA	93,403	93,403
o-Xylene	350	1.1E-03	3.93E-01	NA	3.8E-03	NA	92,993	92,993
Freon 11	2,300	1.1E-03	2.50E+00	NA	3.4E-03	NA	670,262	670,262
Freon 12	6,400	1.2E-03	7.56E+00	NA	7.3E-02	NA	88,263	88,263
Chloroform	160	1.2E-03	1.90E-01	1.6E-06	1.9E-03	103	85,977	103
Carbon Tetrachloride	ND<100	1.0E-03	1.01E-01	1.5E-06	2.4E-03	66	41,367	66
1,2-Dichloroethane	ND<100	1.3E-03	1.26E-01	1.2E-06	1.7E-02	86	5,815	86
1,1,2-Trichloroethane	ND<100	1.1E-03	1.10E-01	6.3E-07	5.3E-01	159	189	159
1,1,2,2-Tetrachloroethane	ND<100	9.2E-04	9.17E-02	1.9E-06	1.3E-03	53	79,564	53
Vinyl Chloride	ND<100	1.4E-03	1.39E-01	3.9E-06	1.3E-03	26	74,954	26

Notes:
bgs = below ground surface.
EPC = exposure point concentration.
SL = screening level.
µg/m^3 = micrograms per cubic meter.

[1] Represents the maximum detected concentration for onsite soil vapor samples (3 purge volumes) collected from 0 to 10 feet bgs. Note: All maximum detected concentrations were detected at 5 feet bgs.
Carbon tetrachloride, 1,2-dichloroethane, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, and vinyl chloride were not detected above the laboratory reporting limit of 100 µg/m^3. Therefore, the reporting limit was used as the EPC.
[2] EPCs in soil vapor ($EPC_{soil\ vapor}$) were coupled with vapor intrusion model to estimate attenuation factors, EPCs in indoor air, cancer risk, and noncancer hazard index for residential scenario.
[3] Represents the Site-specfic SL for carcinogenic effects, based on a target excess cancer risk of one-in-one million (1 x 10^{-6}).
Soil Vapor SL (Carcinogenic Effects) for compound i = Soil Vapor EPC_i x Target Cancer Risk of 1 x 10^{-6} / Cancer $Risk_i$
[4] Represents the Site-specific SL for noncarcinogenic effects, based on a target hazard quotient of one (1).
Soil Vapor SL (Noncarcinogenic Effects) for compound i = Soil Vapor EPC_i x Target Noncancer Hazard Index of 1 / Noncancer Hazard $Index_i$
[5] Represents the lower of the Site-specific SLs based on noncarcinogenic or carcinogenic effects.

Table 2
Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Commercial Exposure Scenario - Soil Classification as Loamy Sand
39155 and 39183 State Street
Fremont, California

Volatile Organic Compounds (VOCs) Detected in Soil Vapor	Soil Vapor	Indoor Air[2]		Cancer Risk	Noncancer Hazard Index	Site-Specific Screening Level (SL)		
	$EPC_{soil\ vapor}$[1] ($\mu g/m^3$)	Soil Vapor to Indoor Air Attenuation Factor (unitless)	$EPC_{indoor\ air}$ ($\mu g/m^3$)	(unitless)	(unitless)	Soil Vapor SL Based on Carcinogenic Effects[3] ($\mu g/m^3$)	Soil Vapor SL Based on Nonarcinogenic Effects[4] ($\mu g/m^3$)	Lowest Soil Vapor SL[5] ($\mu g/m^3$)
Tetrachloroethene	8,500	4.7E-04	3.98E+00	1.9E-06	2.6E-02	4,444	327,781	4,444
Benzene	710	6.4E-04	4.55E-01	1.1E-06	3.5E-02	660	20,499	660
Toluene	1,500	6.0E-04	8.97E-01	NA	6.8E-04	NA	2,197,859	2,197,859
Ethylbenzene	280	5.6E-04	1.56E-01	3.2E-08	3.6E-05	8,780	7,839,657	8,780
m,p-Xylene	1,100	5.6E-04	6.14E-01	NA	1.4E-03	NA	784,585	784,585
o-Xylene	350	5.6E-04	1.96E-01	NA	4.5E-04	NA	781,141	781,141
Freon 11	2,300	5.4E-04	1.25E+00	NA	4.1E-04	NA	5,630,199	5,630,199
Freon 12	6,400	5.9E-04	3.78E+00	NA	8.6E-03	NA	741,413	741,413
Chloroform	160	5.9E-04	9.51E-02	1.8E-07	2.2E-04	897	722,209	897
Carbon Tetrachloride	ND<100	5.0E-04	5.04E-02	1.7E-07	2.9E-04	579	347,482	579
1,2-Dichloroethane	ND<100	6.3E-04	6.28E-02	1.3E-07	2.0E-03	752	48,850	752
1,1,2-Trichloroethane	ND<100	5.5E-04	5.52E-02	7.2E-08	6.3E-02	1,390	1,588	1,390
1,1,2,2-Tetrachloroethane	ND<100	4.6E-04	4.59E-02	2.2E-07	1.5E-04	461	668,342	461
Vinyl Chloride	ND<100	7.0E-04	6.96E-02	4.4E-07	1.6E-04	226	629,616	226

Notes:
bgs = below ground surface.
EPC = exposure point concentration.
SL = screening level.
$\mu g/m^3$ = micrograms per cubic meter.

[1] Represents the maximum detected concentration for onsite soil vapor samples (3 purge volumes) collected from 0 to 10 feet bgs. Note: All maximum detected concentrations were detected at 5 feet bgs.
Carbon tetrachloride, 1,2-dichloroethane, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, and vinyl chloride were not detected above the laboratory reporting limit of 100 $\mu g/m^3$. Therefore, the reporting limit was used as the EPC.
[2] EPCs in soil vapor ($EPC_{soil\ vapor}$) were coupled with vapor intrusion model to estimate attenuation factors, EPCs in indoor air, cancer risk, and noncancer hazard index for commercial scenario.
[3] Represents the Site-specfic SL for carcinogenic effects, based on a target excess cancer risk of one-in-one million (1×10^{-6}).
Soil Vapor SL (Carcinogenic Effects) for compound *i* = Soil Vapor EPC_i x Target Cancer Risk of 1×10^{-6} / Cancer $Risk_i$
[4] Represents the Site-specific SL for noncarcinogenic effects, based on a target hazard quotient of one (1).
Soil Vapor SL (Noncarcinogenic Effects) for compound *i* = Soil Vapor EPC_i x Target Noncancer Hazard Index of 1 / Noncancer Hazard $Index_i$
[5] Represents the lower of the Site-specific SLs based on noncarcinogenic or carcinogenic effects.

Table 3
Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Residential Exposure Scenario - Soil Classification as Sandy Clay Loam
39155 and 39183 State Street
Fremont, California

Volatile Organic Compounds (VOCs) Detected in Soil Vapor	Soil Vapor	Indoor Air[2]				Site-Specific Screening Level (SL)		
	$EPC_{soil\ vapor}$[1] (µg/m^3)	Soil Vapor to Indoor Air Attenuation Factor (unitless)	$EPC_{indoor\ air}$ (µg/m^3)	Cancer Risk (unitless)	Noncancer Hazard Index (unitless)	Soil Vapor SL Based on Carcinogenic Effects[3] (µg/m^3)	Soil Vapor SL Based on Nonarcinogenic Effects[4] (µg/m^3)	Lowest Soil Vapor SL[5] (µg/m^3)
Tetrachloroethene	8,500	4.9E-04	4.20E+00	8.8E-06	1.2E-01	963	73,824	963
Benzene	710	7.6E-04	5.39E-01	5.6E-06	1.7E-01	128	4,122	128
Toluene	1,500	6.9E-04	1.03E+00	NA	3.3E-03	NA	455,126	455,126
Ethylbenzene	280	6.3E-04	1.75E-01	1.6E-07	1.7E-04	1,794	1,666,207	1,794
m,p-Xylene	1,100	6.3E-04	6.88E-01	NA	6.6E-03	NA	166,800	166,800
o-Xylene	350	6.3E-04	2.20E-01	NA	2.1E-03	NA	165,796	165,796
Freon 11	2,300	6.0E-04	1.39E+00	NA	1.9E-03	NA	1,207,772	1,207,772
Freon 12	6,400	6.8E-04	4.33E+00	NA	4.1E-02	NA	154,272	154,272
Chloroform	160	6.8E-04	1.09E-01	8.9E-07	1.1E-03	179	149,896	179
Carbon Tetrachloride	ND<100	5.5E-04	5.45E-02	8.2E-07	1.3E-03	123	76,494	123
1,2-Dichloroethane	ND<100	7.4E-04	7.37E-02	6.8E-07	1.0E-02	147	9,910	147
1,1,2-Trichloroethane	ND<100	6.2E-04	6.15E-02	3.5E-07	3.0E-01	285	339	285
1,1,2,2-Tetrachloroethane	ND<100	4.8E-04	4.83E-02	1.0E-06	6.6E-04	100	151,061	100
Vinyl Chloride	ND<100	8.6E-04	8.56E-02	2.4E-06	8.2E-04	42	121,804	42

Notes:
bgs = below ground surface.
EPC = exposure point concentration.
SL = screening level.
µg/m^3 = micrograms per cubic meter.

[1] Represents the maximum detected concentration for onsite soil vapor samples (3 purge volumes) collected from 0 to 10 feet bgs. Note: All maximum detected concentrations were detected at 5 feet bgs.
Carbon tetrachloride, 1,2-dichloroethane, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, and vinyl chloride were not detected above the laboratory reporting limit of 100 µg/m^3. Therefore, the reporting limit was used as the EPC.
[2] EPCs in soil vapor ($EPC_{soil\ vapor}$) were coupled with vapor intrusion model to estimate attenuation factors, EPCs in indoor air, cancer risk, and noncancer hazard index for residential scenario.
[3] Represents the Site-specfic SL for carcinogenic effects, based on a target excess cancer risk of one-in-one million (1 x 10^{-6}).
Soil Vapor SL (Carcinogenic Effects) for compound i = Soil Vapor EPC_i x Target Cancer Risk of 1 x 10^{-6} / Cancer $Risk_i$
[4] Represents the Site-specific SL for noncarcinogenic effects, based on a target hazard quotient of one (1).
Soil Vapor SL (Noncarcinogenic Effects) for compound i = Soil Vapor EPC_i x Target Noncancer Hazard Index of 1 / Noncancer Hazard $Index_i$
[5] Represents the lower of the Site-specific SLs based on noncarcinogenic or carcinogenic effects.

Table 4
Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Commercial Exposure Scenario - Soil Classification as Sandy Clay Loam
39155 and 39183 State Street
Fremont, California

Volatile Organic Compounds (VOCs) Detected in Soil Vapor	Soil Vapor	Indoor Air[2]				Site-Specific Screening Level (SL)		
	$EPC_{soil\ vapor}$[1] (µg/m³)	Soil Vapor to Indoor Air Attenuation Factor (unitless)	$EPC_{indoor\ air}$ (µg/m³)	Cancer Risk (unitless)	Noncancer Hazard Index (unitless)	Soil Vapor SL Based on Carcinogenic Effects[3] (µg/m³)	Soil Vapor SL Based on Nonarcinogenic Effects[4] (µg/m³)	Lowest Soil Vapor SL[5] (µg/m³)
Tetrachloroethene	8,500	2.5E-04	2.10E+00	1.0E-06	1.4E-02	8,408	620,122	8,408
Benzene	710	3.8E-04	2.69E-01	6.4E-07	2.1E-02	1,114	34,621	1,114
Toluene	1,500	3.4E-04	5.16E-01	NA	3.9E-04	NA	3,823,062	3,823,062
Ethylbenzene	280	3.1E-04	8.76E-02	1.8E-08	2.0E-05	15,676	13,996,141	15,676
m,p-Xylene	1,100	3.1E-04	3.44E-01	NA	7.9E-04	NA	1,401,117	1,401,117
o-Xylene	350	3.1E-04	1.10E-01	NA	2.5E-04	NA	1,392,683	1,392,683
Freon 11	2,300	3.0E-04	6.95E-01	NA	2.3E-04	NA	10,145,282	10,145,282
Freon 12	6,400	3.4E-04	2.16E+00	NA	4.9E-03	NA	1,295,883	1,295,883
Chloroform	160	3.4E-04	5.45E-02	1.0E-07	1.3E-04	1,564	1,259,125	1,564
Carbon Tetrachloride	ND<100	2.7E-04	2.73E-02	9.3E-08	1.6E-04	1,071	642,552	1,071
1,2-Dichloroethane	ND<100	3.7E-04	3.68E-02	7.8E-08	1.2E-03	1,281	83,243	1,281
1,1,2-Trichloroethane	ND<100	3.1E-04	3.08E-02	4.0E-08	3.5E-02	2,491	2,847	2,491
1,1,2,2-Tetrachloroethane	ND<100	2.4E-04	2.42E-02	1.1E-07	7.9E-05	875	1,268,910	875
Vinyl Chloride	ND<100	4.3E-04	4.28E-02	2.7E-07	9.8E-05	367	1,023,151	367

Notes:
bgs = below ground surface.
EPC = exposure point concentration.
SL = screening level.
µg/m³ = micrograms per cubic meter.

[1] Represents the maximum detected concentration for onsite soil vapor samples (3 purge volumes) collected from 0 to 10 feet bgs. Note: All maximum detected concentrations were detected at 5 feet bgs.
Carbon tetrachloride, 1,2-dichloroethane, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, and vinyl chloride were not detected above the laboratory reporting limit of 100 µg/m³. Therefore, the reporting limit was used as the EPC.
[2] EPCs in soil vapor ($EPC_{soil\ vapor}$) were coupled with vapor intrusion model to estimate attenuation factors, EPCs in indoor air, cancer risk, and noncancer hazard index for commercial scenario.
[3] Represents the Site-specfic SL for carcinogenic effects, based on a target excess cancer risk of one-in-one million (1 x 10^{-6}).
Soil Vapor SL (Carcinogenic Effects) for compound i = Soil Vapor EPC_i x Target Cancer Risk of 1 x 10^{-6} / Cancer $Risk_i$
[4] Represents the Site-specific SL for noncarcinogenic effects, based on a target hazard quotient of one (1).
Soil Vapor SL (Noncarcinogenic Effects) for compound i = Soil Vapor EPC_i x Target Noncancer Hazard Index of 1 / Noncancer Hazard $Index_i$
[5] Represents the lower of the Site-specific SLs based on noncarcinogenic or carcinogenic effects.

Table 5
Inhalation Toxicity Values
39155 and 39183 State Street
Fremont, California

Chemical	Inhalation Reference Concentration (RfCi)[1] (µg/m^3)		Inhalation Unit Risk Factor (IUR)[2] (µg/m^3)$^{-1}$	
	Value	**Source**	**Value**	**Source**
Benzene	3.00E+00	DTSC, 2016	2.90E-05	DTSC, 2016
Chloroform	9.80E+01	ATSDR, 2016	2.30E-05	USEPA, 2016b
Ethylbenzene	1.00E+03	USEPA, 2016b	2.50E-06	OEHHA, 2016
Freon 11	7.00E+02	USEPA, 1997	- -	- -
Freon 12	1.00E+02	USEPA, 2016a	- -	- -
Tetrachloroethene	3.50E+01	DTSC, 2016	5.90E-06	DTSC, 2016
Toluene	3.00E+02	DTSC, 2016	- -	- -
m,p-Xylene	1.00E+02	USEPA, 2016b	- -	- -
o-Xylene	1.00E+02	USEPA, 2016b	- -	- -

Notes:
µg/m^3 = Micograms per cubic meter.
"- -" = value was not available from the sources listed below or not applicable for this exposure route.

[1] Inhalation reference concentrations were obtained from the following sources of information: DTSC, 2016; OEHHA, 2016; USEPA, 2016a,b; ATSDR, 2015; USEPA, 1997.
[2] Inhalation unit risk factors were obtained from the following sources of information: DTSC, 2016; OEHHA, 2016; USEPA, 2016a,b.

References:

ATSDR. 2016. Minimal Risk Levels (MRLs). March.

DTSC. 2016. Human Health Risk Assessment Note Number 3: DTSC-modified Screening Levels. California Environmental Protection Agency. June.

OEHHA. 2016. Toxicity Criteria Database. California Environmental Protection Agency. On-line computer database. Last accessed August.

USEPA. 1997. Health Effects Assessment Summary Tables (HEAST) FY 1997 Update. Office of Solid Waste and Emergency Response. July.

USEPA. 2016a. Regional Screening Levels for Chemical Contaminants at Superfund Sites. USEPA Region 3, Region 6, and Region 9. May.

USEPA. 2016b. Integrated Risk Information System (IRIS). On-line computer database. Last accessed August.

Table 6
Risk Characterization for the Future Onsite Resident Receptor
Inhalation of Volatile Organic Compounds Volatilizing from Soil Vapor into Outdoor Air
39155 and 39183 State Street
Fremont, California

Volatile Organic Compounds (VOCs) Detected in Soil Vapor	Soil Vapor	Outdoor Air	Noncarcinogenic Effects		Carcinogenic Effects	
	$EPC_{soil\ vapor}$[1] ($\mu g/m^3$)	**$EPC_{outdoor\ air}$**[2] ($\mu g/m^3$)	**Inhalation Reference Concentration (cRfCi)** ($\mu g/m^3$)	**Hazard Quotient (HQ)** (unitless)	**Inhalation Unit Risk Factor (URF)** $(\mu g/m^3)^{-1}$	**Excess Cancer Risk** (unitless)
Tetrachloroethene	8.50E+03	7.82E-03	3.50E+01	2 E-04	5.90E-06	2 E-08
Benzene	7.10E+02	1.16E-03	3.00E+00	4 E-04	2.90E-05	1 E-08
Toluene	1.50E+03	2.13E-03	3.00E+02	7 E-06	- -	- -
Ethylbenzene	2.80E+02	3.49E-04	1.00E+03	3 E-07	2.50E-06	3 E-10
m,p-Xylene	1.10E+03	1.37E-03	1.00E+02	1 E-05	- -	- -
o-Xylene	3.50E+02	4.40E-04	1.00E+02	4 E-06	- -	- -
Freon 11	2.30E+03	2.74E-03	7.00E+02	4 E-06	- -	- -
Freon 12	6.40E+03	8.87E-03	1.00E+02	9 E-05	- -	- -
Chloroform	1.60E+02	2.24E-04	9.80E+01	2 E-06	2.30E-05	2 E-09
			Hazard Index =	**7 E-04**	**Cancer Risk =**	**3 E-08**

Notes:
bgs = below ground surface.
EPC = exposure point concentration.
SL = screening level.
$\mu g/m^3$ = micrograms per cubic meter.

[1] Represents the maximum detected concentration for onsite soil vapor samples (3 purge volumes) collected from 0 to 10 feet bgs.
Note: All maximum detected concentrations were detected at 5 feet bgs.
[2] EPCs in soil vapor ($EPC_{soil\ vapor}$) were coupled with fate and transport emission rate and box models to estimate EPCs in outdoor air.

ATTACHMENT A

VAPOR INTRUSION MODEL SENSITIVITY ANALYSIS

APEX | Apex Companies, LLC
3478 Buskirk Avenue, Suite 100 • Pleasant Hill, CA 94523
P: (925) 944-2856 • F: (925) 944-2859

November 7, 2016

Ms. Denise Cunningham
SummerHill Homes
3000 Executive Pkwy, Suite 450
San Ramon, CA 94583

Subject: Revised Addendum to Human Health Risk Evaluation of Subsurface Data – Vapor Intrusion Model Sensitivity Analysis 39155 and 39183 State Street, Fremont, California

Dear Ms. Cunningham:

At the request of the Alameda County Environmental Health (ACEH), The Source Group, Inc. (SGI) a division of Apex Companies, LLC, prepared this *Revised Addendum to Human Health Risk Evaluation of Subsurface Data – Vapor Intrusion Model Sensitivity Analysis* (Revised Addendum), which presents the results of a sensitivity analysis on the soil characteristics used as inputs in the vapor intrusion model. This sensitivity analysis was prepared as an addendum to the *Revised Human Health Risk Evaluation of Subsurface Data* for the property at 39155 and 39183 State Street in Fremont, California (the Site), dated November 7, 2016.

In above referenced report, the Department of Toxic Substances Control (DTSC) modified version of the Johnson and Ettinger (1991; J/E) vapor intrusion model (DTSC, 2014) was used to estimate Site-specific screening levels (SLs). The DTSC vapor intrusion model takes into account Site-specific geotechnical data; such as, soil vapor sampling depth, soil dry bulk density, and porosity (total, air-filled, and water-filled). The model is particularly sensitive to the depth to contamination (soil vapor sampling depth) and soil type of the unsaturated zone, which is used to determine density and moisture content (water-filled porosity). With a few exceptions (elevator shafts and sewer lateral sample locations), there was little variability in the depth of soil vapor samples, which were generally collected at approximately 5 feet below ground surface (bgs) across the Site. However, there is some variability in the soil type in the upper vadose zone from 0 to 5 feet bgs across the Site. Therefore, to conduct a sensitivity analysis, soil boring logs for the Site were reviewed to identify the range of predominate soil types from 0 to 5 feet bgs.

REVIEW OF BORING LOGS

In the *Revised Human Health Risk Evaluation of Subsurface Data* report, Site-specific SLs were estimated using the DTSC J/E model. Based on the geotechnical investigation conducted by Rockridge (2015), sandy clay loam was selected as the predominant soil type for the DTSC J/E model. The DTSC (2014) default values for SCL for total porosity (0. 384), and water-filled porosity (0.146) were used as model input parameters. As requested by ACEH, a review of soil boring logs prepared by PES Environmental, Inc. (PES) were reviewed to evaluate the range of predominant soil types from 0 to 5 feet bgs. The soil boring logs are presented in Attachment A of this Revised Addendum. As prepared by PES, geologic cross-section figures illustrate the soil types at the Site (Attachment B of this Revised Addendum). As illustrated on the PES cross-sections, finer-grained soils predominate in the top

5 feet of the site and extend to approximately 20 feet bgs. Coarser-grained soils are locally present and are more commonly found in the southern portion of the site.

Generally, soil boring logs classify soil type based on the U.S. Soil Conservation Service (USCS) soil classification. However, the DTSC J/E model classifies soil type based on the U.S. Department of Agriculture (USDA) soil classification. The following table summarizes the predominant soil type from 0 to 5 feet bgs as indicated in PES' soil boring logs and the corresponding USDA soil classification as suggested in the *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* by U.S. Environmental Protection Agency (USEPA, 2004).

TABLE 1: SUMMARY OF PES SOIL BORING LOGS

Boring	Location at Site	Gravel (%)	Sand (%)	Fines (%)	Soil Type	
					USCS PES Boring Log	USDA DTSC Model
B1	Northern portion	0	10	90	Clay (CH)	Silt Loam (SiL)
B2	Northern portion	0	10	90	Clay (CH)	Silt Loam (SiL)
B3	Southern portion	0	10	90	Clay (CH)	Silt Loam (SiL)
B5	Northern portion	0	10	90	Clay (CH)	Silt Loam (SiL)
B6	Southern portion	0	10	90	Clay (CH)	Silt Loam (SiL)
B7	Northern portion	0	10	90	Clay (CH)	Silt Loam (SiL)
B8	Southern portion	40	40	20	Silty Gravel (GM)	Loamy Sand (LS)/ Sandy Loam (SL)
B11	Northern portion	40	40	20	Silty Gravel (GM)	Loamy Sand (LS)/ Sandy Loam (SL)
B12	Southern portion	0	10	90	Clay (CH)	Silt Loam (SiL)
B13	Southern portion	0	10	90	Clay (CH)	Silt Loam (SiL)
B14	Offsite-Capitol Ave	0	50	50	Silty Sand (SM)	Sandy Loam (SL)/ Loam (L)
B16	Offsite-Capitol Ave	0	30	70	Sandy Clay (CL)	Loam (L)/ Silt Loam (SiL)
B18	Offsite-Capitol Ave	0	30	70	Sandy Clay (CL)	Loam (L)/ Silt Loam (SiL)
B44	Southern portion	70	10	20	Silty Gravel (GM)	Loamy Sand (LS)/ Sandy Loam (SL)
B45	Southern portion	70	10	20	Silty Gravel (GM)	Loamy Sand (LS)/ Sandy Loam (SL)
B46	Southern portion	70	10	20	Silty Gravel (GM)	Loamy Sand (LS)/ Sandy Loam (SL)
B47	Southern portion	70	10	20	Silty Gravel (GM)	Loamy Sand (LS)/ Sandy Loam (SL)

Based on the PES soil boring logs summarized in the table above, the predominant USDA soil types from 0 to 5 feet bgs were silt loam (SiL), loam (L), sandy loam (SL), and loamy sand (LS). In agreement with Mr. Ross Steenson of the San Francisco Bay Regional Water Quality Control Board (SFRWQCB; Attachment B of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report), use of loamy sand in the DTSC J/E model for soil types designated in boring logs as silty gravel is appropriate. As mentioned previously, the geotechnical investigation data collected by Rockridge (2015), indicated sandy clay loam (SCL) was the predominant soil type from 0 to 5 feet bgs. The default geotechnical parameters in the DTSC J/E model for each soil type identified from 0 to 5 feet bgs are summarized in the following table.

TABLE 2: DTSC J/E MODEL – DEFAULT SOIL PROPERTIES					
Soil Type	**Abbreviation**	**Soil Dry Bulk Density** (g/cm^3)	**Porosity Total** (cm^3/cm^3)	**Porosity Water-Filled** (cm^3/cm^3)	**Porosity Air-Filled** (cm^3/cm^3)
Sandy Clay Loam	SCL	1.63	0.384	0.146	0.238
Silt Loam	SiL	1.49	0.439	0.18	0.259
Loam	L	1.59	0.399	0.148	0.251
Sandy Loam	SL	1.62	0.387	0.103	0.284
Loamy Sand	LS	1.62	0.39	0.076	0.314

A simple sensitivity analysis was conducted with the output results of the DTSC J/E model, providing upper and lower bounds on the estimated indoor air concentrations and corresponding risks based on the default parameters (soil dry bulk density, total porosity, and water-filled porosity) for each identified soil type in the above table. To evaluate the sensitivity of each of the predominant soil types, the maximum detected tetrachloroethene (PCE) concentration in soil gas (8,500 $\mu g/m^3$) was used in the DTSC J/E model for a residential exposure scenario. The remaining model parameter inputs were consistent with the model inputs used to estimate Site-specific SLs in the *Revised Human Health Risk Evaluation of Subsurface Data* report, and are summarized in the following table.

TABLE 3: MODEL VARIABLES – VAPOR MIGRATION FROM SOIL VAPOR TO INDOOR AIR		
Properties	**Symbol**	**Assumed Value**
Depth Below Grade to Bottom of Enclosed Space Floor (default)	L_F	15 centimeters
Soil Vapor Sampling Depth Below Grade (5 feet)	L_S	152 centimeters
Average Soil Temperature (default)	T_s	24°C
Vadose Zone SCS Soil Type (Site-specific)	- -	See Table Above
Vadose Zone Soil Dry Bulk Density (Site-specific)	ρ_b	See Table Above
Vadose Zone Soil Total Porosity (Site-specific)	θ_T	See Table Above
Vadose Zone Soil Water-Filled Porosity (Site-specific)	θ_w	See Table Above
Average Vapor Flow Rate into Building (default)	Q_{soil}	5 L/min
Residential Exposure Scenario		
Averaging Time for Carcinogens	AT_C	70 years
Averaging Time for Noncarcinogens	AT_{NC}	26 years
Exposure Duration	ED	26 years
Exposure Frequency	EF	350 days/year
Exposure Time	ET	24 hours/day
Air Exchange Rate	ACH	0.5 $hour^{-1}$
Commercial Exposure Scenario		
Averaging Time for Carcinogens	AT_C	70 years
Averaging Time for Noncarcinogens	AT_{NC}	25 years
Exposure Duration	ED	25 years
Exposure Frequency	EF	250 days/year
Exposure Time	ET	8 hours/day
Air Exchange Rate	ACH	1 $hour^{-1}$

L/min = liter per minute

The spreadsheets containing the input parameters and results of the DTSC J/E model (DTSC, 2014) for subsurface vapor intrusion of PCE into buildings for the different soil types for the residential exposure scenario is provided in

Attachment C of this Revised Addendum. The following table summarizes the vapor intrusion model results for PCE for the different soil types for the future onsite resident receptor.

TABLE 4: SUMMARY OF VAPOR INTRUSION MODEL RESULTS FOR PCE UNDER RESIDENT EXPOSURE SCENARIO

Chemical	Soil Gas Concentration ($\mu g/m^3$)	Soil Type	Attenuation Factor (unitless)	Indoor Air Concentration ($\mu g/m^3$)	Cancer Risk (unitless)	Noncancer Hazard (unitless)
PCE	8,500	SCL	4.9E-04	4.2E+00	8.8E-06	1.2E-01
		SiL	5.0E-04	4.2E+00	8.9E-06	1.2E-01
		L	5.4E-04	4.5E+00	9.6E-06	1.2E-01
		SL	7.6E-04	6.4E+00	1.4E-05	1.8E-01
		LS	9.4E-04	8.0E+00	1.7E-05	2.2E-01

The larger the attenuation factor produced by the model, the greater the intrusion of vapors into indoor air. As shown in the table above, sandy clay loam soil type results in the lowest soil vapor to indoor air attenuation factor and indoor air concentration of PCE and loamy sand results in the highest attenuation factor and indoor air concentration of PCE. Consequently, estimated cancer risks and noncancer hazards are lowest for sandy clay loam and highest for loamy sand. These two soil types represent the outer limits of the range of appropriate soil types for the Site.

Using DTSC default soil properties for loamy sand and sandy clay loam, Site-specific SLs were estimated for the residential and commercial exposure scenarios for VOCs detected at the Site and 5 additional VOCs not detected above the reporting limits in soil vapor (carbon tetrachloride, 1,2-dichloroethane, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, and vinyl chloride). The Site-specific SLs based on loamy sand and sandy clay loam are presented in Tables 1 through 4 of the *Revised Human Health Risk Evaluation of Subsurface Data* report and summarized in the following table. This table also includes the San Francisco Regional Water Quality Control Board (SFRWQCB) soil vapor Environmental Screening Levels (ESLs).

TABLE 5: SUMMARY OF SFRWQCB ESL AND SITE-SPECIFIC SL

Chemical	SFRWQCB Soil Vapor ESL		Site-Specific SLs Loamy Sand		Site-Specific SLs Sandy Clay Loam	
	Residential ($\mu g/m^3$)	Commercial ($\mu g/m^3$)	Residential ($\mu g/m^3$)	Commercial ($\mu g/m^3$)	Residential ($\mu g/m^3$)	Commercial ($\mu g/m^3$)
Tetrachloroethene (PCE)	240	2,100	500	4,400	960	8,400
Benzene	48	420	76	660	130	1,100
Toluene	160,000	1,300,000	260,000	2,200,000	460,000	3,800,000
Ethylbenzene	560	4,900	1,000	8,800	1,800	16,000
m,p-Xylene	52,000	440,000	93,000	780,000	170,000	1,400,000
o-Xylene	52,000	440,000	93,000	780,000	170,000	1,400,000
Trichlorofluoromethane (Freon 11)	Not available	Not available	670,000	5,600,000	1,200,000	10,000,000
Dichlorodifluoromethane (Freon 12)	Not available	Not available	88,000	740,000	150,000	1,300,000
Chloroform	61	530	100	900	180	1,600
Carbon Tetrachloride	33	290	66	580	120	1,100
1,2-Dichloroethane	54	470	86	750	150	1,300
1,1,2-Trichloroethane	88	770	160	1,400	290	2,500
1,1,2,2-Tetrachloroethane	24	210	53	460	100	880
Vinyl Chloride	4.7	160	26	230	42	370

The spreadsheets containing the input parameters and results of the DTSC J/E model (DTSC, 2014) for subsurface vapor intrusion of VOCs into buildings for loamy sand and sandy clay loam for the residential and commercial exposure scenarios is provided in Attachment E of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report. The methods used to develop the Site-specific SLs are described in Attachment D of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report.

Based on Table 1, the soil from 0 to 5 feet bgs reflects loamy sand in 6 of 17 soil boring logs. In general, the loamy sand is limited to the southern portion of the Site. At the 11 remaining locations across the Site, the soil 0 to 5 feet bgs reflects a loam to silt loam. As mentioned previously, the geotechnical investigation conducted by Rockridge (2015), indicated sandy clay loam was the predominant soil type from 0 to 5 feet bgs. Based on the Rockridge geotechnical investigation results and a majority of the PES soil borings for the Site, the predominant soil type from 0 to 5 feet bgs reflects sandy clay loam or silt loam. Based on Site-specific geotechnical data and soil boring logs, the Site-specific SLs based on sandy clay loam are appropriate the majority of the Site.

SUMMARY AND CONCLUSIONS

This sensitivity analysis for the soil characteristics used as inputs in the vapor intrusion model, indicates that sandy clay loam soil type results in the lowest soil vapor to indoor air attenuation factor and indoor air concentration and loamy sand results in the highest attenuation factor and indoor air concentration. Based on Site-specific geotechnical data and soil boring logs, the Site-specific SLs based on sandy clay loam are appropriate for the majority of the Site. Regardless of which soil vapor SLs are appropriate for the Site, the site remedy for the PCE, benzene, and chloroform impacted areas of the Site does not change. The remedy, which has been proposed to ACEH (i.e., soil excavation in the southern portion of the site; installation of a Geoseal membrane at elevator shafts at Building A; and a membrane/passive venting system for the at-grade townhomes near State Street; PES, 2016a,b), will reduce any potential risks to future onsite resident and commercial receptors.

Sincerely,
The Source Group, Inc.

ivy inouye

Ivy Inouye
Senior Toxicologist

cc: Mr. Tom Graf, GrafCon
Mr. Carl J. Michelsen, PES Environmental, Inc.

Attachments

Attachment A – PES Soil Boring Logs
Attachment B – PES Geologic Cross-Sections
Plate 1 - Site Plan and Cross-Section Locations
Plate 2 - Geologic Cross Section A-A′
Plate 3 - Geologic Cross Section B-B′
Attachment C – DTSC J/E Model for Subsurface Vapor Intrusion of PCE into Buildings for the Different Soil Types for the Residential Exposure Scenario

References

Department of Toxic Substances Control (DTSC). 2014. DTSC Screening-Level Model for Soil Gas Contamination. California Environmental Protection Agency. Last Modified December.

Johnson, P.C. and R.A. Ettinger. 1991. Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings. Environmental Science and Technology. Vol. 25, No. 8, pp. 1445-52.

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Steenson, Ross. 2016. Regional Water Board Staff Letter: Consideration of Biodegradation for Site-Specific Vapor Intrusion Evaluations at Petroleum Sites. San Francisco Bay Regional Water Quality Control Board. November 3.

U.S. Environmental Protection Agency (USEPA). 2004. User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings. Office of Emergency and Remedial Response. February.

ATTACHMENT A

PES SOIL BORING LOGS

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B1

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
				DARK BROWN CLAY (CH) (7.5YR 3/2), moist, very stiff, trace fine sand, (0% gravel, 10% sand, 90% fines), high plasticity, cohesive
0.9				B1-1.0-2.0
0.7				B1-3.0-4.0
		5		Bottom of boring at 5 feet bgs. Backfilled with neat cement grout.
		10		
		15		
		20		
		25		
		30		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	5 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE
1

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B2

PID (ppm)	Blows/6-in.	DEPTH (FT)	MATERIALS DESCRIPTION
			ASPHALT
1.0			DARK BROWN SILT WITH SAND (ML) (7.5YR 3/4), dry, very stiff, fine - to coarse - grained sand, (0% gravel, 30% sand, 70% fines), non-cohesive
2.5			DARK BROWN CLAY (CH) (7.5 YR 3/2), moist, very stiff, trace fine - to coarse - grained sand, (0% gravel, 10% sand, 90% fines), cohesive, high plasticity
		5	
3.0			
			BROWN SILTY SAND (SM) (7.5YR 4/3), moist, medium stiff, fine - to medium - grained sand, (0% gravel, 70% sand, 30% fines), non-cohesive, non-plastic
0.8		10	
0.3			
		15	
		20	
			Gravelly from 21 to 22 feet bgs, concrete present.
0.0			
		25	
		30	

(Continued)

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	40 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE

2

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B2

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
		35		
			∇	Wet at 37 feet bgs.
		40		Bottom of boring at 40 feet bgs. Backfilled with neat cement grout.
		45		
		50		
		55		
		60		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	40 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE

2

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B3

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
1.0				DARK BROWN CLAY WITH SAND (CH) (7.5YR 3/2), moist, very stiff, trace fine sand, (0% gravel, 10% sand, 90% fines), high plasticity, cohesive B3-1.0-2.0
1.6				B3-3.0-4.0
		5		Bottom of boring at 5 feet bgs. Backfilled with neat cement grout.
		10		
		15		
		20		
		25		
		30		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	5 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE
3

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B5

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
0.8				DARK BROWN CLAY WITH SAND (CH) (7.5YR 3/2), moist, very stiff, trace fine sand, (0% gravel, 10% sand, 90% fines), high plasticity, cohesive B5-1.0-2.0
1.1				B5-3.0-4.0
		5		Bottom of boring at 5 feet bgs. Backfilled with neat cement grout.
		10		
		15		
		20		
		25		
		30		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	5 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE
4

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B6

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
				DARK BROWN CLAY WITH SAND (CH)
0.1				(7.5YR 3/2), moist, very stiff, trace fine sand, (0% gravel, 10% sand, 90% fines), high plasticity, cohesive B6-1.0-2.0
1.1				B6-3.0-4.0
		5		Bottom of boring at 5 feet bgs. Backfilled with neat cement grout.
		10		
		15		
		20		
		25		
		30		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	5 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE
5

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B7

PID (ppm)	Blows/6-in.	DEPTH (FT)	MATERIALS DESCRIPTION
		0	ASPHALT
			DARK BROWN CLAY WITH SAND (CH)
0.0			(7.5YR 3/2), moist, very stiff, trace fine sand (0% gravel, 10% sand, 90% fines), high plasticity, cohesive B7-1.0-2.0
0.3			B7-3.0-4.0
		5	Bottom of boring at 5 feet bgs. Backfilled with neat cement grout.
		10	
		15	
		20	
		25	
		30	

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	5 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE 6

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B8

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
0.0				DARK BROWN CLAY (CH) (7.5YR 3/2), moist, very stiff, trace fine sand (0% gravel, 10% sand, 90% fines), high plasticity, cohesive B8-1.0-2.0
0.2				BROWN SILTY GRAVEL WITH SAND (GM) (7.5YR 5/2), dry, loose, small to large gravel, some fine - to coarse - grained sand, (40% gravel, 40% sand, 20% fines), non-cohesive B8-3.0-4.0
		5		Bottom of boring at 5 feet bgs. Backfilled with neat cement grout.
		10		
		15		
		20		
		25		
		30		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	5 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE

7

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B11

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
0.3				DARK BROWN CLAY (CH) (7.5YR 3/2), moist, very stiff, trace fine sand (0% gravel, 10% sand, 90% fines), high plasticity, cohesive B11-1.0-2.0
0.2				BROWN SILTY GRAVEL WITH SAND (GM) (7.5YR 5/2), dry, loose, small to large gravel, some fine - to coarse - grained sand, (40% gravel, 40% sand, 20% fines), non-cohesive B11-3.0-4.0
		5		Bottom of boring at 5 feet bgs. Backfilled with neat cement grout.
		10		
		15		
		20		
		25		
		30		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	5 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE
8

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B12

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
0.0				DARK BROWN CLAY (CH) (7.5YR 3/2), moist, very stiff, trace fine sand, (0% gravel, 10% sand, 90% fines), high plasticity, cohesive B12-1.0-2.0
0.3				B12-3.0-4.0
		5		Bottom of boring at 5 feet bgs. Backfilled with neat cement grout.
		10		
		15		
		20		
		25		
		30		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	5 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE

9

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B13

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
				DARK BROWN CLAY (CH)
0.3				(7.5YR 3/2), moist, very stiff, trace fine sand, (0% gravel, 10% sand, 90% fines), high plasticity, cohesive B13-1.0-2.0
0.4				B13-3.0-4.0
		5		Bottom of boring at 5 feet bgs. Backfilled with neat cement grout.
		10		
		15		
		20		
		25		
		30		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	5 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE
10

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B14

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
				BASE ROCK
0.0				STRONG BROWN, SILTY SAND (SM) (7.5YR 4/6), dry, poorly graded, loose to medium stiff, fine - to medium - grained sand, (0% gravel, 50% sand, 50% fines)
0.0		5		
		10		
0.0				
		15		
0.0		20		BROWN SILTY SAND WITH GRAVEL (SM) (7.5YR 4/3), loose to medium stiff, fine - to medium - grained sand, small to large gravel, (20% gravel, 55% sand, 25% fines)
0.2		25		
0.2				
		30		

(Continued)

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	44 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE 11

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
		35		
0.5				BROWN CLAY WITH SAND (CH) (7.5YR 4/2), stiff, fine - grained sand, (0% gravel, 15% sand, 85% fines), high plasticity, cohesive
0.2		40		BROWN CLAY (CH) (7.5YR 4/2), stiff, fine - grained sand (0% gravel, 10% sand, 90% fines), high plasticity, cohesive
				Bottom of boring at 44 feet bgs. Backfilled with neat cement grout.
		45		
		50		
		55		
		60		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	44 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B16

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
0.1				STRONG BROWN SANDY CLAY (CL) (7.5YR 4/6), dry, stiff to very stiff, fine - grained sand, (0% gravel, 30% sand, 70% fines), medium plasticity, cohesive B16-1.0-2.0
0.3				B16-3.0-4.0
		5		Bottom of boring at 5 feet bgs. Backfilled with neat cement grout.
		10		
		15		
		20		
		25		
		30		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	5 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE

12

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B18

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
		0		STRONG BROWN SANDY CLAY (CL) (7.5YR 4/6), dry, stiff to very stiff, fine - grained sand, (0% gravel, 30% sand, 70% fines), medium plasticity, cohesive
0.1				
0.3				
		5		
		10		
0.1				
		15		
0.3				
0.1		20		BROWN SILTY SAND WITH GRAVEL (SM) (7.5YR 4/3), loose to medium dense, fine - to medium - grained sand, small to large gravel, (20% gravel, 55% sand, 25% fines).
0.1				
		25		
		30		

(Continued)

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	44 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PLATE
13

PES Environmental, Inc.
Engineering & Environmental Services

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
0.1		35		BROWN CLAY WITH SAND (CH) (7.5YR 4/2), moist, stiff to very stiff, fine - grained sand, (0% gravel, 15% sand, 85% fines), high plasticity, cohesive
0.0		40		BROWN CLAY (CH) (7.5YR 4/2), moist, very stiff, fine - grained sand, (0% gravel, 10% sand, 90% fines), high plasticiy, cohesive
		45		Bottom of boring at 44 feet bgs. Backfilled with neat cement grout.
		50		
		55		
		60		

PROJECT	Regis Homes Bay Area, LLC	REVIEWED BY	GDT
LOCATION	39155 & 38183 State Street, Fremont, California	DIAMETER OF HOLE	7 inches
JOB NUMBER	1098.007.01.001	TOTAL DEPTH OF HOLE	44 feet
LOGGED BY	G. Creps	DATE STARTED	10/27/14
DRILL RIG	Direct push	DATE COMPLETED	10/27/14

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B44

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
				DARK BROWN SILTY GRAVEL (GM) (7.5 YR 3/3), dry, rounded to subangular gravel from 0.2- to 1-inch diameter, (70% gravel, 10% sand, 20% fines)
				Sample ID: B44s-1.0-2.0
0.1				
0.3				*Sample ID: B44s-3.0-4.0*
				Refusal on concrete debris at 4 feet bgs. Boring backfilled with neat cement grout.
		5		
		10		

PROJECT	SummerHill Homes	REVIEWED BY	GDT
LOCATION	39155 State Street, Femont, California	DIAMETER OF HOLE	2 inches
JOB NUMBER	220.003.02.001	TOTAL DEPTH OF HOLE	4 feet
LOGGED BY	ME	DATE STARTED	9/21/15
DRILL RIG	Direct Push	DATE COMPLETED	9/21/15

PLATE

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B45

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
				DARK BROWN SILTY GRAVEL (GM) (7.5 YR 3/3), dry, rounded to subangular gravel from 0.2- to 1-inch diameter, (70% gravel, 10% sand, 20% fines)
0.0				*Sample ID: B45s-1.0-2.0*
0.0				*Sample ID: B45s-3.0-4.0*
				Refusal on concrete debris at 4 feet bgs. Boring backfilled with neat cement grout.
		5		
		10		

PROJECT	SummerHill Homes	REVIEWED BY	GDT
LOCATION	39155 State Street, Femont, California	DIAMETER OF HOLE	2 inches
JOB NUMBER	220.003.02.001	TOTAL DEPTH OF HOLE	4 feet
LOGGED BY	ME	DATE STARTED	9/21/15
DRILL RIG	Direct Push	DATE COMPLETED	9/21/15

PLATE

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B46

PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
				ASPHALT
				DARK BROWN SILTY GRAVEL (GM) (7.5 YR 3/3), dry, rounded to subangular gravel from 0.2- to 1-inch diameter, (70% gravel, 10% sand, 20% fines)
				Sample ID: B46s-1.0-2.0
0.0				
				Lense of very fine-grained sand from 2.5 to 2.8 feet bgs (cement)
0.0				*Sample ID: B46s-3.0-4.0*
				Refusal on concrete debris at 4 feet bgs. Boring backfilled with neat cement grout.
		5		
		10		

PROJECT	SummerHill Homes	REVIEWED BY	GDT
LOCATION	39155 State Street, Femont, California	DIAMETER OF HOLE	2 inches
JOB NUMBER	220.003.02.001	TOTAL DEPTH OF HOLE	4 feet
LOGGED BY	ME	DATE STARTED	9/21/15
DRILL RIG	Direct Push	DATE COMPLETED	9/21/15

PLATE

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF SOIL BORING B47

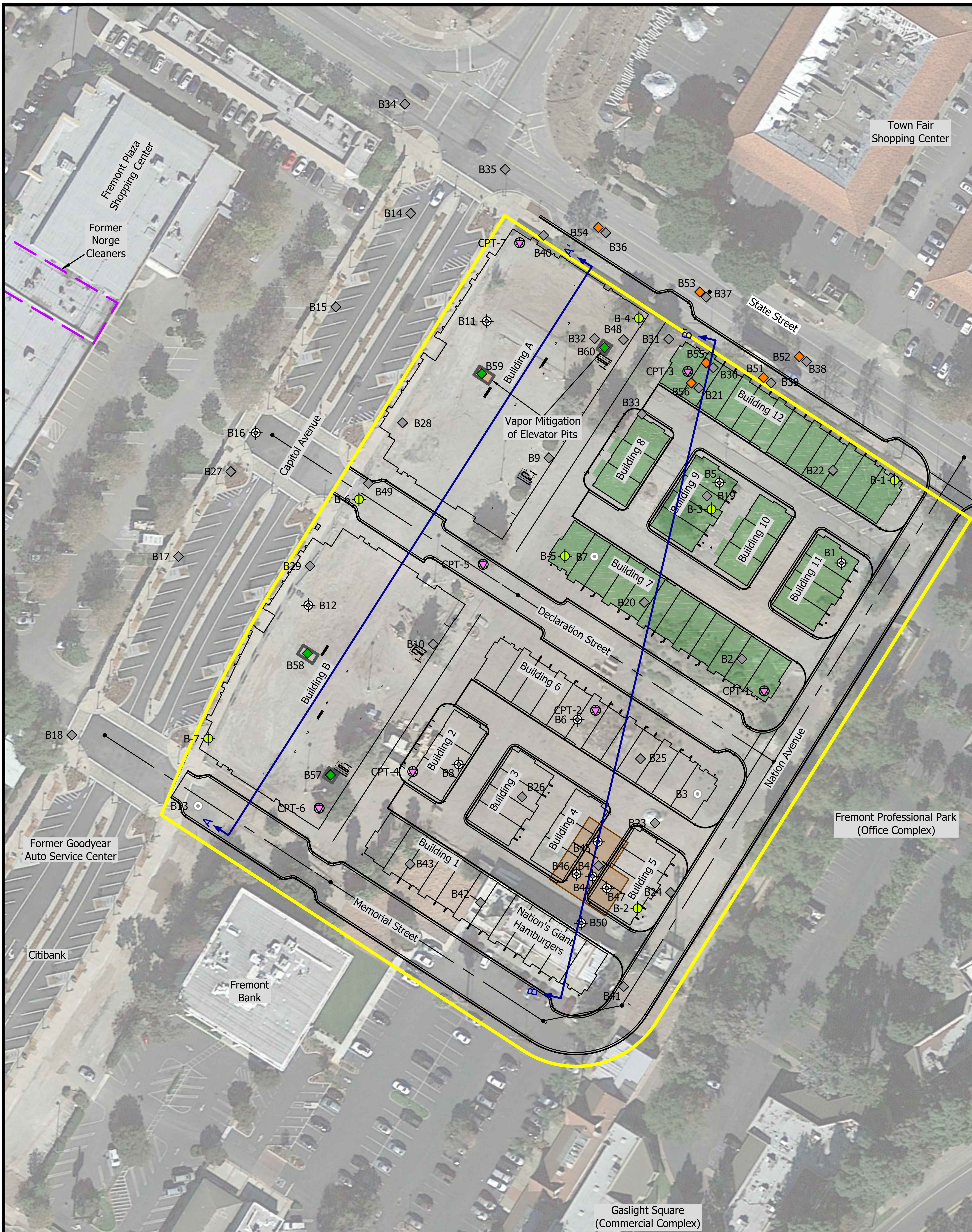
PID (ppm)	Blows/6-in.	DEPTH (FT)	GRAPHICS	MATERIALS DESCRIPTION
		0		ASPHALT
				DARK BROWN SILTY GRAVEL (GM) (7.5 YR 3/3), dry, rounded to subangular gravel from 0.2- to 1-inch diameter, (70% gravel, 10% sand, 20% fines)
				Sample ID: B47s-1.5-2.5
0.0				
				2-inch thick lense of olive green silt/clay present at 3.6 feet bgs, slight organic odor
				Brick debris present from 4 to 4.5 feet bgs
0.0				*Sample ID: B47s-3.5-4.5*
				Refusal on concrete debris at 4.5 feet bgs. Boring backfilled with neat cement grout.
		5		
		10		

PROJECT	SummerHill Homes	REVIEWED BY	GDT
LOCATION	39155 State Street, Femont, California	DIAMETER OF HOLE	2 inches
JOB NUMBER	220.003.02.001	TOTAL DEPTH OF HOLE	4.5 feet
LOGGED BY	ME	DATE STARTED	9/21/15
DRILL RIG	Direct Push	DATE COMPLETED	9/21/15

PLATE

ATTACHMENT B

PES GEOLOGIC CROSS-SECTIONS



Explanation

	Approximate Property Boundary
B17	Soil Vapor Sampling Location (PES)
B6	Soil Vapor and Soil Sampling Location (PES)
B13	Soil Sampling Location (PES)
B53	Soil Vapor Sample Location
B57	Soil Vapor Sample Location within planned elevator pit
B-1	Approximate Location of Boring by Rockridge Geotechnical Inc. June 2015
CPT-1	Approximate Location of Cone Penetration Test by Rockridge Geotechnical, Inc., June 2015
A A'	Cross-Section Location (Arrows show direction of view)
	Area of Excavation
	Planned Vapor Mitigation Areas for at-grade Townhomes
	Planned Vapor Mitigation Areas for Below Grade Parking Elevator Pits

0 80
SCALE IN FEET
N

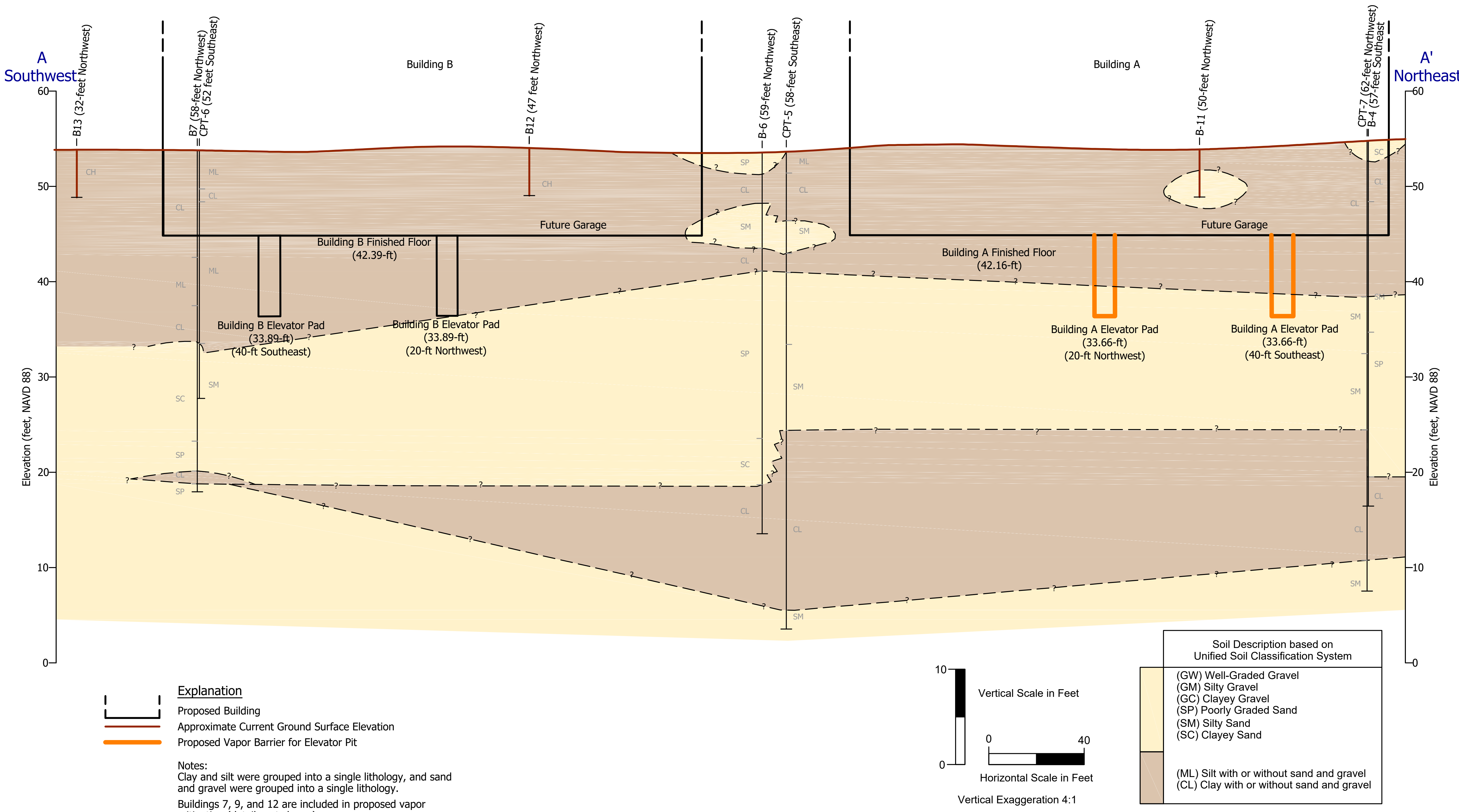
Aerial Photo: October 30, 2015 (Google 2016)

PES Environmental, Inc.
Engineering & Environmental Services

Site Plan and Cross Section Locations
State Street Center
Fremont, California

PLATE
1

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
220.003.03.003	22000303003_ADD_1	CJM	9/16



Soil Description based on Unified Soil Classification System	
(light)	(GW) Well-Graded Gravel (GM) Silty Gravel (GC) Clayey Gravel (SP) Poorly Graded Sand (SM) Silty Sand (SC) Clayey Sand
(dark)	(ML) Silt with or without sand and gravel (CL) Clay with or without sand and gravel

Explanation

Proposed Building
Approximate Current Ground Surface Elevation
Proposed Vapor Barrier for Elevator Pit

Notes:
Clay and silt were grouped into a single lithology, and sand and gravel were grouped into a single lithology.

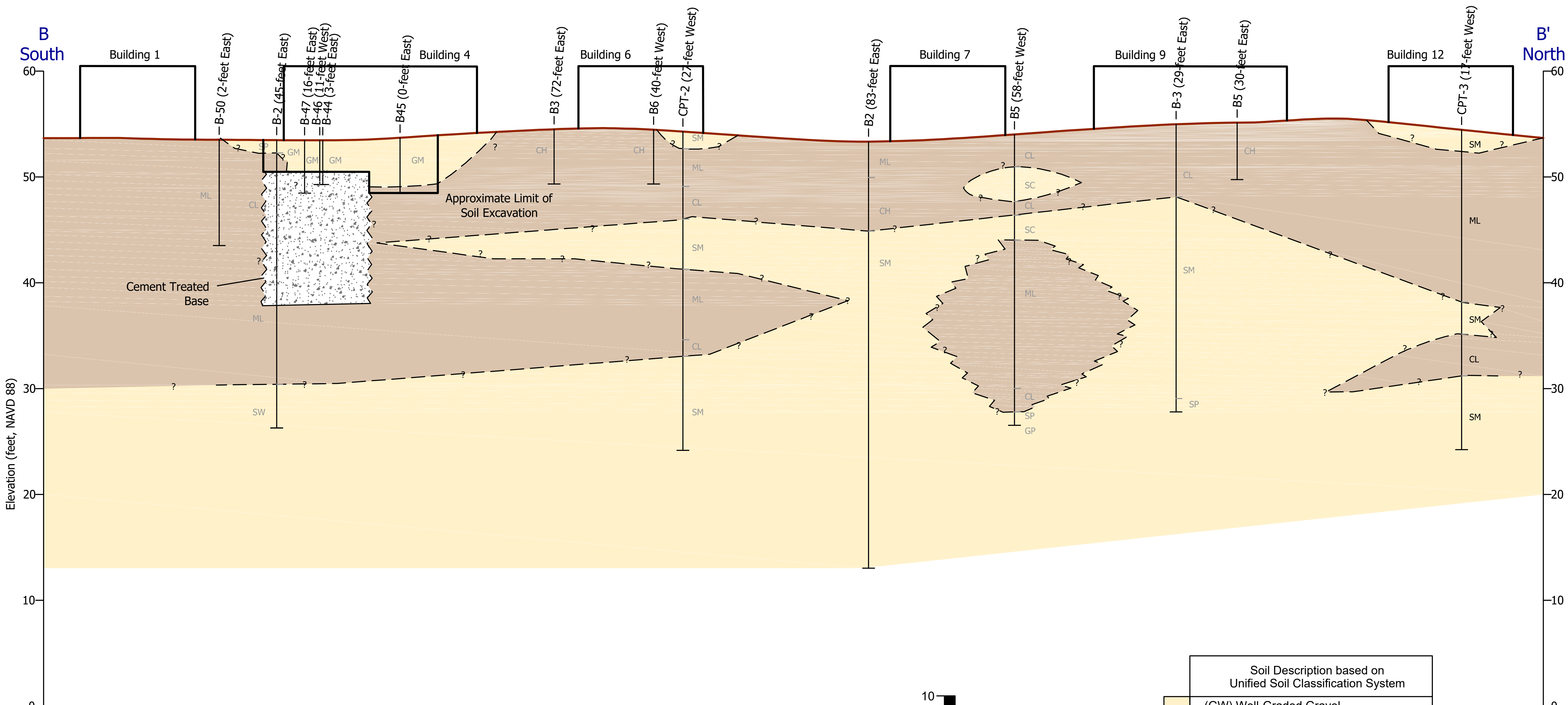
Buildings 7, 9, and 12 are included in proposed vapor mitigation (details not shown)

PES Environmental, Inc.
Engineering & Environmental Services

Geologic Cross Section A-A'
39155 and 39183 State Street
Fremont, California

PLATE
2

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
220.003.03.003	22000303003_ADD_2-3	CJM	9/16



Explanation

Projected Location of Proposed Building (Future Pad not shown)

Approximate Current Ground Surface Elevation

Notes:
Clay and silt were grouped into a single lithology, and sand and gravel were grouped into a single lithology.

Vertical Scale in Feet (0–10)

Horizontal Scale in Feet (0–40)

Vertical Exaggeration 4:1

Soil Description based on Unified Soil Classification System
(GW) Well-Graded Gravel (GM) Silty Gravel (GC) Clayey Gravel (SP) Poorly Graded Sand (SM) Silty Sand (SC) Clayey Sand
(ML) Silt with or without sand and gravel (CL) Clay with or without sand and gravel

PES Environmental, Inc.
Engineering & Environmental Services

Geologic Cross Section B-B'
39155 and 39183 State Street
Fremont, California

PLATE
3

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
220.003.03.003	22000303003_ADD_2-3_r1	CJM	10/16

ATTACHMENT C

DTSC J/E MODEL FOR SUBSURFACE VAPOR INTRUSION OF PCE INTO BUILDINGS FOR THE DIFFERENT SOIL TYPES FOR THE RESIDENTIAL EXPOSURE SCENARIO

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Tetrachloroethylene

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
8.50E+03	4.9E-04	4.2E+00	8.8E-06	1.2E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
127184	8.50E+03			Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Tetrachloroethylene**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
8.50E+03	5.0E-04	4.2E+00	8.9E-06	1.2E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
127184	8.50E+03			Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SIL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SIL	1.49	0.439	0.18	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Tetrachloroethylene**

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
8.50E+03	5.4E-04	4.5E+00	9.6E-06	1.2E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
127184	8.50E+03			Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	L		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
L	1.59	0.399	0.148	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)⁻¹
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Tetrachloroethylene

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
8.50E+03	7.6E-04	6.4E+00	1.4E-05	1.8E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)		ENTER Soil gas conc., C_g (ppmv)	Chemical
127184	8.50E+03	OR		Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SL	OR	

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SL	1.62	0.387	0.103	5

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Tetrachloroethylene

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
8.50E+03	9.4E-04	8.0E+00	1.7E-05	2.2E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)		ENTER Soil gas conc., C_g (ppmv)	Chemical
		OR		
127184	8.50E+03			Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
				OR	
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

ATTACHMENT B

RWQCB LETTER

San Francisco Bay Regional Water Quality Control Board

November 3, 2016 (RAS)

Mr. Tom Graf
GrafCon
1606 Juanita Lane
Tiburon, CA 94920
via email: tom@grafcon.us

Subject: Consideration of Biodegradation for Site-Specific Vapor Intrusion Evaluations at Petroleum Sites

Dear Mr. Graf:

Per our telephone conversation a few weeks ago, the State Water Resources Control Board (SWRCB) September 2012, Low-Threat Underground Storage Tank Case Closure Policy (LTCP; SWRCB 2012b) provides soil gas criteria for benzene, ethylbenzene, and naphthalene where a bioattenuation zone is present. These criteria are significantly higher than the concentrations presented in our February 2016, Environmental Screening Levels (ESLs), which do not consider biodegradation potential. This means that the ESLs and calculations using the Johnson and Ettinger model (JEM) with site-specific soil and moisture conditions, neither of which includes biodegradation, can be several orders of magnitude lower than those allowable per the LTCP.

Section 4.1.2 of the ESL User's Guide explains that petroleum hydrocarbons are susceptible to biodegradation, and therefore the vapor intrusion ESLs can be overly conservative for petroleum-only sites. Research has shown that concentrations of hydrocarbons in soil can be reduced by three to seven orders of magnitude within a few feet of the vapor source in clean soil where adequate oxygen is present (USEPA 2012; SRWCB 2012a and references therein; Lahvis et al. 2013; USEPA 2015). The LTCP defines clean soil as total petroleum hydrocarbons (TPH) less than 100 mg/kg and uses an oxygen criterion of greater than or equal to 4 percent (see Appendix 4, sheet 2 of 2, of the LTCP). For the situation where the TPH and oxygen criteria are met, the LTCP incorporates a bioattenuation factor of 1,000, which increases the allowable soil gas concentration by three orders of magnitude. We expect biodegradation of hydrocarbons to occur under these conditions at non-UST sites as well. Therefore, we support the use of the bioattenuation factor as part of a site-specific evaluation, applied to ESLs or site-specific JEM results, where appropriate (i.e., the criteria are met: clean soil and oxygen content). For example, the current benzene soil gas ESL for a residential scenario is 48 $\mu g/m^3$. Applying the bioattenuation factor would increase that value to 48,000 $\mu g/m^3$.

Therefore, if a site has benzene soil gas concentrations less than 1,000 $\mu g/m^3$, sufficient oxygen, and low to non-detect concentrations of TPH in the upper five feet of soil, these conditions indicate benzene in soil gas poses no significant risk for a residential scenario (unrestricted).

We additionally spoke about using loamy sand in the JEM to represent silty gravel in calculating site-specific soil gas criteria for chemicals other than those in the LTCP. The JEM uses a different soil classification system (USDA Natural Resource Conservation Service Soil Texture Classification) than that typically used in the remediation industry (Unified Soil Classification System). Table 11 of the USEPA user's guide for their spreadsheet version of the JEM (USEPA 2004) provides a means of correlating between the two classifications systems. Based on that table, a loamy sand appears to be a reasonable representation for a silty gravel. Appendix D of the ESL User's Guide provides general recommendations for site-specific vapor intrusion models. Table 1 in Appendix D compares and ranks the effective diffusivity (akin to vapor permeability) for each of the soil types in the soil gas versions of the JEM. As shown in that table, loamy sand has an effective diffusivity that is nearly the same as sand. Therefore, I support the use of loamy sand in the JEM to represent silty gravel.

Please contact me at 510.622.2445 or via email at ross.steenson@waterboards.ca.gov if you have any questions.

Sincerely,

Ross Steenson, CHG
Engineering Geologist
Groundwater Protection Division

Attachments: References

cc:

Ms. Cheryl Prowell, Regional Water Board, cheryl.prowell@waterboards.ca.gov
Mr. Alec Naugle, Regional Water Board, alec.naugle@waterboards.ca.gov
Ms. Nicole Fry, Regional Water Board, nicole.fry@waterboards.ca.gov

REFERENCES

Lahvis, M.A., I. Hers, R.V. Davis, J. Wright, and G.E. DeVaull. 2013. Vapor Intrusion Screening at Petroleum UST Sites. Groundwater Monitoring & Remediation, 33, no. 2, pp. 53-67.

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ATTACHMENT C

SOIL GEOTECHNICAL DATA

ROCKRIDGE GEOTECHNICAL

Prepared for **SummerHill Homes LLC**

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
STATE STREET AND CAPITOL AVENUE
FREMONT, CALIFORNIA

August 30, 2015
Project No. 15-905

270 Grand Avenue
Oakland, CA 94610

www.rockridgegeo.com

510 420-5738 tel
510 652-3096 fax

ROCKRIDGE
GEOTECHNICAL

August 30, 2015
Project No. 15-905

Ms. Denise Cunningham
SummerHill Homes LLC
3000 Executive Parkway, Suite 450
San Ramon, California 94583

Subject: Final Report
Geotechnical Investigation
Proposed Residential Development
State Street and Capitol Avenue
Fremont, California

Dear Ms. Cunningham,

We are pleased to present the results of our geotechnical investigation for the proposed residential development to be constructed at the intersection of State Street and Capitol Avenue in Fremont, California. Our geotechnical study was performed in accordance with our proposal, dated May 5, 2015, and our Professional Service Agreement with SummerHill Homes LLC, dated August 3, 2015.

The subject property consists of two relatively level, contiguous parcels (Parcel A and Parcel B) encompassing an area of about 176,400 square feet. It is bordered by one- to two-story commercial buildings and asphalt-concrete parking lots to the northwest, southwest and southeast, and State Street to the northeast. Although the site is currently vacant, it was previously occupied by a commercial structure with an adjacent asphalt-concrete parking lot. The structure has been demolished and removed, leaving the asphalt-concrete parking area and mature trees in place. There is currently construction near the site to extend Capitol Avenue through to Fremont Boulevard.

Plans are to construct eleven at-grade, three-story townhomes buildings on the eastern two-thirds of the site and two mixed-use buildings on the western one-third of the site. The mixed-use buildings will each have one level of below-grade parking and a one-story concrete podium above the garage that will contain both retail space and parking. Three stories of residential flats and townhomes will be constructed above the podium level. Other improvements include new streets along the eastern and southern edges of the site, as well as “B” Street, which will run through the middle of the site.

On the basis of the results of our geotechnical study, we conclude the proposed residential development can be constructed as planned, provided the recommendations presented in this report are incorporated into the project plans and specifications and properly implemented during construction. The primary geotechnical concerns at the site are: 1) the presence of moderately expansive near-surface soil, and 2) the potential for up to one inch of seismically induced differential settlement over a horizontal distance of 30 feet. We conclude the proposed townhomes should be supported on either conventionally reinforced mat foundations or post-tensioned slabs-on-grade underlain by at least two feet of properly moisture-conditioned on-site soil. We conclude the mixed-use buildings should either be supported on a mat foundation or spread footings bottomed on soil improved using Rapid Impaction Compaction (RIC).

The recommendations contained in our report are based on a limited subsurface investigation. Consequently, variations between expected and actual subsurface conditions may be found in localized areas during construction. Therefore, we should be engaged to observe grading, fill placement, and foundations installation, during which time we may make changes in our recommendations, if deemed necessary.

We appreciate the opportunity to provide our services to you on this project. If you have any questions, please call.

Sincerely yours,
ROCKRIDGE GEOTECHNICAL, INC.

REGISTERED PROFESSIONAL ENGINEER
CRAIG S. SHIELDS
GE2116
3/31/17
GEOTECHNICAL
STATE OF CALIFORNIA

Craig S. Shields, P.E., G.E.
Principal Geotechnical Engineer

Enclosure

ROCKRIDGE GEOTECHNICAL

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GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
STATE STREET AND CAPITOL AVENUE
Fremont, California

1.0 INTRODUCTION

This report presents the results of the geotechnical investigation performed by Rockridge Geotechnical, Inc. for the proposed residential development to be constructed near the intersection of State Street and Capitol Avenue in Fremont, California. The site is on the southwestern side of State Street between Capitol and Beacon avenues, as shown on the Site Location Map, Figure 1.

The subject property consists of two relatively level, contiguous parcels (Parcel A and Parcel B) encompassing an area of about 176,400 square feet. It is bordered by one- to two-story commercial buildings and asphalt-concrete parking lots to the northwest, southwest and southeast, and State Street to the northeast. Although the site is currently vacant, it was previously occupied by a commercial structure with an adjacent asphalt-concrete parking lot. The structure has been demolished and removed, leaving the asphalt-concrete parking area and mature trees in place. There is currently construction near the site to extend Capitol Avenue through to Fremont Boulevard.

Plans are to construct 11 at-grade, three-story townhomes buildings on the eastern two-thirds of the site and two mixed-use buildings on the western one-third of the site. The mixed-use buildings will each have one level of below-grade parking and a one-story concrete podium above the garage that will contain both retail space and parking. Three stories of residential flats and townhomes will be constructed above the podium level. Other improvements include new streets along the eastern and southern edges of the site, as well as “B” Street, which will run through the middle of the site.

2.0 SCOPE OF WORK

Our investigation was performed in accordance with our proposal dated May 5, 2015 and our Professional Service Agreement, dated August 3, 2015, with SummerHill Homes LLC. Our scope of work consisted of exploring subsurface conditions at the site by drilling test borings, performing cone penetration tests (CPTs), and performing laboratory testing on selected soil samples. We used the data from our field investigation to perform engineering analyses to develop conclusions and recommendations regarding:

- site seismicity and seismic hazards, including the potential for liquefaction and liquefaction-induced ground failure
- the most appropriate foundation type(s) for the proposed structures
- design criteria for the recommended foundation type(s), including vertical and lateral capacities
- estimates of foundation settlement
- lateral earth pressures for basement wall design
- subgrade preparation for slab-on-grade floors and exterior flatwork
- site grading and excavation, including criteria for the fill quality and compaction
- 2013 California Building Code (CBC) site class and design spectral response acceleration parameters
- soil corrosivity
- construction considerations.

3.0 FIELD INVESTIGATION AND LABORATORY TESTING

Our field investigation consisted of drilling seven test borings, performing seven CPTs, and performing laboratory testing on selected soil samples. Prior to advancing the test borings, we obtained a drilling permit from Alameda County Water District (ACWD) and contacted Underground Service Alert (USA) to notify them of our work, as required by law. Details of the field investigation and laboratory testing are described below.

3.1 Test Borings

Our field investigation included drilling seven test borings, designated as Borings B-1 through B-7, at the approximate locations shown on Figure 2. The borings were drilled to depths ranging from 26-1/2 to 40 feet below the existing ground surface (bgs) using a truck-mounted drill rig equipped with hollow-stem augers. During drilling, our field engineer logged the soil encountered and obtained representative samples for visual classification and laboratory testing. The logs of the borings are presented on Figures A-1 through A-7 in Appendix A. The soil encountered in the borings was classified in accordance with the classification charts shown on Figures A-8.

Soil samples were obtained using the following samplers:

- Sprague and Henwood (S&H) split-barrel sampler with a 3.0-inch outside diameter and 2.5-inch inside diameter, lined with 2.43-inch inside diameter brass or stainless steel tubes.
- Standard Penetration Test (SPT) split-barrel sampler with a 2.0-inch outside and 1.5-inch inside diameter, without liners.

The type of sampler used was selected based on soil type and the desired sample quality for laboratory testing. In general, the S&H sampler was used to obtain samples in medium stiff to very stiff cohesive soil and the SPT sampler was used to evaluate the relative density of cohesionless soil.

The SPT and S&H samplers were driven with a 140-pound, downhole, wireline hammer falling about 30 inches per drop. The samplers were driven up to 18 inches and the hammer blows required to drive the samplers were recorded every six inches and are presented on the boring logs. A "blow count" is defined as the number of hammer blows per six inches of penetration or 50 blows for six inches or less of penetration. The blow counts required to drive the S&H and SPT samplers were converted to approximate SPT N-values using factors of 0.7 and 1.2, respectively, to account for sampler type and approximate hammer energy. The blow counts used for this conversion were: (1) the last two blow counts if the sampler was driven more than 12 inches, (2) the last one blow count if the sampler was driven more than six inches but less than 12 inches, and (3) the only blow count if the sampler was driven six inches or less. The converted SPT N-values are presented on the boring logs.

Upon completion, the boreholes were backfilled with neat cement grout under the observation of a grout inspector from ACWD, the pavement was patched with quick-set concrete, and drilling spoils generated by the borings were placed in landscaped areas on site.

3.2 Laboratory Testing

We re-examined the soil samples obtained from our borings to confirm the field classifications and selected representative samples for laboratory testing. Selected soil samples were tested to measure moisture content, dry density, Atterberg limits, particle-size distribution (gradation), resistance value (R-value), and corrosivity. The results of the laboratory tests are presented on the boring logs and in Appendix B.

4.0 SUBSURFACE CONDITIONS

Regional geologic information (Figure 3) indicates the site is underlain Holocene-age alluvium (Qha). Our borings indicate the site is blanketed by stiff to hard clay with varying sand content that extends to depths ranging from approximately 5 to 11-1/2 feet bgs. Atterberg limits tests indicate the near-surface clay has low to moderate expansion potential. Beneath the surficial clay layer are heterogeneous alluvial deposits consisting of loose to very dense silty sand, medium dense to very dense sand with varying gravel content, medium dense clayey sand, stiff to very stiff, non-plastic sandy silt, and stiff to very stiff clay with varying sand content.

Groundwater was not encountered during drilling of any of the test borings, which extended to a maximum depth of 40 feet bgs. Based on a CPT pore pressure dissipation test performed at a depth of 44.8 feet bgs at the CPT-7 location, the depth to groundwater is estimated to be 40.5 feet bgs at that location at the time the test was performed.

Our borings were drilled following a long drought. The groundwater level at the site is expected to fluctuate several feet seasonally with potentially larger fluctuations annually, depending on the amount of rainfall. To further evaluate the depth to the groundwater table at the site, we reviewed information on the State of California Water Resources Control Board GeoTracker website (http://geotracker.swrcb.ca.gov). Groundwater monitoring data from January 2006 at a nearby site indicate the highest groundwater levels measured during that period was about 32-1/2 feet bgs. Based on the available information, we recommend a design groundwater of 30 feet bgs be used for the site.

5.0 SEISMIC CONSIDERATIONS

5.1 Regional Seismicity

The site is located in the Coast Ranges geomorphic province of California that is characterized by northwest-trending valleys and ridges. These topographic features are controlled by folds and faults that resulted from the collision of the Farallon plate and North American plate and subsequent strike-slip faulting along the San Andreas Fault system. The San Andreas Fault is more than 600 miles long from Point Arena in the north to the Gulf of California in the south. The Coast Ranges province is bounded on the east by the Great Valley and on the west by the Pacific Ocean.

The major active faults in the area are the Hayward, Mount Diablo Thrust, Calaveras, and San Andreas faults. These and other faults in the region are shown on Figure 4. For these and other active faults within a 50-kilometer radius of the site, the distance from the site and estimated mean characteristic Moment magnitude[1] [2007 Working Group on California Earthquake Probabilities (WGCEP) (USGS 2008) and Cao et al. (2003)] are summarized in Table 1.

[1] Moment magnitude is an energy-based scale and provides a physically meaningful measure of the size of a faulting event. Moment magnitude is directly related to average slip and fault rupture area.

TABLE 1
Regional Faults and Seismicity

Fault Segment	Approximate Distance from Site (km)	Direction from Site	Mean Characteristic Moment Magnitude
Total Hayward	2	Northeast	7.0
Total Hayward – Rodgers Creek	2	Northeast	7.3
Total Calaveras	11	East	7.0
Mount Diablo Thrust	25	Northeast	6.7
Monte Vista - Shannon	25	Southwest	6.5
N. San Andreas - Peninsula	28	Southwest	7.2
N. San Andreas (1906 Event)	28	Southwest	8.0
Greenville Connected	32	Northeast	7.0
Green Valley Connected	39	North	6.8
N. San Andreas – Santa Cruz	42	South	7.1
San Gregorio Connected	44	West	7.5
Great Valley 7	46	East	6.9

Since 1800, four major earthquakes have been recorded on the San Andreas Fault. In 1836, an earthquake with an estimated maximum intensity of VII on the Modified Mercalli (MM) scale occurred east of Monterey Bay on the San Andreas Fault (Toppozada and Borchardt 1998). The estimated Moment magnitude, M_w, for this earthquake is about 6.25. In 1838, an earthquake occurred with an estimated intensity of about VIII-IX (MM), corresponding to an M_w of about 7.5. The San Francisco Earthquake of 1906 caused the most significant damage in the history of the Bay Area in terms of loss of lives and property damage. This earthquake created a surface rupture along the San Andreas Fault from Shelter Cove to San Juan Bautista approximately 470 kilometers in length. It had a maximum intensity of XI (MM), an M_w of about 7.9, and was felt

560 kilometers away in Oregon, Nevada, and Los Angeles. The most recent earthquake to affect the Bay Area was the Loma Prieta Earthquake of 17 October 1989 with an M_w of 6.9. This earthquake occurred in the Santa Cruz Mountains about 58 kilometers southwest of the site.

In 1868, an earthquake with an estimated maximum intensity of X on the MM scale occurred on the southern segment (between San Leandro and Fremont) of the Hayward Fault. The estimated M_w for the earthquake is 7.0. In 1861, an earthquake of unknown magnitude (probably an M_w of about 6.5) was reported on the Calaveras Fault. The most recent significant earthquake on this fault was the 1984 Morgan Hill earthquake ($M_w = 6.2$).

The U.S. Geological Survey's (USGS) 2007 WGCEP has compiled the earthquake fault research for the San Francisco Bay area in order to estimate the probability of fault segment rupture. They have determined that the overall probability of moment magnitude 6.7 or greater earthquake occurring in the San Francisco Bay Region during the next thirty years is 63 percent. The highest probabilities are assigned to the Hayward/Rodgers Creek Fault and the northern segment of the San Andreas Fault; these probabilities are 31 and 21 percent, respectively (USGS 2008). The probabilities assigned to Calaveras, Concord-Green Valley, and Mount Diablo Thrust faults are 7, 3, and 1 percent, respectively (USGS 2008).

5.2 Geologic Hazards

Because the project site is in a seismically active region, we evaluated the potential for earthquake-induced geologic hazards, including ground shaking, ground surface rupture, liquefaction,[2] lateral spreading,[3] and cyclic densification[4]. We used the results of our field investigation to evaluate the potential of these phenomena occurring at the project site.

5.2.1 Ground Shaking

The seismicity of the site is governed by the activity of the Hayward and Calaveras faults, although ground shaking from future earthquakes on other faults, including the Mount Diablo Thrust and San Andreas faults, will also be felt at the site. The intensity of earthquake ground motion at the site will depend upon the characteristics of the generating fault, distance to the earthquake epicenter, and magnitude and duration of the earthquake. We judge that strong to very strong ground shaking could occur at the site during a large earthquake on one of the nearby faults.

5.2.2 Ground Surface Rupture

Historically, ground surface displacements closely follow the trace of geologically young faults. The site is not within an Earthquake Fault Zone, as defined by the Alquist-Priolo Earthquake Fault Zoning Act, and no known active or potentially active faults exist on the site. We therefore conclude the risk of fault offset at the site from a known active fault is very low. In a seismically active area, the remote possibility exists for future faulting in areas where no faults previously existed; however, we conclude the risk of surface faulting and consequent secondary ground failure from previously unknown faults is also very low.

---

2 Liquefaction is a phenomenon where loose, saturated, cohesionless soil experiences temporary reduction in strength during cyclic loading such as that produced by earthquakes.

3 Lateral spreading is a phenomenon in which surficial soil displaces along a shear zone that has formed within an underlying liquefied layer. Upon reaching mobilization, the surficial blocks are transported downslope or in the direction of a free face by earthquake and gravitational forces.

4 Cyclic densification is a phenomenon in which non-saturated, cohesionless soil is compacted by earthquake vibrations, causing ground-surface settlement.

5.2.3 Liquefaction and Associated Hazards

When a saturated, cohesionless soil liquefies, it experiences a temporary loss of shear strength created by a transient rise in excess pore pressure generated by strong ground motion. Soil susceptible to liquefaction includes loose to medium dense sand and gravel, low-plasticity silt, and some low-plasticity clay deposits. Flow failure, lateral spreading, differential settlement, loss of bearing strength, ground fissures and sand boils are evidence of excess pore pressure generation and liquefaction. The site is **not** located within a zone of liquefaction potential as shown on the map titled *State of California Seismic Hazard Zones, Nile Quadrangle, Official Map*, prepared by the California Geological Survey (CGS), dated October 19, 2004 (see Figure 5).

We evaluated the liquefaction potential of soil encountered at the site using data collected from our CPTs and borings. Our liquefaction analyses were performed using the methodology proposed by P.K. Robertson (2009). We also used the relationship proposed by Zhang, Robertson, and Brachman (2002) to estimate post-liquefaction volumetric strains and corresponding ground surface settlement; a relationship that is an extension of the work by Ishihara and Yoshimine (1992).

Our analyses were performed using the approximate in-situ groundwater depths measured in our CPTs and a "during earthquake" groundwater depth of 30 feet bgs. In accordance with the 2013 CBC, we used a peak ground acceleration of 0.83 times gravity (g) in our liquefaction evaluation; this peak ground acceleration is consistent with the Maximum Considered Earthquake Geometric Mean (MCE_G) peak ground acceleration adjusted for site effects (PGA_M). We also used a moment magnitude 7.33 earthquake, which is consistent with the mean characteristic moment magnitude for the Hayward Fault, as presented in Table 1.

Our analyses indicate there are thin layers of cohesive soil between depths of approximately 30 and 44 feet bgs that are susceptible to cyclic softening as a result of pore pressure build-up during a major earthquake. We estimate total and differential ground settlement resulting from post-earthquake reconsolidation of these layers following a MCE event with PGA_M of 0.83g will be on the order of 1/2 inch and 1/4 inch across a horizontal distance of 30 feet, respectively.

Lateral spreading occurs when a continuous layer of soil liquefies at depth and the soil layers above move toward an unsupported face, such as a shoreline slope, or in the direction of a regional slope or gradient. Based on the lack of controlling boundary conditions and the cohesive nature of the soil that may experience cyclic softening, we conclude the potential for lateral spreading to occur at the project site is very low.

5.2.4 Cyclic Densification

Cyclic densification (also referred to as differential compaction) of non-saturated sand (sand above groundwater table) can occur during an earthquake, resulting in settlement of the ground surface and overlying improvements. The site is underlain by areas of loose to medium dense sand above the groundwater table that is susceptible to cyclic densification. We estimate ground settlement as a result of cyclic densification during a major earthquake could be up to one inch and differential settlement could be up to about 3/4 inch over a horizontal distance of 30 feet.

6.0 DISCUSSION AND CONCLUSIONS

From a geotechnical standpoint, we conclude the proposed residential development can be constructed as planned, provided the recommendations presented in this report are incorporated into the project plans and specifications and implemented during construction. The primary geotechnical concerns at the site are: 1) the presence of moderately expansive near-surface soil, and 2) the potential for up to one inch of seismically induced differential settlement over a horizontal distance of 30 feet. This and other geotechnical issues as they pertain to the proposed development are discussed in this section.

6.1 Foundations

Considering the presence of moderately expansive near-surface soil and the potential for up to one inch of seismically induced differential settlement, we conclude the proposed townhomes should be supported on either conventionally reinforced mat foundations or post-tensioned slabs-on-grade underlain by at least two feet of properly moisture-conditioned on-site soil. If it is not practical to excavate, moisture-condition and recompact the upper two feet of soil beneath the townhomes due to rainy weather, the upper 18 inches of the townhome building pads may be treated in place with lime.

The excavation for the proposed below-grade levels beneath the mixed-use buildings will remove the moderately expansive near-surface soil and expose low-plasticity soil, which may consist of materials, such as sandy silt, silty sand, and clayey sand, which have moderate strength and are moderately compressible. We estimate settlement of footings bottomed on the native soil will be approximately one inch under static conditions and differential settlement will be about 3/4 inch over a horizontal distance of 30 feet. As discussed above, an additional one inch of seismically induced differential settlement may occur during a major earthquake from a combination of liquefaction and cyclic densification. The estimated differential settlement of 1-1/2 inches under a combination of static and seismic loading is larger than can be accommodated by a conventional spread footing foundation. Therefore, we conclude the mixed-use buildings should either be supported on a mat foundation or spread footings bottomed on improved soil. We believe the most economical ground improvement method for this site consists of using a Rapid Impact Compactor (RIC) to densify the upper 15 feet of soil (measured below footings for below-grade level). The RIC is a track-mounted machine that imparts energy by dropping an approximately 7.5-ton weight from a controlled height of about three feet onto a patented foot. The energy is delivered at a rate of 40 to 60 blows per minute. Drop height, number of blows, and penetration per blow are monitored and/or controlled by an on-board data acquisition system. Compaction points are performed on a geometric grid, the spacing of which is determined based on the properties of the soil to be densified.

If RIC is performed, we conclude conventional spread footings could be used to support the mixed-use buildings. We estimate total settlement of the buildings would be less than 3/4 inch under static conditions and differential settlement would be less than 1/2 inch of over a horizontal distance of 30 feet. We estimate seismically induced differential settlement would be less than 1/4 inch over a horizontal distance of 30 feet.

The soil that will be exposed at the base of the excavation for the below-grade parking levels is susceptible to softening and disturbance if exposed to rain. Therefore, if construction will occur during the rainy season, measures should be taken to protect the subgrade. These measures could include in-place cement treatment of the soil or placement of a six-inch-thick layer of compacted aggregate base over the subgrade. Footing excavations may be protected from rain by placing a 1- to 2-inch-thick layer of concrete ("mud slab") on the footing excavation bottoms after they are inspected by our firm.

6.2 Excavation Support

We anticipate the finished floor of the below-grade parking garages for the mixed-use buildings will be about 10 feet bgs. Therefore, we estimate construction of the below-grade level and foundations will require excavations up to about 12 feet in depth. Where there is adequate space, the sides of the excavation for the below-grade parking garage can be sloped. Excavations that will be deeper than 5 feet and will be entered by workers should be shored or sloped in accordance with the Occupational Safety and Health Administration (OSHA) standards (29 CFR Part 1926). The shoring designer should be responsible for the shoring design. The contractor should be responsible for the construction and safety of temporary slopes and shoring.

Where there is inadequate space to slope the sides of the excavation, shoring should be installed. We judge that a soldier pile-and-lagging shoring system is most appropriate for support of the proposed excavations for this project. A soldier pile-and-lagging system usually consists of steel H-beams and concrete placed in predrilled holes extending below the bottom of the excavation. The steel H-beams can also be installed with a vibratory hammer provided there are no vibration-sensitive improvements within 25 feet of the soldier piles. Wood lagging is placed between the piles as the excavation proceeds from the top down. Where the required cut is less than about 12 feet, a soldier pile and lagging system can typically provide economical shoring without tiebacks, and therefore will not encroach beyond the property line. Where cuts exceed about 12 feet in height, soldier pile-and-lagging systems are typically more economical if they include tieback anchors.

A structural/civil engineer knowledgeable in this type of construction should be retained to design the shoring. The shoring designer should design the shoring system for lateral deformation of less than 1/2 inch at any location on the shoring where there is an adjacent structure within a horizontal distance equal to twice the retained soil height and one inch where there are no structures within that horizontal distance. We should review the final shoring plans and calculations to check that they are consistent with the recommendations presented in this report.

6.3 Soil Corrosivity

Laboratory testing was performed by Sunland Analytical to evaluate the corrosivity of soil samples from Boring B-2 at a depth of 3 feet bgs and from Boring B-7 at a depth of 12 feet bgs. The results of the tests are presented in Appendix B. Based on the results of the resistivity tests performed on the samples, we conclude the soil is corrosive to buried metal. Accordingly, all buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric-coated steel or iron should be protected against corrosion depending upon the critical nature of the structure. If it is necessary to have metal in contact with soil, a corrosion engineer should be consulted to provide recommendations for corrosion protection. The results indicate that sulfate ion concentrations are insufficient to damage reinforced concrete structures below ground, and the pH and chloride concentration of the soil do not present a problem with reinforcing steel in buried concrete structures.

6.4 Construction Considerations

The soil to be excavated for the below-grade garage, foundations for the at-grade building, and utilities is expected to consist of clay above a depth of five feet bgs and interbedded soil (clay, silt and sand) below a depth of five feet bgs. If site grading is performed during the rainy season, the near-surface clay will likely be wet and will have to be dried before compaction can be achieved. Heavy rubber-tired equipment could cause excessive deflection (pumping) of the wet clay and, therefore, should be avoided. If construction occurs during the winter, it may be necessary to winterize the site by lime treating the upper 18 inches of clay for the at-grade buildings and cement treating the upper 12 inches of the subgrade for the below-grade garages.

7.0 RECOMMENDATIONS

Our recommendations for site preparation and grading, temporary cut slopes and shoring, foundation and basement wall design, and other geotechnical aspects of the project are presented in this section.

7.1 Site Preparation and Grading

Site demolition should include the removal of existing pavements, foundations, and underground utilities. In general, abandoned underground utilities should be removed to the property line or service connections and properly capped or plugged with concrete. Where existing utility lines are outside of the proposed building footprints and will not interfere with the proposed construction, they may be abandoned in-place provided the lines are filled with lean concrete or cement grout to the property line. Voids resulting from demolition activities should be properly backfilled with compacted fill following the recommendations provided later in this section. Removed asphalt concrete should be taken to an asphalt recycling facility.

In areas that will receive pavements or exterior concrete flatwork, the soil subgrade exposed following stripping and clearing should be scarified to a depth of at least 12 inches, moisture-conditioned to at least three percent above optimum moisture content, and compacted to at least 90 percent relative compaction[5]. In the proposed building pad areas, the soil beneath the pads should be excavated to a depth of 12 inches below finished pad grade. The excavations should

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[5] Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same material, as determined by the ASTM D1557 laboratory compaction procedure.

extend at least five feet outside the proposed building footprints. The excavation subgrade should then be scarified to a depth of at least 12 inches, moisture-conditioned to at least three percent above optimum moisture content, and compacted to at least 90 percent relative compaction. If the existing moisture content of the soil is already at least three percent above optimum moisture content, it is not necessary to scarify the soil prior to compaction. After compaction of the excavation subgrade, the excavated soil should be placed in lifts not exceeding eight inches in loose thickness, moisture-conditioned to at least three percent above optimum moisture content, and compacted to at least 90 percent. The building pad subgrade should be protected against drying by either wetting the subgrade or by using imported Class 2 aggregate base as fill for the upper four inches of the building pads. If construction will occur during the rainy season, then lime treatment of the upper 18 inches of the building pads may be performed in lieu of the overexcavation and recompaction described above.

Fill may consist of on-site soil that is free of organic matter and rocks or lumps larger than four inches in greatest dimension. If it is necessary to import soil (select fill), the material should be free of organic matter, contains no rocks or lumps larger than four inches in greatest dimension, has a liquid limit of less than 40 and a plasticity index lower than 12, and is approved by the Geotechnical Engineer. Samples of proposed imported fill material should be submitted to the Geotechnical Engineer at least three business days prior to use at the site. The grading contractor should provide analytical test results or other suitable environmental documentation indicating the imported fill is free of hazardous materials at least three days before use at the site. If this data is not available, up to two weeks should be allowed to perform analytical testing on the proposed imported material.

Fill should be placed in horizontal lifts not exceeding eight inches in uncompacted thickness, moisture-conditioned to at least three percent optimum moisture content and compacted to at least 90 percent relative compaction. If low-plasticity on-site or imported soil, such as silty sand or sand, will be used as fill, it should be moisture-conditioned to above optimum moisture content, and compacted to at least 90 percent relative compaction. Low-plasticity fill should be compacted to at least 95 percent relative compaction where the fill is: (1) placed below foundations; (2) greater than five feet in thickness; or (3) consists of clean sand or gravel, defined as soil with less than 10 percent fines by weight. The upper one foot of pavement subgrade should also be compacted to at least 95 percent relative compaction, and be non-yielding.

7.1.1 Exterior Flatwork Subgrade Preparation

We recommend a minimum of six inches of Class 2 aggregate base (AB) be placed below exterior concrete flatwork, such as patios and sidewalks. The subgrade and Class 2 AB should be moisture-conditioned and compacted to at least 90 percent relative compaction. The prepared subgrade should be kept moist until it is covered with the Class 2 AB.

7.1.2 Utility Trench Backfill

Excavations for utility trenches can be readily made with a backhoe. All trenches should conform to the current CAL-OSHA requirements. To provide uniform support, pipes or conduits should be bedded on a minimum of four inches of sand or fine gravel. After the pipes and conduits are tested, inspected (if required) and approved, they should be covered to a depth of six inches with sand or fine gravel, which should be mechanically tamped.

Backfill for utility trenches and other excavations is also considered fill, and should be placed and compacted as according to the recommendations previously presented. If imported clean sand or gravel (defined as soil with less than 10 percent fines) is used as backfill, it should be compacted to at least 95 percent relative compaction. Jetting of trench backfill should not be permitted. Special care should be taken when backfilling utility trenches in pavement areas. Poor compaction may cause excessive settlements, resulting in damage to the pavement section.

Where utility trenches enter the at-grade building pads, an impermeable plug consisting of lean concrete or sand-cement slurry, at least three feet in length, should be installed where the trenches enter the building footprint. Furthermore, where sand- or gravel-backfilled trenches cross planter areas and pass below asphalt or concrete pavements, a similar plug should be placed at the edge of the pavement. The purpose of these recommendations is to reduce the potential for water to become trapped in trenches beneath the buildings or pavements. This trapped water can cause heaving of soils beneath slabs and softening of subgrade soil beneath pavements.

7.1.3 Lime-Treated Soil

Lime treatment of fine-grained soils generally includes site preparation, application of lime, mixing, compaction, and curing of the lime treated soil. Field quality control measures should include checking the depth of lime treatment, degree of pulverization, lime spread rate measurement, lime content measurement, and moisture content and density measurements, and mixing efficiency. Quality control may also include laboratory tests for unconfined compressive strength tests on representative samples.

The lime treatment process should be designed by a contractor specializing in its use and who is experienced in the application of lime in similar soil conditions. Based on our experience with lime treatment, we judge that the specialty contractor should be able to treat the moderately to highly expansive on-site material to produce a non-expansive fill for the building pad subgrades and, if desired, for exterior flatwork and pavement subgrades. For planning purposes, we recommend assuming the lime treatment will consist of at least four percent of Quicklime by dry weight of soil. An average dry unit weight of 110 pounds per cubic foot (pcf) should be assumed for design purposes. The specialty contractor should confirm this amount is suitable and prepare a treatment specification for our review prior to construction.

7.1.4 Drainage and Landscaping

Positive surface drainage should be provided around the buildings to direct surface water away from the foundations. To reduce the potential for water ponding adjacent to the building, we recommend the ground surface within a horizontal distance of five feet from the buildings slope down away from the buildings with a surface gradient of at least two percent in unpaved areas and one percent in paved areas. In addition, roof downspouts should be discharged into controlled drainage facilities to keep the water away from the foundations. The use of water-intensive landscaping around the perimeter of the buildings should be avoided to reduce the amount of water introduced to the moderately expansive clay subgrade.

Care should be taken to minimize the potential for subsurface water to collect beneath flatwork and pavements. Where landscape beds and tree wells are immediately adjacent to pavements and flatwork that are not designed as permeable systems, we recommend vertical cutoff barriers be incorporated into the design to prevent irrigation water from saturating the subgrade and AB. These barriers may consist of either flexible impermeable membranes or deepened concrete curbs.

7.2 Foundation Support and Settlement

We recommend the at-grade townhouses be supported on either conventional mat foundations or P-T slabs. We recommend the mixed-use buildings be supported on either a conventional mat foundation or on spread footings underlain by soil improved using RIC or other methods. Recommendations for each foundation type are presented in the following sections.

7.2.1 Mat Foundations

We recommend conventional mat foundations be at least 12 inches thick. For the at-grade buildings, the edges of the mat should be thickened such that the mat edge is bottomed at least 12 inches below the adjacent exterior grade. The minimum edge embedment depth may be decreased to 6 inches if the upper 18 inches of soil on the building pads is treated with lime. Where a mat foundation is constructed near a bioswale or other stormwater treatment area, the edge of the slab should be founded below an imaginary line extending up at an inclination of 1.5:1 (horizontal:vertical) from the base of the bioswale/treatment area. Conventional mat foundations should be designed using an allowable bearing capacity of 3,000 pounds per square foot (psf) for dead-plus-live loads. This value may be increased by one-third for total design loads, which includes wind or seismic forces. To evaluate the pressure distribution beneath the mat foundation, we recommend a modulus of vertical subgrade reaction (K_S) of 25 pounds per cubic inch (pci) be used. This value has been corrected to take into account the mat width and may be increased by one-third percent for total load conditions. To check the mat stiffness to resist the estimated seismically induced differential settlement, the mat foundations should be designed to distribute the superimposed structural loads assuming an area of reduced support measuring 15 by 15 feet at any location within the interior of the mat and 5 by 15 feet around the perimeter of the mat, where the 15-foot dimension is measured parallel to the edge of the mat. The subgrade modulus in the areas of reduced support should be taken as 5 pci. Once the structural engineer estimates the distribution of bearing stress on the bottom of the mat, we should review the distribution and revise the modulus of subgrade reaction, if appropriate.

Lateral loads may be resisted by a combination of friction along the base of the mat and passive resistance against the vertical faces of the mat foundation. To compute lateral resistance, we recommend using an equivalent fluid weight of 260 pounds per cubic foot (pcf); the upper foot of soil should be ignored unless confined by a slab or pavement. Frictional resistance should be computed using a base friction coefficient of 0.30 where the mat is in contact with the soil. Where a vapor retarder is placed beneath the mat, a base friction coefficient of 0.20 should be used. The passive pressure and frictional resistance values include a factor of safety of at least 1.5.

To reduce water vapor transmission through the mat foundations, we recommend a vapor retarder be placed between the bottom of the mat and the underlying subgrade soil. The vapor retarder should be at least 15 mils thick and meet the requirements for Class B vapor retarders stated in ASTM E1745. The vapor retarder should be placed in accordance with the requirements of ASTM E1643. These requirements include overlapping seams by six inches, taping seams, and sealing penetrations in the vapor retarder. A vapor retarder is not required beneath the mat foundation in the parking garage; however, it should be placed beneath the mat in areas that will be used for storage and enclosed rooms, such as mechanical and electrical rooms.

The mat subgrade should be free of loose, weak, or disturbed material. The mat subgrade should be prepared as recommended in Section 7.1. We should check the mat subgrade prior to placement of the vapor retarder and/or reinforcing steel.

7.2.2 Post-Tensioned Slabs-on-Grade

We recommend P-T slabs be at least 10 inches thick. The edges of the foundation should be thickened such that the foundation edge is bottomed at least 12 inches below the adjacent exterior grade. The minimum edge embedment depth may be decreased to 6 inches if the upper 18 inches of soil on the building pads is treated with lime. Where a P-T slab is constructed near a bioswale or other stormwater treatment area, the edge of the slab should be founded below an imaginary line extending up at an inclination of 1.5:1 (horizontal:vertical) from the base of the bioswale/treatment area. The maximum bearing pressure beneath the P-T slab should not exceed 3,000 psf under dead-plus-live-load conditions and 4,000 psf under total load conditions. For design of P-T slabs, we recommend using the parameters presented below in Table 2. To check the P-T slab stiffness to resist seismically induced differential settlement, the P-T slabs should be designed to distribute the superimposed structural loads assuming an area of reduced support measuring 15 by 15 feet at any location within the interior of the P-T slab and 5 by 15 feet around the perimeter of the foundation, where the 15-foot dimension is measured parallel to the edge of the P-T slab. The subgrade modulus in the areas of reduced support should be taken as 5 pci.

TABLE 2
P-T Slab Design Parameters

Parameter	Value
Thornwaite Moisture Index	20
Edge moisture variation distance edge lift center lift	 4.9 feet 9.0 feet
Percentage fines	92%
Percentage of clay	35%
Liquid limit	38%
Plasticity Index	20%
Suction Variance at Ground	1.5 pF
Soil differential movement edge lift center lift	 1.5 inches 0.7 inches

Lateral loads can be resisted by a combination of passive pressure on the vertical faces of the foundation and friction along the bottom of the mat or P-T slab. Passive resistance may be computed using an equivalent fluid weight of 260 pounds per cubic foot (pcf). The upper one foot of soil should be ignored unless it is confined by slabs or pavement. Frictional resistance should be computed using a base friction coefficient of 0.30 where the slab is in contact with native soil and 0.20 where the slab is in underlain by a vapor retarder. These values include a factor of safety of at least 1.5 and may be used in combination without reduction.

To reduce water vapor transmission through the P-T slabs, we recommend a vapor retarder be placed between the bottom of the P-T slab and the underlying subgrade soil. The vapor retarder should be at least 15 mils thick and meet the requirements for Class B vapor retarders stated in ASTM E1745. The vapor retarder should be placed in accordance with the requirements of

ASTM E1643. These requirements include overlapping seams by six inches, taping seams, and sealing penetrations in the vapor retarder.

Concrete can be placed directly on the vapor retarder provided the water/cement (w/c) ratio of the concrete does not exceed 0.45 and water is not added in the field. If necessary, workability may be increased by adding plasticizers. In addition, the slab should be properly cured. Before floor coverings are placed over P-T slab foundations, the contractor should check that the concrete surface and the moisture emission levels (if emission testing is required) meet the manufacturer's requirements.

The subgrade for the P-T slabs should be free of standing water, debris, and disturbed materials prior to placing concrete. The bottoms and sides of the excavations should be wetted following excavation and maintained in a moist condition until concrete is placed. We should check the foundation subgrade prior to placement of reinforcing steel.

7.2.3 Spread Footings

Spread footings may be used to support the mixed-use buildings provided ground improvement is performed to strengthen the upper 15 feet of soil beneath the footings. Continuous footings should be at least 18 inches wide and isolated spread footings should be at least 24 inches wide. Footings should be bottomed at least 24 inches below the bottom of the floor slab. Footings on improved soil may be designed using an allowable bearing pressure of 5,000 pounds per square foot (psf) for dead-plus-live loads; this value may be increased by one-third for total design loads, which includes wind or seismic forces.

Lateral loads may be resisted by a combination of passive pressure on the vertical faces of the footings and friction between the bottoms of the footings and the underlying soil. To compute lateral resistance for footings, we recommend using an equivalent fluid weight of 300 pcf. The upper foot of soil should be ignored for passive resistance unless confined by a slab or pavement. Frictional resistance should be computed using a base friction coefficient of 0.35. The passive pressure and frictional resistance values include a factor of safety of at least 1.5 and may be used in combination without reduction.

Footing excavations should bottom in firm soil and be free of standing water, debris, and weak and disturbed materials prior to placing concrete. The bottoms and sides of the footing excavations should be maintained in a moist condition until concrete is placed. We should check footing excavations prior to placement of reinforcing steel.

7.3 Ground Improvement

As discussed previously, ground improvement should be performed beneath the footprint of the proposed mixed-use buildings if spread footing foundations will be used. Based on our experience, we conclude the most economical type of ground improvement for the site conditions consists of dynamic compaction using the RIC. The sequence of compaction using the RIC in a 20- by 20-foot-square area consists of performing compaction at either 9 or 13 points, with more compaction points for looser soil. We recommend a 13-point grid be used to densify the soil within the proposed building footprint. The RIC should be performed at the base of the excavation for the below-grade garage and should extend at least five feet outside the building footprint where space permits. RIC should be performed no closer than 25 feet horizontally from off-site storm drain/sanitary sewer lines and no closer than 10 feet horizontally from the edge of public sidewalks.

We recommend the upper 15 feet of soil, measured below the bottom of the proposed spread footings be improved to achieve minimum equivalent SPT N-values (uncorrected for overburden) of 25 for sand, 22 for silty sand, and 18 for non-plastic sandy silt. We should drill 3 to 4 post-treatment borings to check the desired improvement has been achieved. The bid should provide a unit price (on a square-foot basis) to retreat areas; however, the base bid should assume no recompaction is required.

Treatment with the RIC results in craters that are about 24 to 30 inches deep on the subgrade. Therefore, recompaction of the upper two feet of soil at the base of the excavation should be performed after completion of the ground improvement.

7.4 Basement Walls

Basement walls should be designed to resist lateral earth pressure imposed by the retained soil, as well as a surcharge pressure from nearby vehicles and foundations, where appropriate. Where basement walls will be restrained from movement at the top by the building floor slab, they should be designed for at-rest conditions. We recommend basement walls at the site be designed using an at-rest equivalent fluid weight of 56 pcf. To evaluate the basement walls for seismic loading, we recommend using an active equivalent fluid weight of 37 pcf plus a seismic increment of 33 pcf (triangular distribution). Site retaining walls that are free to rotate may be designed using an equivalent fluid weight of 37 pcf. For seismic evaluation of site retaining walls that are free to rotate, we recommend using an active equivalent fluid weight of 37 pcf plus a seismic increment of 13 pcf (triangular distribution).

Where traffic loads are expected within 10 feet of the walls, an additional design load of 100 psf should be applied to the upper ten feet of the wall. Basement walls adjacent to existing buildings should be designed for surcharge pressures if the foundations supporting the adjacent buildings are founded above the zone-of-influence for the basement walls. This zone is defined as an imaginary line extending up from the bottom of the wall at an inclination of 1.5:1. The influence on a wall from a foundation that is founded within this zone of influence should be analyzed on an individual basis after the geometry has been determined.

The lateral earth pressures recommended are applicable to walls that are backdrained above the water table to prevent the buildup of hydrostatic pressure. One acceptable method for backdraining the walls is to place a prefabricated drainage panel (Miradrain 6000 or equivalent) against the shoring or the back of the walls. The drainage panel should extend down to a four-inch-diameter perforated PVC collector pipe at the base of the walls. The pipe should be surrounded on all sides by at least four inches of Caltrans Class 2 permeable material (see

Caltrans Standard Specifications Section 68-1.025) or 3/4-inch drain rock wrapped in filter fabric (Mirafi 140NC or equivalent). The collector pipe should outlet into the storm drain system outside the garage, if possible. Where shoring is installed and there is insufficient room to install a perforated pipe between the shoring and the back of the basement wall, the drainage panel should extend down to a proprietary, prefabricated collector drain system, such as Tremdrain Total Drain or Hydroduct Coil, designed to work in conjunction with the drainage panel. The pipe should be connected to a suitable discharge point inside or outside the basement. We should check the manufacturer's specifications regarding the proposed prefabricated drainage panel material to verify it is appropriate for its intended use. To protect against moisture migration into the below-grade parking levels, we recommend that the below-grade walls be water-proofed and water stops be installed at all construction joints.

If backfill is required behind basement walls, the walls should be braced, or hand compaction equipment used, to prevent unacceptable surcharges on walls (as determined by the Structural Engineer).

7.5 Concrete Slab-on-Grade Floor

The floor slab for the below-grade parking garages should be at least five inches thick and reinforced with No. 4 bars at 18 inches on center. The finished floor for the below-grade parking levels will be well above the design groundwater level. A capillary moisture break and vapor retarder are generally not required below parking slabs-on-grade because there is sufficient air circulation to limit condensation of moisture on the slab surface; however, we recommend a capillary break and vapor retarder be placed in areas where there is a floor covering, areas used for storage, and any enclosed rooms. Where a capillary moisture break/vapor retarder is not used, we recommend six inches of Class 2 aggregate base compacted to at least 95 percent relative compaction be placed beneath the parking garage slab and and ramp.

A capillary moisture break consists of at least four inches of clean, free-draining gravel or crushed rock. The vapor retarder should meet the requirements for Class B vapor retarders stated in ASTM E1745. The vapor retarder should be placed in accordance with the requirements of

ASTM E1643. These requirements include overlapping seams by six inches, taping seams, and sealing penetrations in the vapor retarder.

If required by the structural engineer, the vapor retarder may be covered with two inches of sand to aid in curing the concrete and to protect the vapor retarder during slab construction. The sand overlying the vapor retarder should be moist at the time concrete is placed. However, excess water trapped in the sand could eventually be transmitted as vapor through the slab. Therefore, if rain is forecast prior to pouring the slab, the sand should be covered with plastic sheeting to avoid wetting. If the sand becomes wet, concrete should not be placed until the sand has been dried or replaced. The particle size of the capillary break material and sand (if used) should meet the gradation requirements presented in Table 3.

TABLE 3
Gradation Requirements for Capillary Moisture Break

Sieve Size	Percentage Passing Sieve
Gravel or Crushed Rock	
1 inch	90 – 100
¾ inch	30 – 100
½ inch	5 – 25
3/8 inch	0 – 6
Sand	
No. 4	100
No. 200	0 – 5

Concrete mixes with high water/cement (w/c) ratios result in excess water in the concrete, which increases the cure time and results in excessive vapor transmission through the slab. Therefore, concrete for the floor slab should have a low w/c ratio - less than 0.50. If necessary, workability should be increased by adding plasticizers. In addition, the slab should be properly cured. Before the floor covering is placed, the contractor should check that the concrete surface and the moisture emission levels (if emission testing is required) meet the manufacturer's requirements.

7.6 Temporary Cut Slopes and Shoring

The safety of workers and equipment in or near the excavation is the responsibility of the contractor. The selection, design, construction, and performance of the shoring system should be the responsibility of the contractor. A structural engineer/civil engineer knowledgeable in this type of construction should design the shoring. We should review the geotechnical aspects of the proposed shoring system to ensure that it meets our requirements. During construction, we should observe the installation of the shoring system and check the condition of the soil encountered during excavation.

We judge that temporary cuts in on-site soil which are less than 20 feet high, above groundwater, and inclined in accordance to OSHA guidelines for Type B soil will be stable provided that they are not surcharged by equipment or building material. Temporary shoring will be required where temporary slopes are not possible because of space constraints.

7.6.1 Cantilevered Soldier Pile and Lagging Shoring System

A cantilevered soldier pile and lagging system should be designed using an active equivalent fluid weight of 37 pcf for level backfill conditions, provided there are no building foundations within a horizontal distance equal to 1.5 times the retained soil height. If there are foundations within that horizontal distance, then the shoring should be designed using an at-rest pressure of 56 pcf plus the surcharge load imposed by the building foundation. Where traffic loads are expected within 10 feet of the shoring walls, an additional design load of 100 psf should be applied to the upper 10 feet of the wall. Shoring should be designed for surcharge loads where there will be construction equipment and/or stockpiled soil within a horizontal distance of 1.5 times the excavation height from the edge of excavation; and from adjacent foundations located above an imaginary line that extends at an inclination of 1.5:1 (horizontal: vertical), projected upward from the bottom edge of the proposed excavation that are not underpinned. We can provide recommendations for surcharge pressures once surcharge loads are known.

Passive resistance at the toe of the soldier pile should be computed using an equivalent fluid weights of 260 pcf with a maximum passive earth pressure of 2,500 psf, respectively. The upper foot of soil should be ignored when computing passive resistance. Passive pressure can be assumed to act over an area of three soldier pile widths assuming the toe of the soldier pile is filled with structural concrete. If lean concrete is placed in the soldier pile shaft, the passive pressure can be assumed to act over two pile diameters. These passive pressure values include a factor of safety of at least 1.5.

7.7 Flexible and Rigid Pavement Design

Design recommendations for asphalt concrete and Portland cement concrete pavements are presented in the following sections.

7.7.1 Rigid (Portland Cement Concrete) Pavement

For concrete pavement that will experience only passenger car and light truck traffic, we recommend the concrete be at least five inches thick over six inches of Class 2 aggregate base (AB). The thickness of concrete pavement that may be subject to traffic from heavier vehicles, such as garbage and/or delivery trucks, will depend on the weight of the trucks and the amount of truck traffic. Assuming a maximum single-axle load of 20,000 pounds and a maximum tandem axle of 32,000 pounds, the recommended rigid pavement section for these axle loads is 6-1/2 inches of Portland cement concrete over six inches of Class 2 aggregate base compacted to at least 95 percent relative compaction. Prior to placement of the aggregate base, we should confirm by proof rolling that the native soil subgrade is firm and non-yielding. If the subgrade deflects excessively during proof rolling, it should be scarified, aerated, and recompacted as discussed in Section 7.1 of this report.

The modulus of rupture of the concrete should be at least 500 psi at 28 days. Contraction joints should be constructed at 15-foot spacing. Where the outer edge of a concrete pavement meets asphalt pavement, the concrete slab should be thickened by 50 percent at a taper not to exceed a slope of 1 in 10. Concrete slabs subject to vehicular traffic should be reinforced with a minimum of No. 4 bars spaced at 16 inches in both directions.

7.7.2 Flexible (Asphalt Concrete) Pavement Design

The State of California flexible pavement design method was used to develop the recommended asphalt concrete (AC) pavement sections. Based on the laboratory R-value test results, we used an R-value of 21 for pavement design. Table 4 presents our pavement section recommendations for traffic indices (TIs) of 4.5 through 7.0 and a 30-year pavement design life. Actual TIs should be determined through a traffic engineer's analysis of expected automobile and truck traffic at the site.

TABLE 4
Recommended Asphalt Pavement Sections
30-Year Design Life

TI	Asphaltic Concrete (inches)	Class 2 Aggregate Base R = 78 (inches)
4.5	3.0	7.0
5.0	3.0	9.0
5.5	3.5	9.5
6.0	4.0	10.0
6.5	4.0	12.0
7.0	4.5	12.5
7.5	5.0	13.0
8.0	5.0	15.0

The soil subgrade beneath AC pavements should be prepared and compacted in accordance with the recommendations presented in Section 7.1. In addition, the subgrade should be a firm and non-yielding surface. The subgrade should be proof-rolled to confirm it is non-yielding prior to placing the aggregate base. The Class 2 aggregate base should be moisture-conditioned to near optimum moisture content and compacted to at least 95 percent relative compaction.

7.8 Seismic Design

For design in accordance with the 2013 CBC, we recommend Site Class D be used. The latitude and longitude of the site are 37.5494° and -121.9848°, respectively. Hence, in accordance with the 2013 CBC, we recommend the following:

- S_S = 2.172g, S_1 = 0.896g
- S_{MS} = 2.172g, S_{M1} = 1.344g
- S_{DS} = 1.448g, S_{D1} = 0.896g
- Seismic Design Category E for Risk Categories I, II, and III.

8.0 ADDITIONAL GEOTECHNICAL SERVICES

Prior to construction, Rockridge Geotechnical should review the project plans and specifications to verify that they conform to the intent of our recommendations. During construction, our field engineer should provide on-site observation and testing during site preparation, placement and compaction of fill, and installation of shoring and building foundations. These observations will allow us to compare actual with anticipated subsurface conditions and to verify that the contractor's work conforms to the geotechnical aspects of the plans and specifications.

9.0 LIMITATIONS

This geotechnical investigation has been conducted in accordance with the standard of care commonly used as state-of-practice in the profession. No other warranties are either expressed or implied. The recommendations made in this report are based on the assumption that the subsurface conditions do not deviate appreciably from those disclosed in the exploratory borings and CPTs. If any variations or undesirable conditions are encountered during construction, we should be notified so that additional recommendations can be made. The foundation recommendations presented in this report are developed exclusively for the proposed development described in this report and are not valid for other locations and construction in the project vicinity.

REFERENCES

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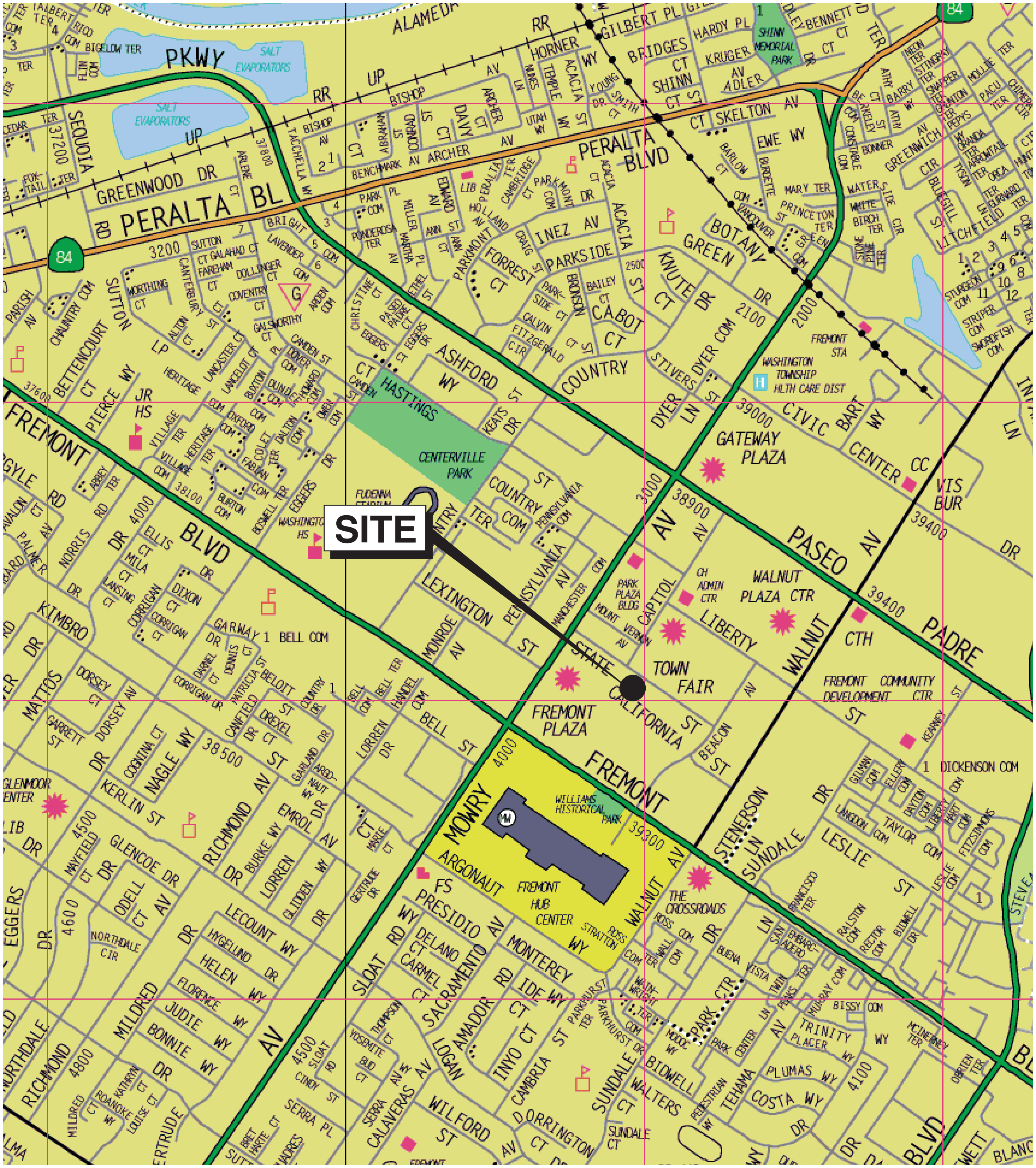
ROCKRIDGE GEOTECHNICAL

FIGURES



Base map: The Thomas Guide
Alameda County
2002

0 1/4 1/2 Mile

Approximate scale

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

SITE LOCATION MAP

Date 06/28/15	Project No. 15-905	Figure 1

Reference: Base map from a drawing titled "Conceptual Site Plan", by KTGY Group, Inc, dated August 11, 2014.

STATE STREET AND CAPITOL AVENUE Fremont, California		
SITE PLAN		
Date 07/09/15	Project No. 15-905	Figure 2

ROCKRIDGE GEOTECHNICAL

Base map: Goolge Earth with U.S. Geological Survey (USGS), Alameda County, 2015.

EXPLANATION

Qha	**Alluvium (Holocene)**
Qpa	**Alluvium (Pleistocene)**
(line)	**Geologic contact: dashed where approximate and dotted where concealed, queried where uncertin**

0 1500 3000 Feet

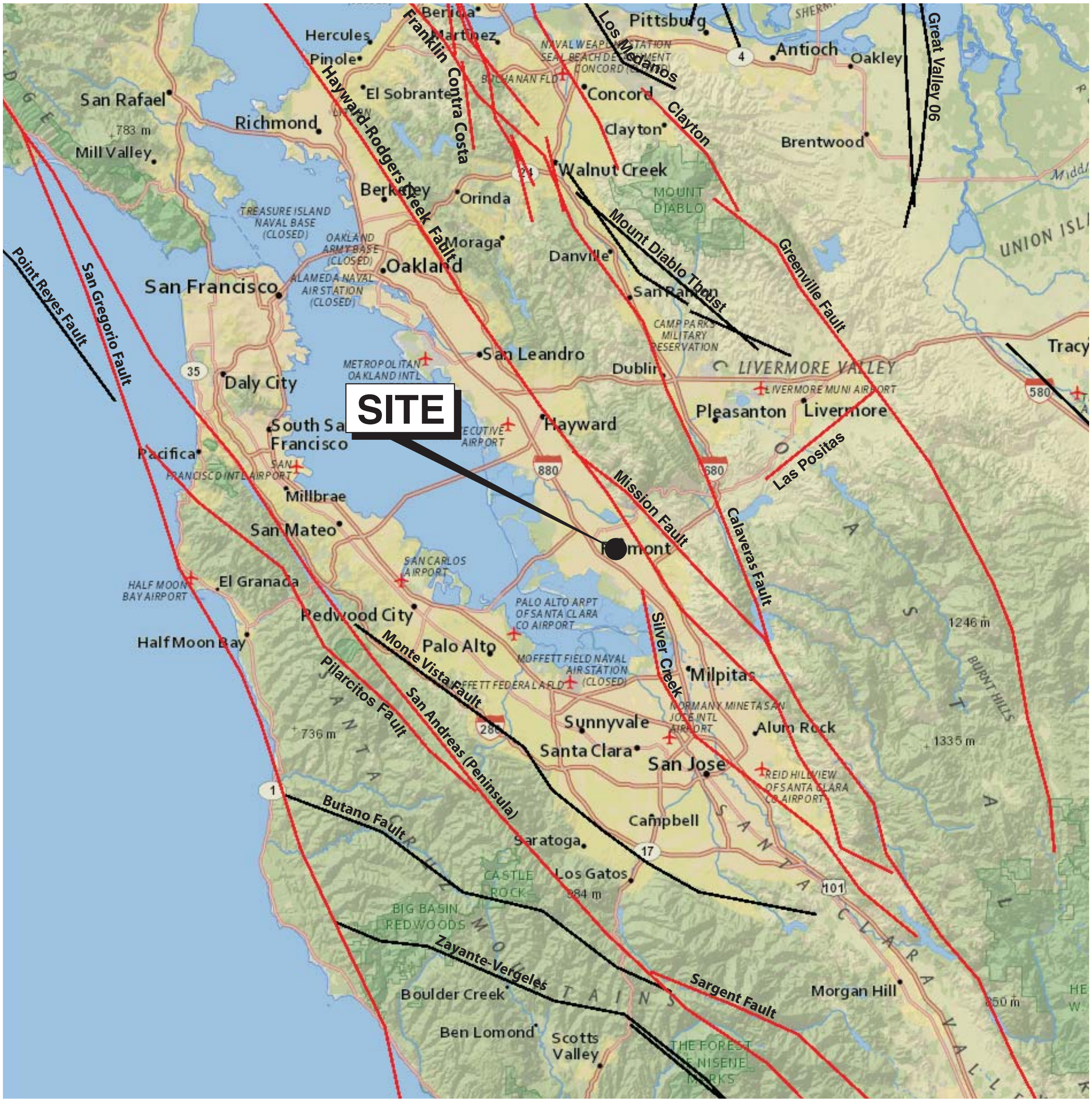
Approximate Scale

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

REGIONAL GEOLOGIC MAP

Date 06/28/15	Project No. 15-905	Figure 3



Base Map: U.S. Geological Survey, National Seismic Hazards Maps - Fault Sources, 2014.

EXPLANATION

Strike slip

Thrust (Reverse)

Normal

0 5 10 Miles

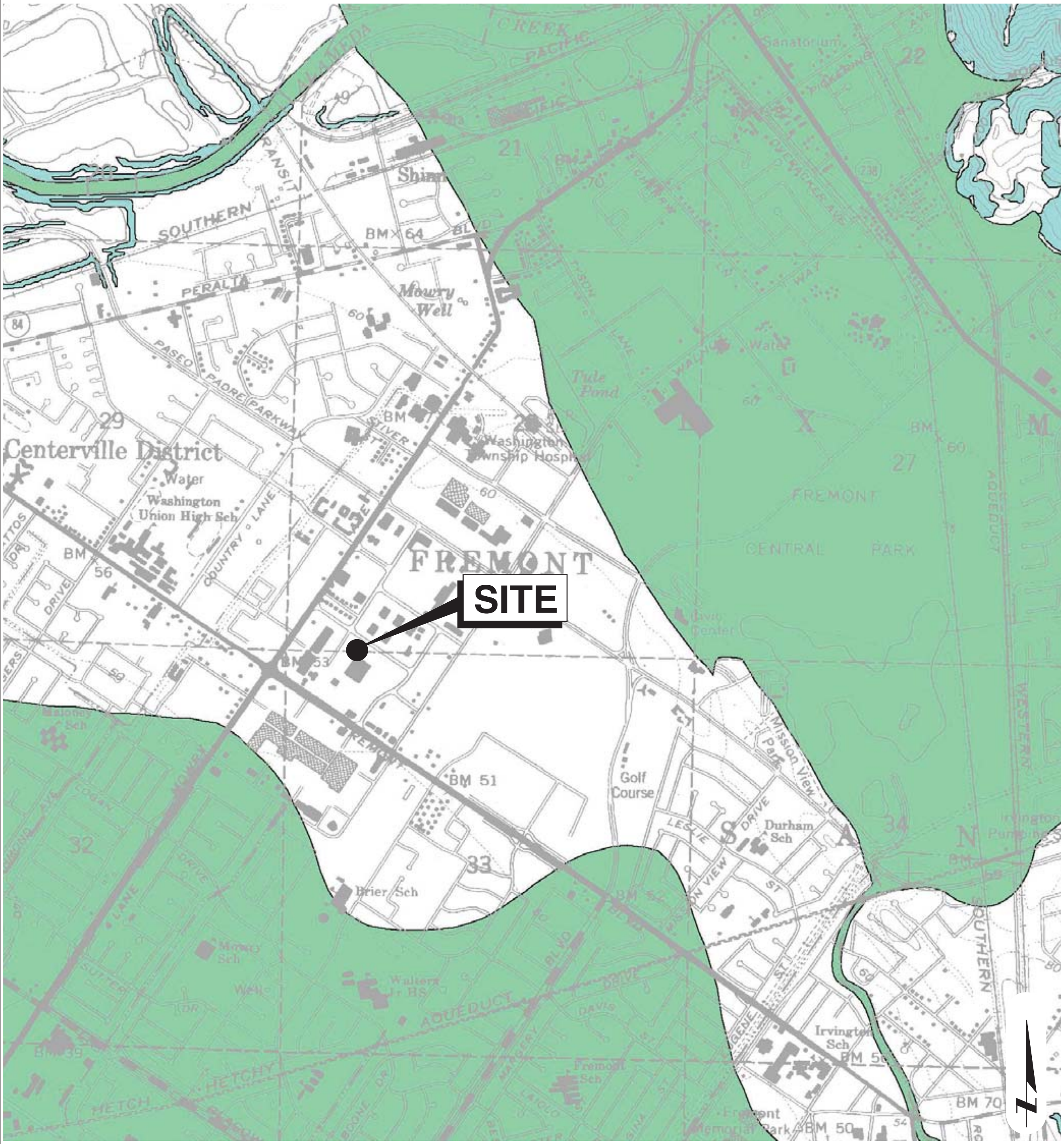
Approximate scale

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

REGIONAL FAULT MAP

Date 06/28/15	Project No. 15-905	Figure 4



EXPLANATION

(green)	**Liquefaction;** Areas where historic occurence of liquefaction, or local topographic, geological, geotechnical, and subsurface water conditions indicate a potential for permanent ground displacements.
(blue)	**Earthquake-Induced Landslides;** Areas where previous occurence of landslide movement, or local topographic, geological, geotechnical, and subsurface water conditions indicate a potential for permanent ground displacements.

0 1,500 3,000 Feet

Approximate scale

Reference:
State of California "Seismic Hazard Zones"
Niles Quadrangle
Released on October 19, 2004

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

REGIONAL SEISMIC HAZARDS MAP

Date 06/28/15 | Project No. 15-905 | Figure 5

ROCKRIDGE GEOTECHNICAL

APPENDIX A

Logs of Test Borings and Cone Penetration Tests

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-1

Boring location:	See Site Plan, Figure 2
Date started: 6/17/15	Date finished: 6/17/15
Drilling method:	Hollow Stem Auger
Hammer weight/drop: 140 lbs./30 inches	Hammer type: Downhole
Sampler:	Sprague & Henwood (S&H)
Logged by:	K. Samlik

LABORATORY TEST DATA

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0					3 inches Asphalt						
0–1.5				SP	GRAVELLY SAND (SP) brown, medium dense, moist						
2	S&H	8, 8, 17	18	CL	CLAY with SAND (CL) black, very stiff, moist						
4	S&H	12, 16, 18	24	CL	dark brown						
5				CL	light brown, increased sand content LL = 34, PL = 16, PI = 18	TxUU	500	2,400		15.6	111
6	S&H	8, 9, 12	15	CL		TxUU	550	2,880		17.9	112
6.5–7.5				CL	SANDY CLAY (CL) light brown, stiff, moist, fine-grained sand						
8	S&H	5, 6, 7	9	SM	SILTY SAND (SM) light brown, loose, moist, fine gravel				38		
11	S&H	5, 7, 12	13	CL	SANDY CLAY (CL) olive-brown, stiff, moist, fine-grained sand						
16	S&H	9, 11, 14	18	ML	SANDY SILT (ML) light brown, very stiff, moist, fine-grained sand				62		
21	S&H	9, 10, 12	15	ML							
26	S&H	7, 12, 20	22	ML							

Boring terminated at a depth of 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905
Figure: A-1

PROJECT:	STATE STREET AND CAPITOL AVENUE Fremont, California	Log of Boring B-2
		PAGE 1 OF 1

Boring location: See Site Plan, Figure 2

Date started: 6/17/15 | Date finished: 6/17/15

Drilling method: Hollow Stem Auger

Hammer weight/drop: 140 lbs./30 inches | Hammer type: Downhole

Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)

Logged by: K. Samlik

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0					3 inches Asphalt						
1				SP	GRAVELLY SAND (SP) brown, medium dense, moist						
2	S&H	13 14 21	25	CL	CLAY with SAND (CL) black, very stiff, moist LL = 32, PL = 18, PI = 14					15.7	118
4	S&H	16 19 32	36	CL	dark brown, hard						
6	S&H	14 16 18	24	CL	very stiff						
7–8	S&H	9 10 12	15	CL	CLAY with SAND (CL) brown, very stiff, moist, fine-grained sand						
10–11	S&H	5 7 12	13	ML	SANDY SILT (ML) light brown, stiff, moist, fine-grained sand				81		
16	S&H	10 11 13	17	ML	very stiff						
21	S&H	9 11 12	16	ML							
24	S&H	30 26 20	32	SW	GRAVELLY SAND (SW) brown, dense, moist						
26	SPT	24 31 36	80	SW	very dense						

Boring terminated at a depth of 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905 | Figure: A-2

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-3

Boring location: See Site Plan, Figure 2
Logged by: K. Samlik
Date started: 6/17/15
Date finished: 6/17/15
Drilling method: Hollow Stem Auger
Hammer weight/drop: 140 lbs./30 inches
Hammer type: Downhole
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0					2- 3 inches Asphalt						
0–1				CL	SANDY CLAY (CL) brown, stiff, moist						
1–2	S&H	9, 8, 12	14	CL	CLAY with SAND (CL) black, stiff, moist LL = 30, PL = 17, PI = 13					18.0	114
3–4	S&H	11, 23, 27	35	CL	dark brown, hard; hard						
5–6	S&H	7, 9, 10	13	CL	brown, stiff						
6–8	S&H	6, 8, 9	12	SM	SILTY SAND (SM) light brown, medium dense, moist, fine-grained sand				44		
10–11	SPT	4, 5, 5	12	SM							
15–16	SPT	5, 6, 9	18	SM							
20–21	S&H	9, 11, 16	19	SM							
25–26	SPT	17, 20, 28	58	SM	very dense						
26–27				SP	SAND with GRAVEL (SP) dark brown, very dense, moist						

Boring terminated at a depth of 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905
Figure: A-3

PROJECT:	STATE STREET AND CAPITOL AVENUE Fremont, California	**Log of Boring B-4** PAGE 1 OF 2

Boring location: See Site Plan, Figure 2
Date started: 6/17/15 | Date finished: 6/17/15
Drilling method: Hollow Stem Auger
Hammer weight/drop: 140 lbs./30 inches | Hammer type: Downhole
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)

Logged by: K. Samlik

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0					3 inches Asphalt						
0–1				SC	CLAYEY SAND with GRAVEL (SC) brown, medium dense, moist						
1–2	S&H	8, 13, 25	27								
1.5–5				CL	CLAY with SAND (CL) brown, very stiff, moist, trace gravel						
5–6	S&H	12, 24, 32	39	CL	CLAY with SAND (CL) brown, hard, moist						
6–20				SM	SILTY SAND (SM) light brown, medium dense, moist, fine-grained sand						
10–11.5	S&H	13, 16, 21	26								
12–13.5	S&H	12, 15, 20	25						38		
15–16.5	S&H	10, 11, 14	18								
20–25				SP	SAND with GRAVEL (SP) brown, dense, moist, trace fines						
20–21.5	SPT	9, 11, 16	32								
25–30				SP	GRAVELLY SAND (SP) brown, dense, moist						
25–26.5	SPT	13, 16, 19	42								

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905 | Figure: A-4a

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-4

DEPTH (feet)	Sampler Type	Sample	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
31	SPT		17 18 20	46	SP	GRAVELLY SAND (SP) (continued)						
35–36	S&H		13 7 8	11	CL	CLAY (CL) olive-brown, stiff, moist						

Boring terminated at a depth of 36.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905

Figure: A-4b

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-5

Boring location: See Site Plan, Figure 2
Logged by: K. Samlik
Date started: 6/17/15 Date finished: 6/17/15
Drilling method: Hollow Stem Auger
Hammer weight/drop: 140 lbs./30 inches Hammer type: Downhole
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–3	S&H	11 23 30	37	CL	CLAY (CL) brown, hard, moist						
3–5	S&H	12 22 28	35	SC	CLAYEY SAND (SC) dark brown with mottled brown, dense, moist LL = 33, PL = 15, PI = 18				50	15.2	117
5–6.5	S&H	13 15 19	22	SC	dark brown, medium dense						
6.5–7.5				CL	SANDY CLAY (CL) brown, very stiff, moist						
7.5–10	S&H	9 12 15	19	SC	CLAYEY SAND (SC) brown, medium dense, moist						
10–24	S&H	5 7 11	13	ML	SANDY SILT (ML) light brown, stiff, moist, fine-grained sand				86		
	S&H	17 9 11	14	ML							
	S&H	7 8 10	13	ML							
24–25.6				CL	CLAY (CL) brown, hard, moist						
25.6–26.4	S&H	7 23 42	46	SP	SAND (SP) brown, dense, moist						
26.4–26.5				GP	SANDY GRAVEL (GP) brown, dense, moist						

Boring terminated at a depth of 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905 Figure: A-5

PROJECT:	STATE STREET AND CAPITOL AVENUE Fremont, California	Log of Boring B-6 PAGE 1 OF 2

Boring location: See Site Plan, Figure 2

Logged by: K. Samlik

Date started: 6/17/15 | Date finished: 6/17/15

Drilling method: Hollow Stem Auger

Hammer weight/drop: 140 lbs./30 inches | Hammer type: Downhole

Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)

DEPTH (feet)	SAMPLES: Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	LABORATORY TEST DATA: Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0					3 inches Asphalt						
0–1				SP	SAND with GRAVEL (SP) light brown, medium dense, moist						
1–5				CL	CLAY (CL) dark brown, very stiff, moist						
2	S&H	13, 12, 19	22								
5–10				SM	SILTY SAND (SM) brown, medium dense, moist, fine-grained						
6	S&H	5, 7, 8	11						43		
10–12				CL	CLAY with SAND (CL) light brown, stiff, moist						
11	S&H	5, 7, 10	12								
12–30				SP	SAND (SP) brown, medium dense, moist						
13	S&H	8, 9, 11	14						5		
16	SPT	9, 7, 8	18								
21	SPT	9, 7, 3	12		trace fines gravel present						
26	SPT	9, 11, 14	30		medium dense to dense, gravel present						
30											

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905 | Figure: A-6a

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-6

DEPTH (feet)	Sampler Type	Sample	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
31	SPT		6 12 15	32	SC	CLAYEY SAND (SC) olive brown, dense, moist						
32												
33												
34												
35												
36	S&H		7 9 10	13	CL	CLAY (CL) olive brown, stiff, moist						
37												
38												
39	S&H		10 12 13	19		very stiff						
40												
41												
42												
43												
44												
45												
46												
47												
48												
49												
50												
51												
52												
53												
54												
55												
56												
57												
58												
59												
60												

Boring terminated at a depth of 40 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905

Figure: A-6b

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-7

Boring location: See Site Plan, Figure 2
Logged by: K. Samlik
Date started: 6/18/15 Date finished: 6/18/15
Drilling method: Hollow Stem Auger
Hammer weight/drop: 140 lbs./30 inches Hammer type: Downhole
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0					3 inches Asphalt						
				CL	SANDY CLAY with GRAVEL (CL) brown, very stiff, moist						
1–2	S&H	12 14 16	21	CL	CLAY with SAND (CL) dark brown, very stiff, moist						
5–6	S&H	9 12 14	18		brown						
10–11	S&H	7 11 13	17		increased sand content LL = 27, PL = 17, PI = 10				69	16.4	114
12–13	S&H	7 9 10	13	ML	SANDY SILT (ML) light brown, stiff, moist, fine-grained sand				55		
15–16	S&H	8 10 11	15	CL	SILTY CLAY with SAND (CL) brown, stiff to very stiff, moist LL = 26, PL = 19, PI = 7	TxUU	1,300	2,630		16.2	113
20–21	SPT	7 9 10	23	SC	CLAYEY SAND (SC) brown, medium dense, moist						
25–26	SPT	8 10 11	25		dark brown						
					olive-brown						
30											

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905
Figure: A-7a

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-7

DEPTH (feet)	Sampler Type	Sample	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
31	SPT		10 8 9	20	SP	SAND with GRAVEL (SP) brown, medium dense, moist				13		
32												
33												
34	S&H		11 14 19	23	CL	SANDY CLAY (CL) olive, very stiff, moist						
35					CL	CLAY (CL) olive, very stiff, moist						
					SP	SAND (SP) brown, medium dense, moist						
36–60												

Boring terminated at a depth of 35 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905

Figure: A-7b

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions		Symbols	Typical Names
Coarse-Grained Soils (more than half of soil > no. 200 sieve size	**Gravels** (More than half of coarse fraction > no. 4 sieve size)	**GW**	Well-graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	Sands (More than half of coarse fraction < no. 4 sieve size)	**SW**	Well-graded sands or gravelly sands, little or no fines
		SP	Poorly-graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
Fine -Grained Soils (more than half of soil < no. 200 sieve size)	**Silts and Clays** LL = < 50	**ML**	Inorganic silts and clayey silts of low plasticity, sandy silts, gravelly silts
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
		OL	Organic silts and organic silt-clays of low plasticity
	Silts and Clays LL = > 50	**MH**	Inorganic silts of high plasticity
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic silts and clays of high plasticity
Highly Organic Soils		**PT**	Peat and other highly organic soils

GRAIN SIZE CHART

Classification	Range of Grain Sizes: U.S. Standard Sieve Size	Range of Grain Sizes: Grain Size in Millimeters
Boulders	Above 12"	Above 305
Cobbles	12" to 3"	305 to 76.2
Gravel	3" to No. 4	76.2 to 4.76
coarse	3" to 3/4"	76.2 to 19.1
fine	3/4" to No. 4	19.1 to 4.76
Sand	No. 4 to No. 200	4.76 to 0.075
coarse	No. 4 to No. 10	4.76 to 2.00
medium	No. 10 to No. 40	2.00 to 0.420
fine	No. 40 to No. 200	0.420 to 0.075
Silt and Clay	Below No. 200	Below 0.075

▽ Unstabilized groundwater level

▼ Stabilized groundwater level

SAMPLE DESIGNATIONS/SYMBOLS

- Sample taken with Sprague & Henwood split-barrel sampler with a 3.0-inch outside diameter and a 2.43-inch inside diameter. Darkened area indicates soil recovered
- Classification sample taken with Standard Penetration Test sampler
- Undisturbed sample taken with thin-walled tube
- Disturbed sample
- Sampling attempted with no recovery
- Core sample
- Analytical laboratory sample
- Sample taken with Direct Push sampler
- Sonic

SAMPLER TYPE

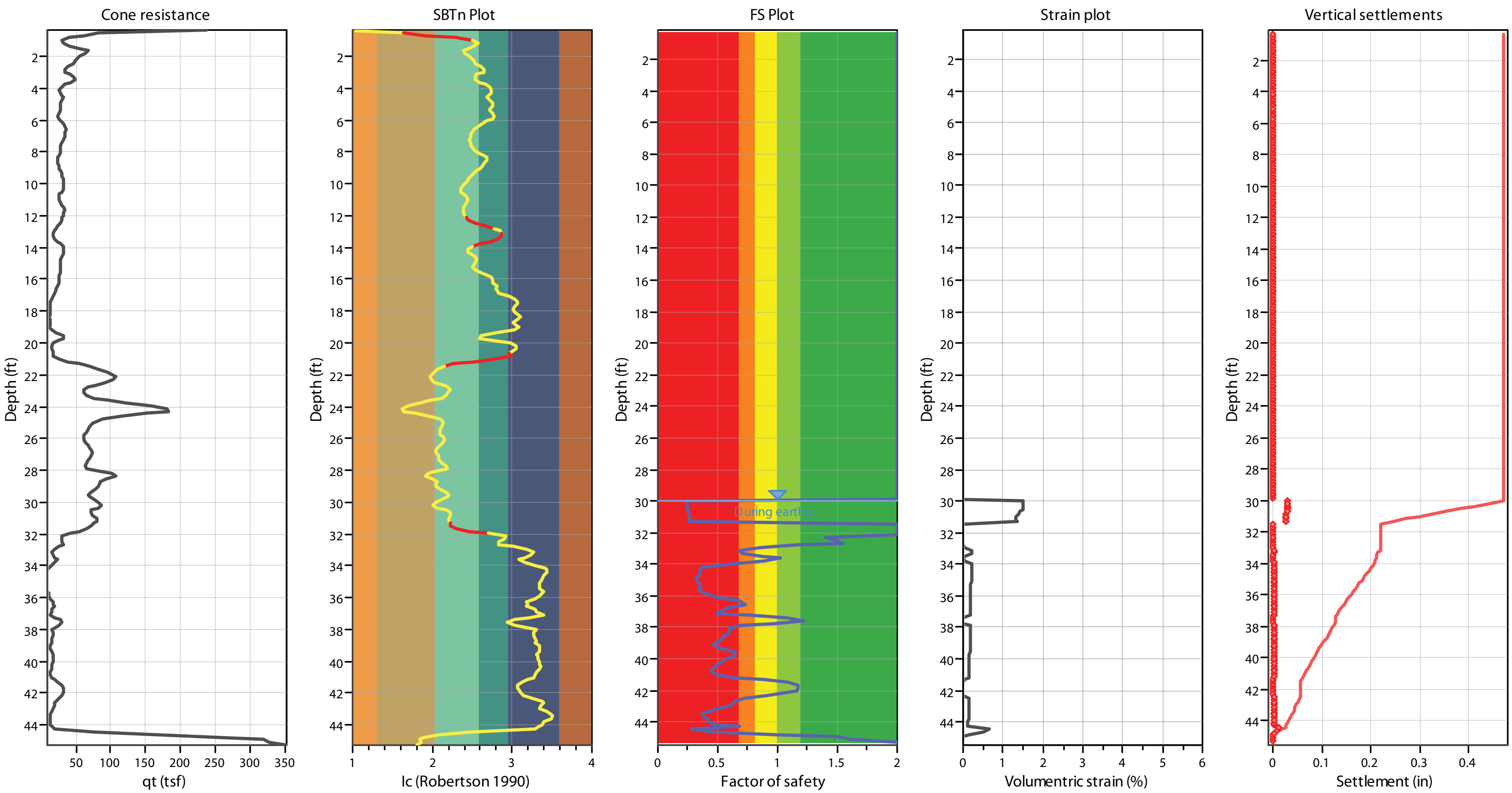
C	Core barrel
CA	California split-barrel sampler with 2.5-inch outside diameter and a 1.93-inch inside diameter
D&M	Dames & Moore piston sampler using 2.5-inch outside diameter, thin-walled tube
O	Osterberg piston sampler using 3.0-inch outside diameter, thin-walled Shelby tube
PT	Pitcher tube sampler using 3.0-inch outside diameter, thin-walled Shelby tube
S&H	Sprague & Henwood split-barrel sampler with a 3.0-inch outside diameter and a 2.43-inch inside diameter
SPT	Standard Penetration Test (SPT) split-barrel sampler with a 2.0-inch outside diameter and a 1.5-inch inside diameter
ST	Shelby Tube (3.0-inch outside diameter, thin-walled tube) advanced with hydraulic pressure

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CLASSIFICATION CHART

Date 06/28/15 | Project No. 15-905 | Figure A-8



Total depth: ____ ft, Date: _________
Measured Groundwater Depth: ___ feet
Approximate Ground Surface Elevation: ________________
Cone Operator: _______________________

SBT legend

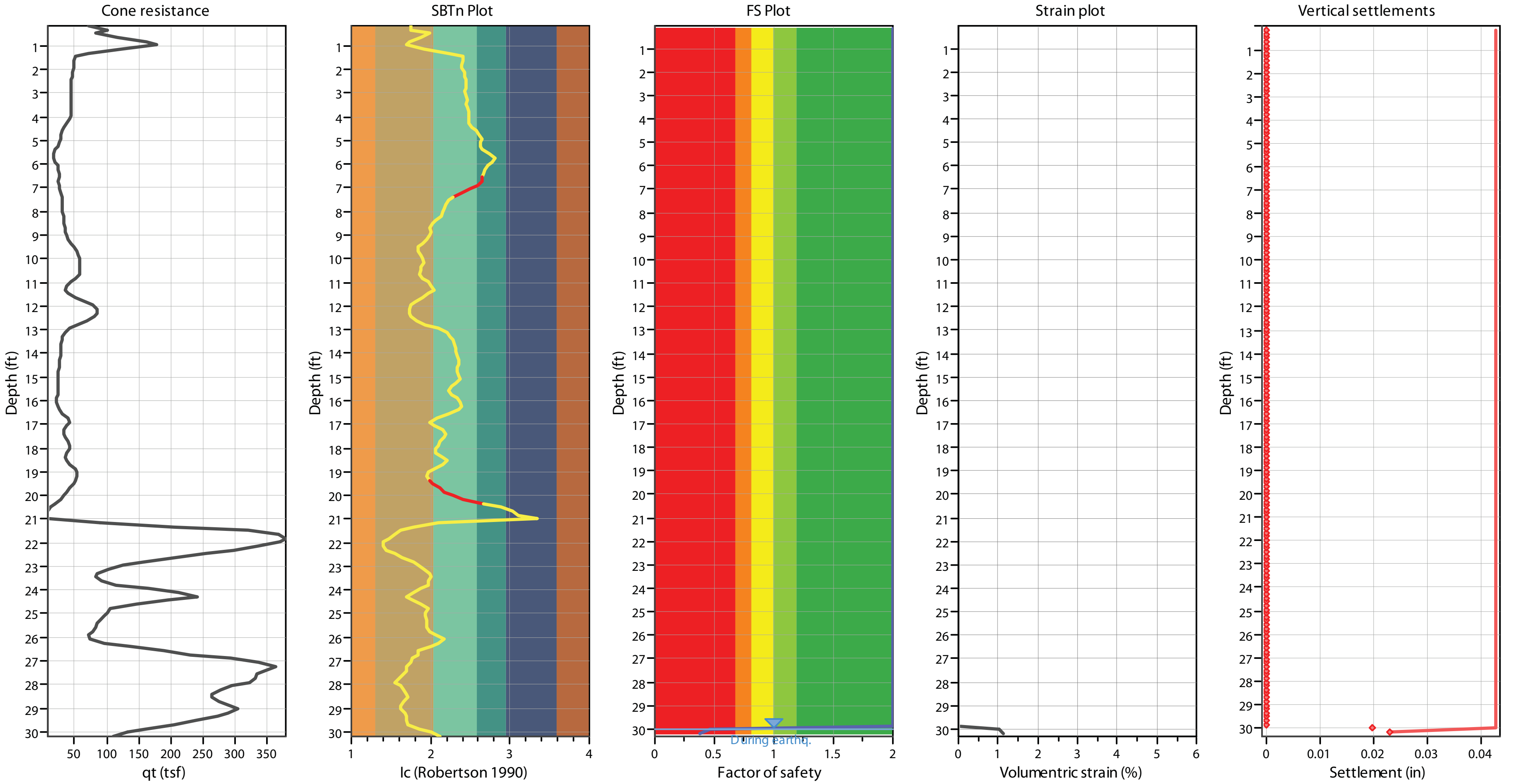
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-1

Date 07/07/15	Project No. 15-905	Figure A-9



SBT legend

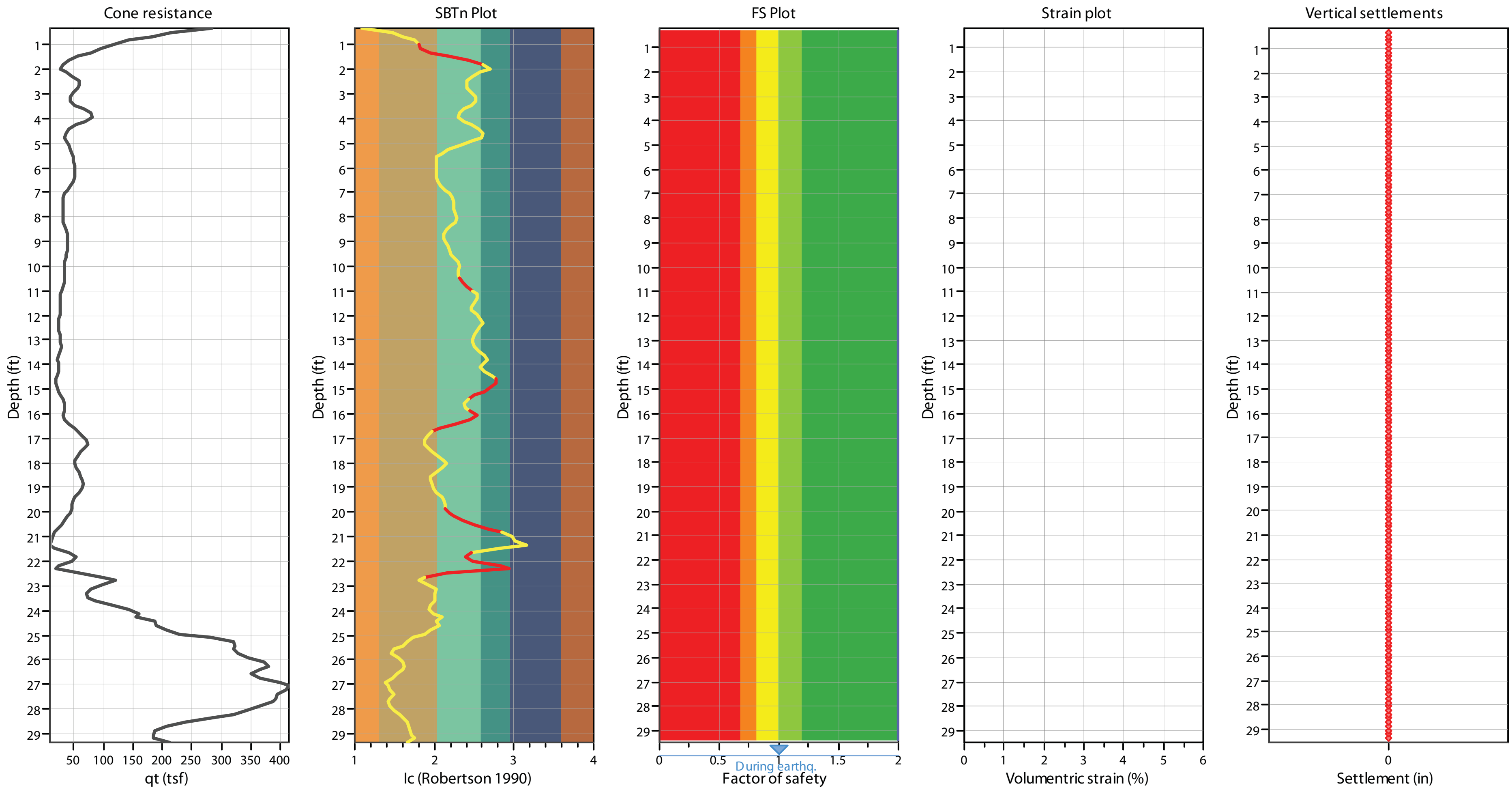
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-2

Date 07/07/15 | Project No. 15-905 | Figure A-10



SBT legend

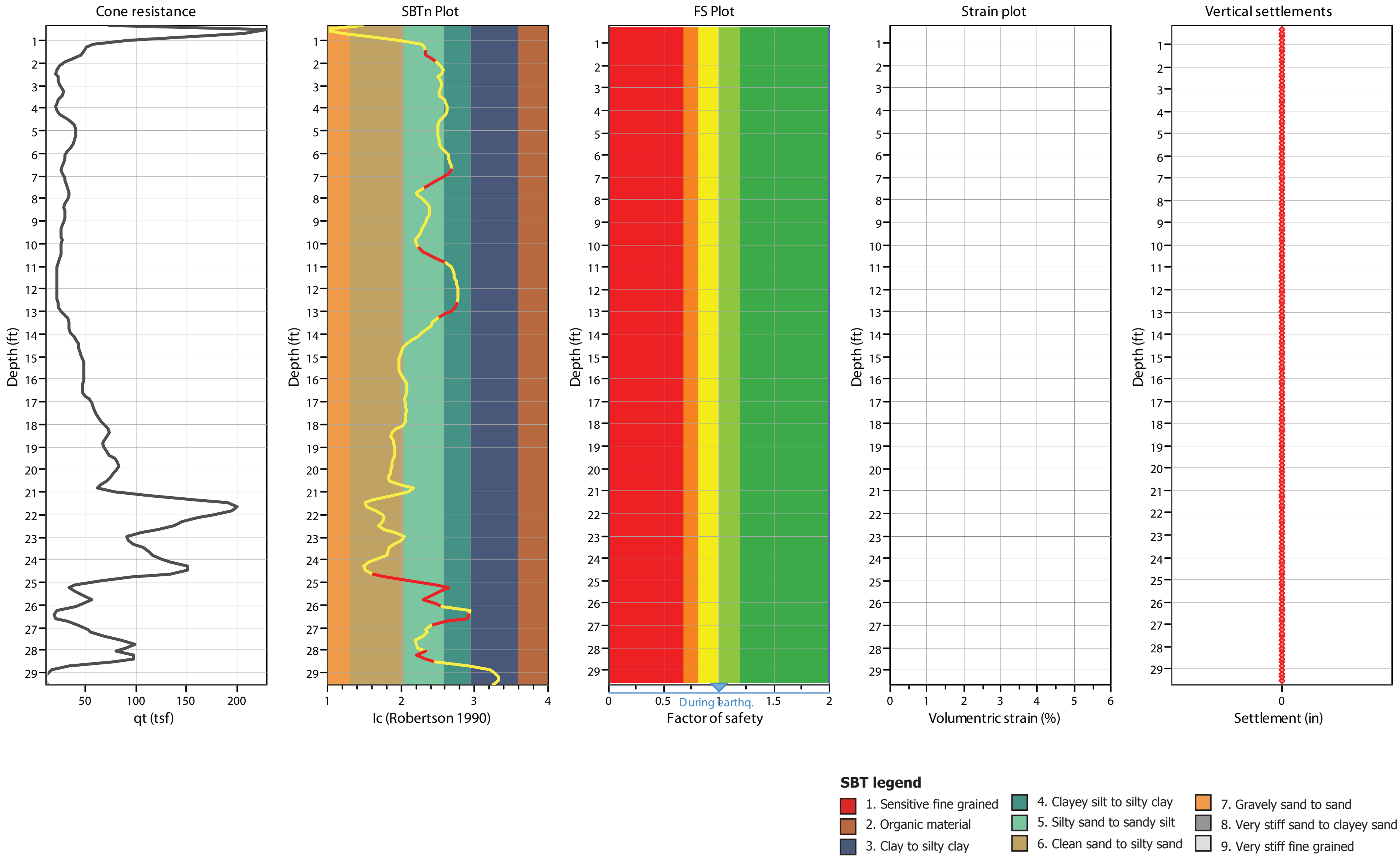
- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-3

Date 07/07/15	Project No. 15-905	Figure A-11

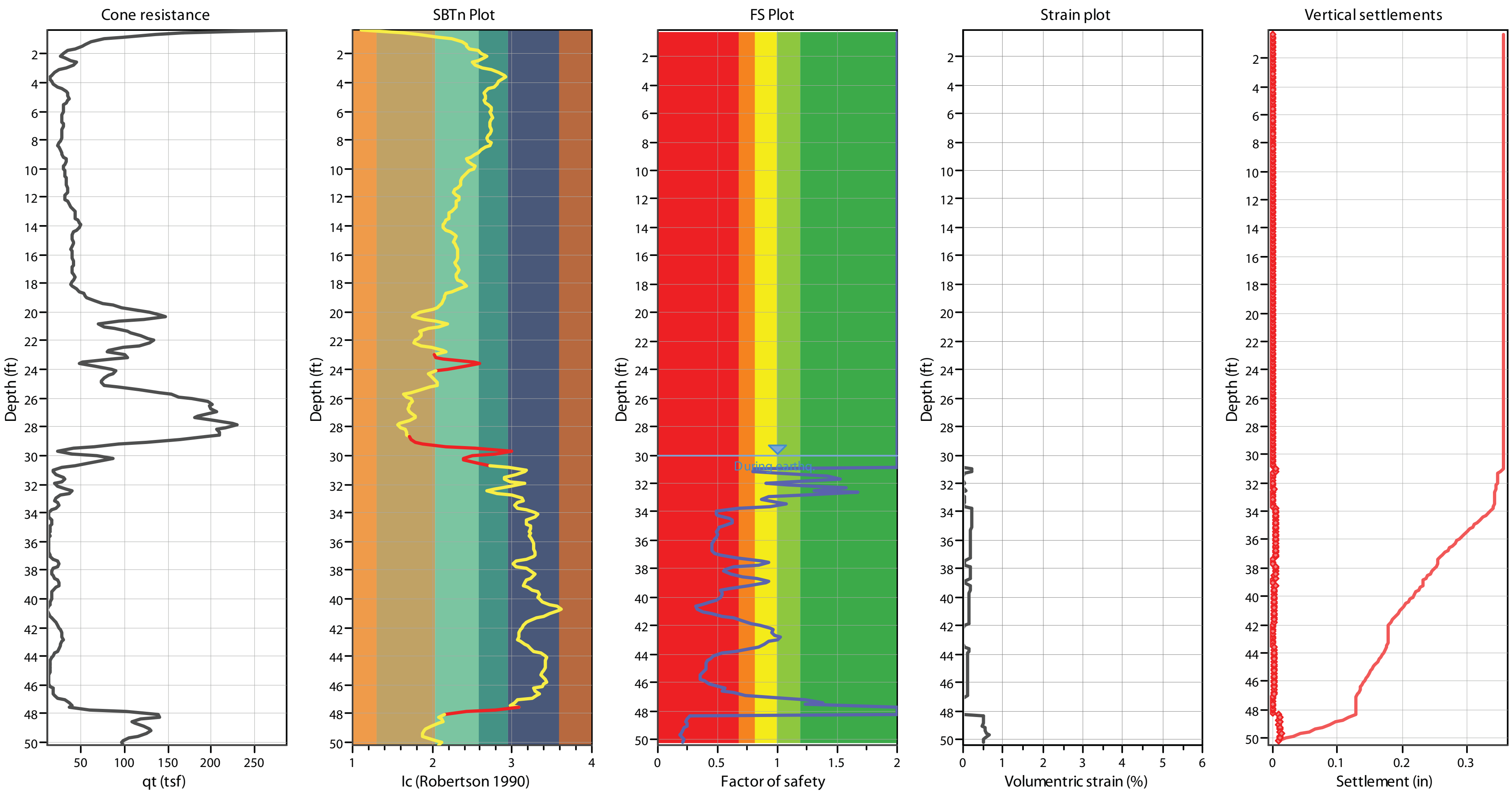


STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-4

Date 07/07/15	Project No. 15-905	Figure A-12



SBT legend

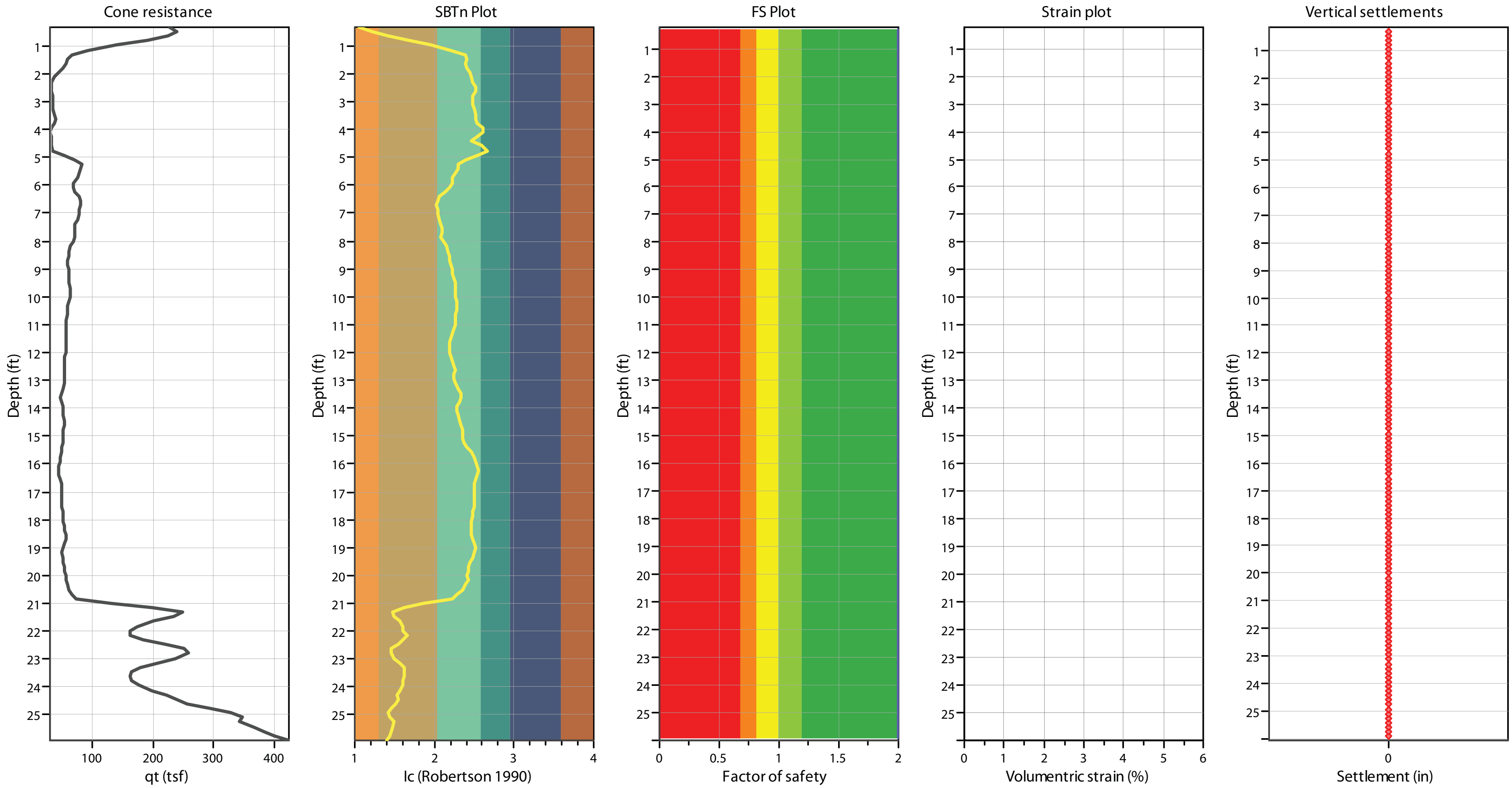
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-5

Date 07/07/15	Project No. 15-905	Figure A-13



SBT legend

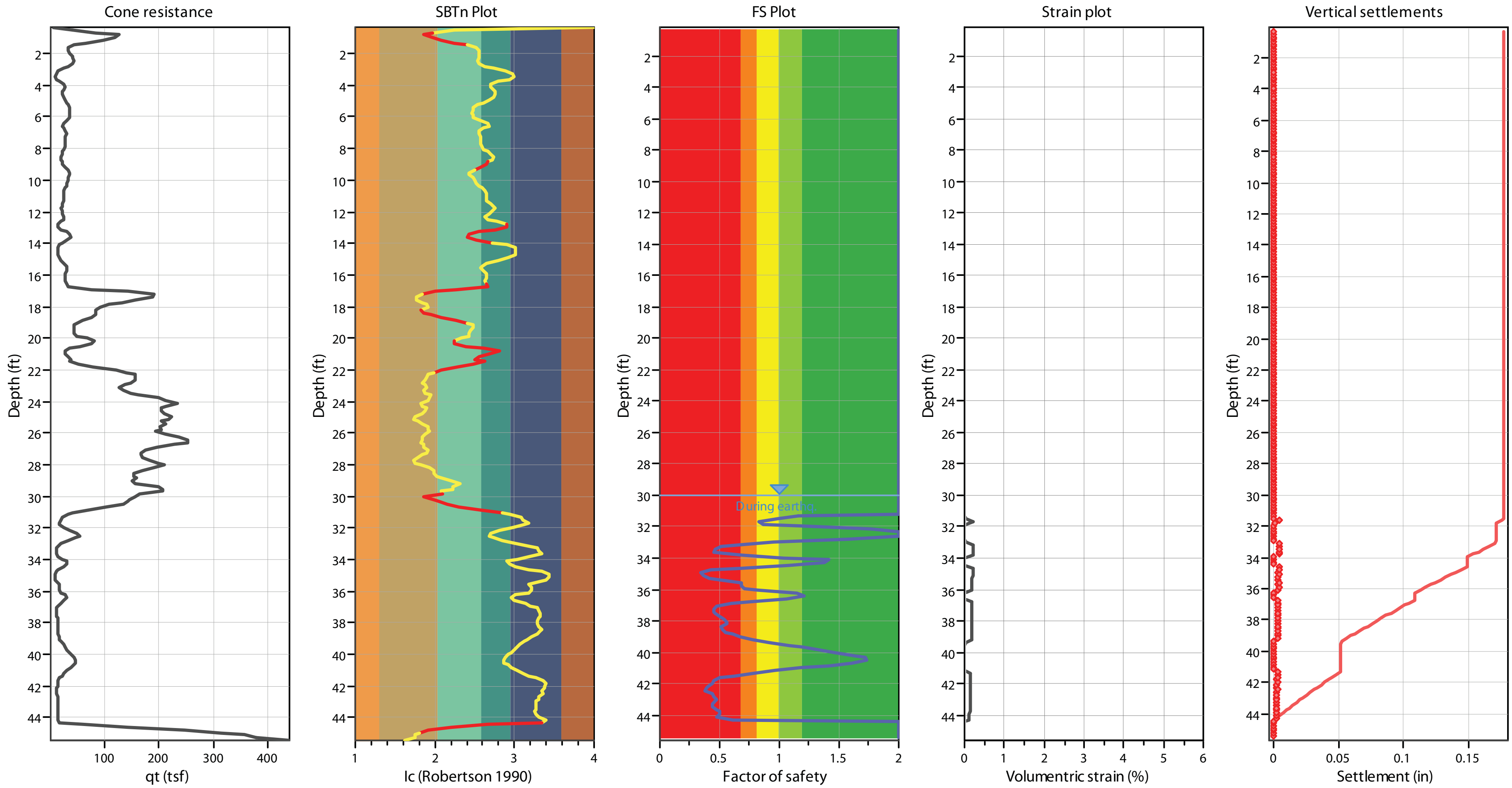
- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-6

Date 07/07/15	Project No. 15-905	Figure A-14



SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS

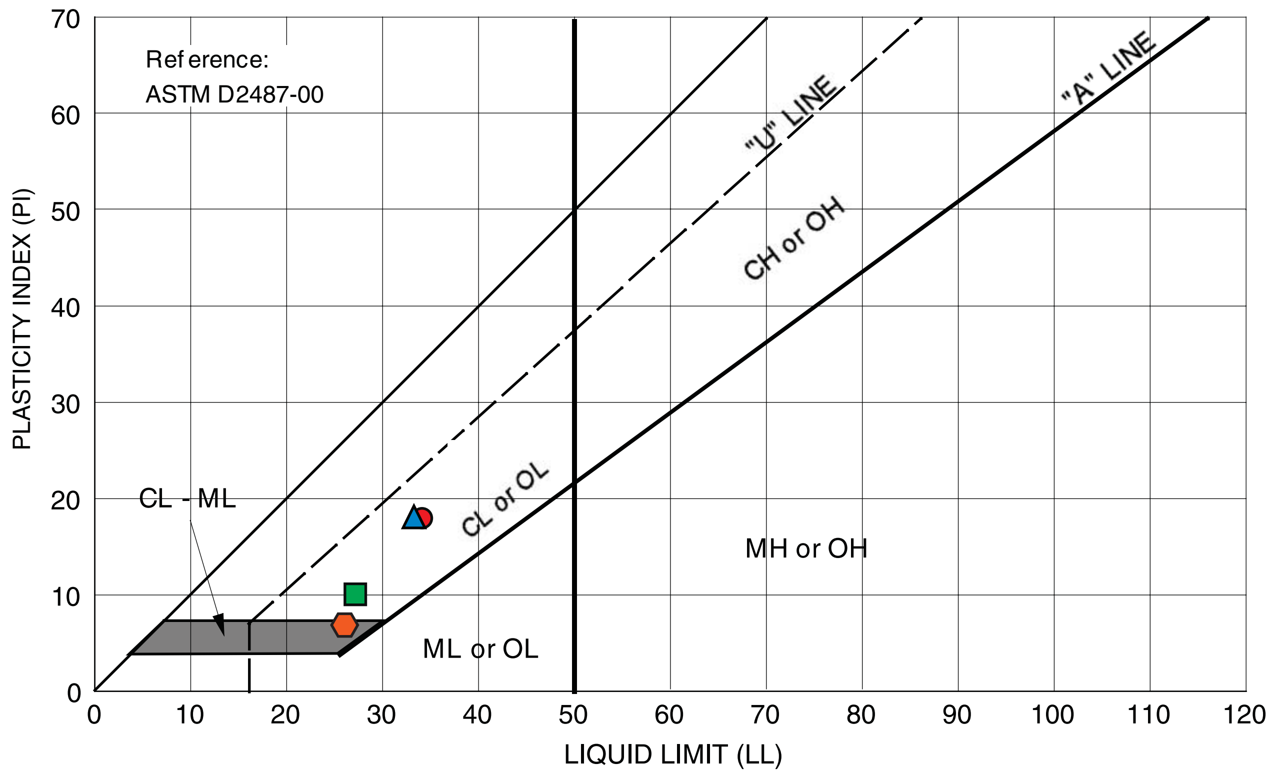
CPT-7

Date 07/07/15	Project No. 15-905	Figure A-15

ROCKRIDGE
GEOTECHNICAL

APPENDIX B

Laboratory Test Data



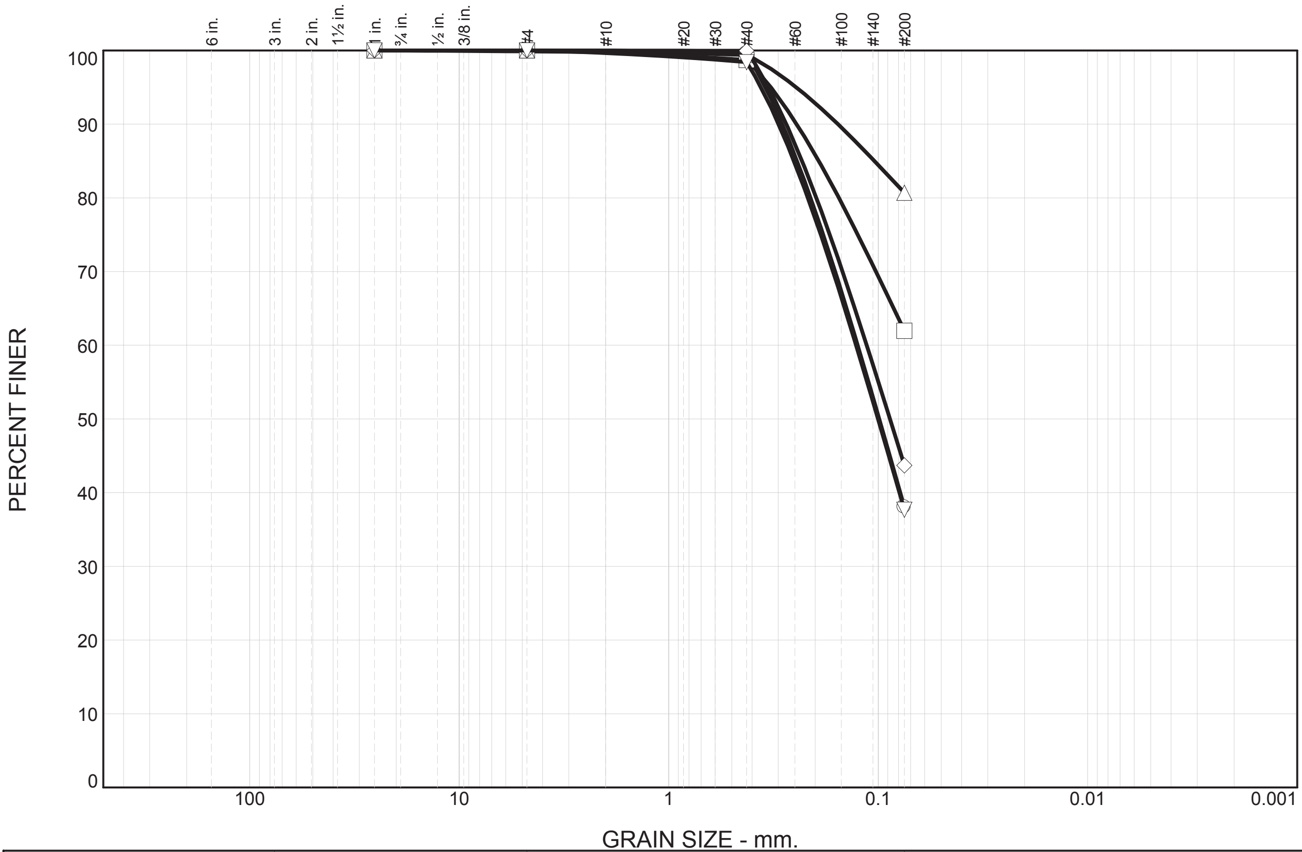
Symbol	Source	Description and Classification	Natural M.C. (%)	Liquid Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
● (red circle)	B-1 at 5.0 feet	CLAY (CL), light brown	15.6	34	18	--
▲ (blue triangle)	B-5 at 3.5 feet	CLAYEY SAND (SC), dark brown with mottled brown	15.2	33	18	50
■ (green square)	B-7 at 10.5 feet	CLAY (CL), dark brown	16.4	27	10	69
⬢ (orange hexagon)	B-7 at 15.5 feet	CLAY with SAND (CL), brown	16.2	26	7	--

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

PLASTICITY CHART

Date 07/07/15 | Project No. 15-905 | Figure B-1



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

MATERIAL DATA

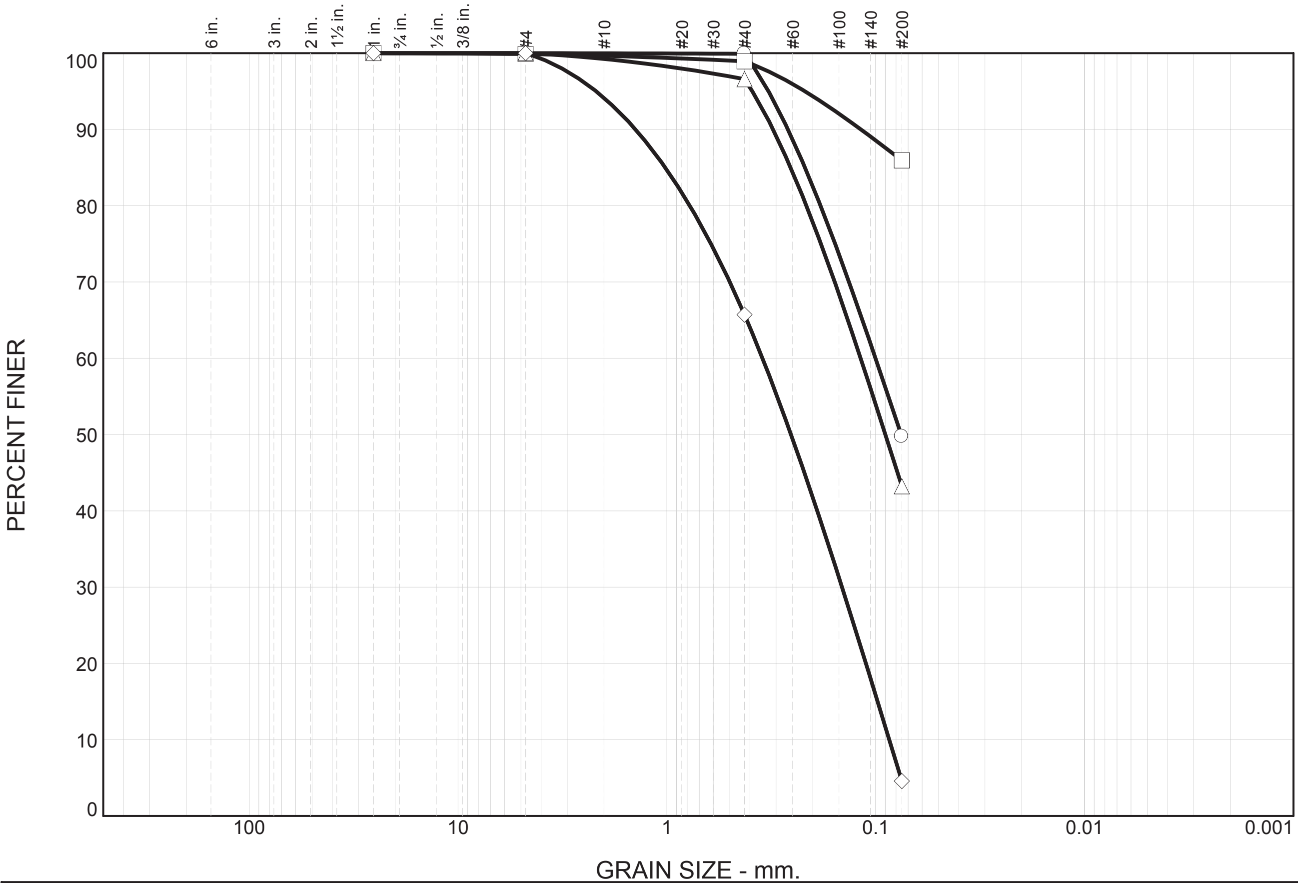
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-1	7	8.0'	SILTY SAND, light brown	SM
□	B-1	11	15.5'	SANDY CLAY, olive-brown	SM
△	B-2	10	10.5'	SANDY SILT, light brown	ML
◇	B-3	7	7.5'	SILTY SAND, light brown	SM
▽	B-4	7	12.5'	SILTY SAND, light brown	SM

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION REPORT

Date 07/07/15 | Project No. 15-905 | Figure B-2



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

MATERIAL DATA

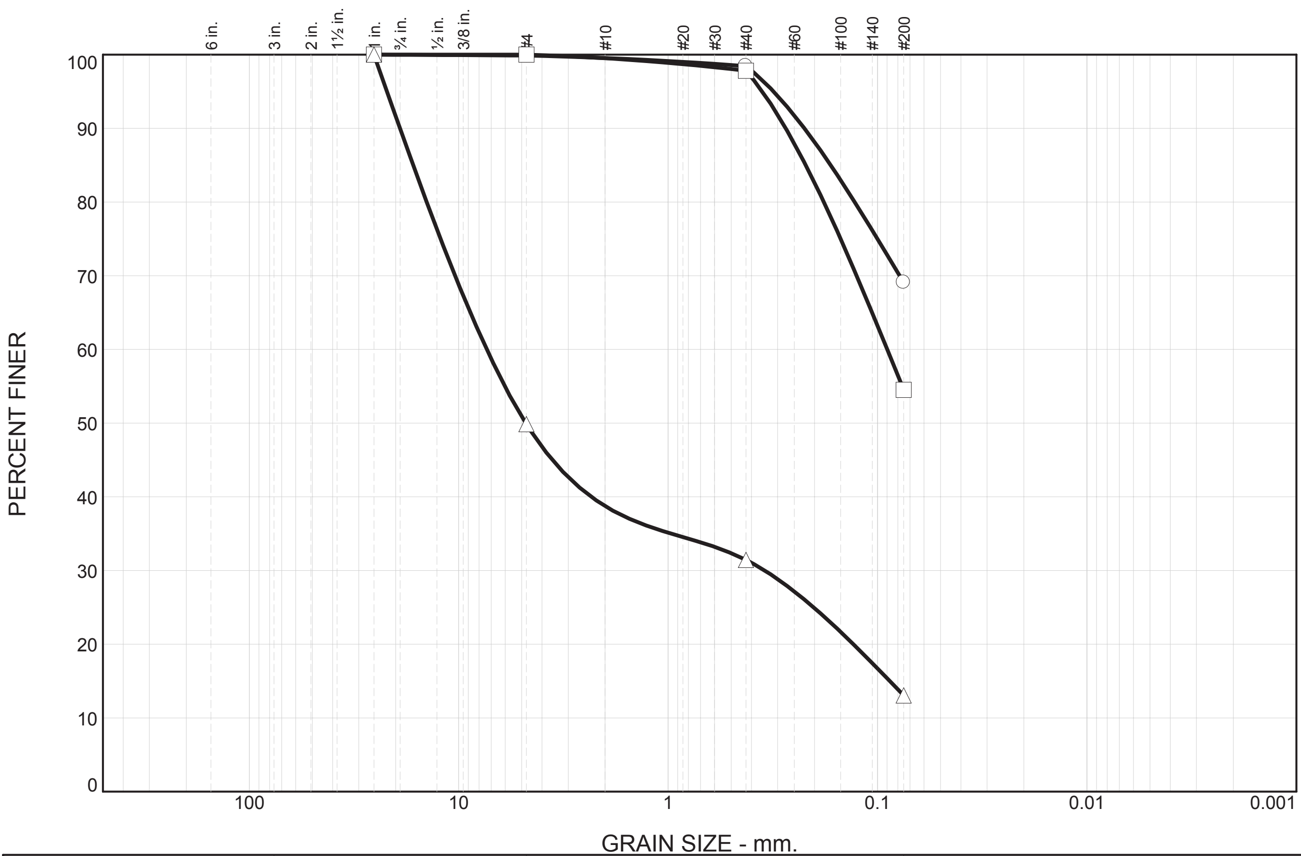
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-5	4	3.5'	SILTY SAND, dark brown with mottled brown	SC
□	B-5	9	11.0'	CLAYEY SAND, brown	ML
△	B-6	4	6.0'	SILTY SAND, brown	SM
◇	B-6	7	12.0'	SAND, brown	SP

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION REPORT

Date 07/07/15 | Project No. 15-905 | Figure B-3



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

MATERIAL DATA

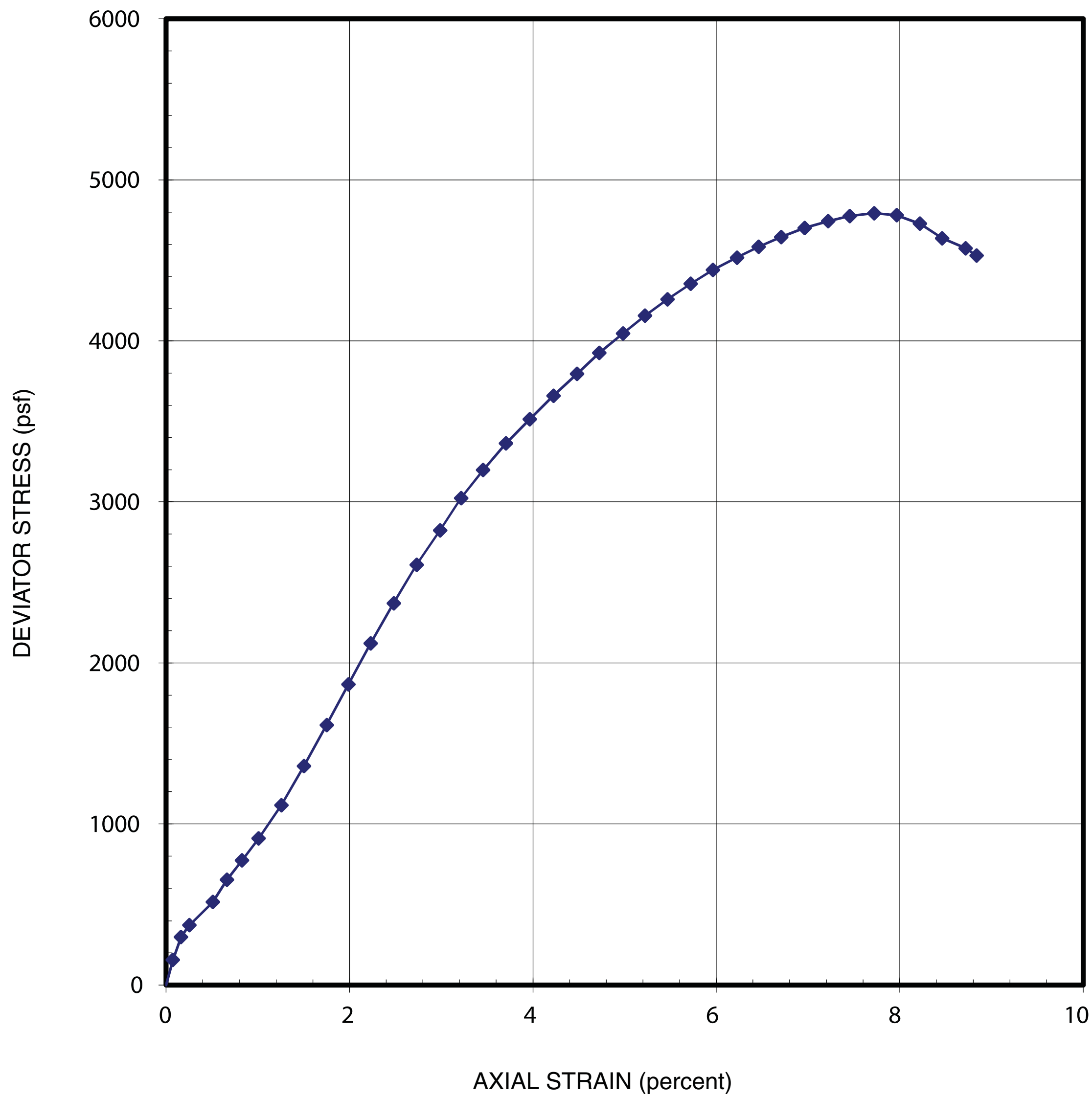
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-7	6	10.5'	CLAY, brown	CL
□	B-7	8	12.5'	SANDY SILT	ML
△	B-7	14	30.0'	SAND with GRAVEL, brown	SP

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION REPORT

Date 07/07/15	Project No. 15-905	Figure B-4



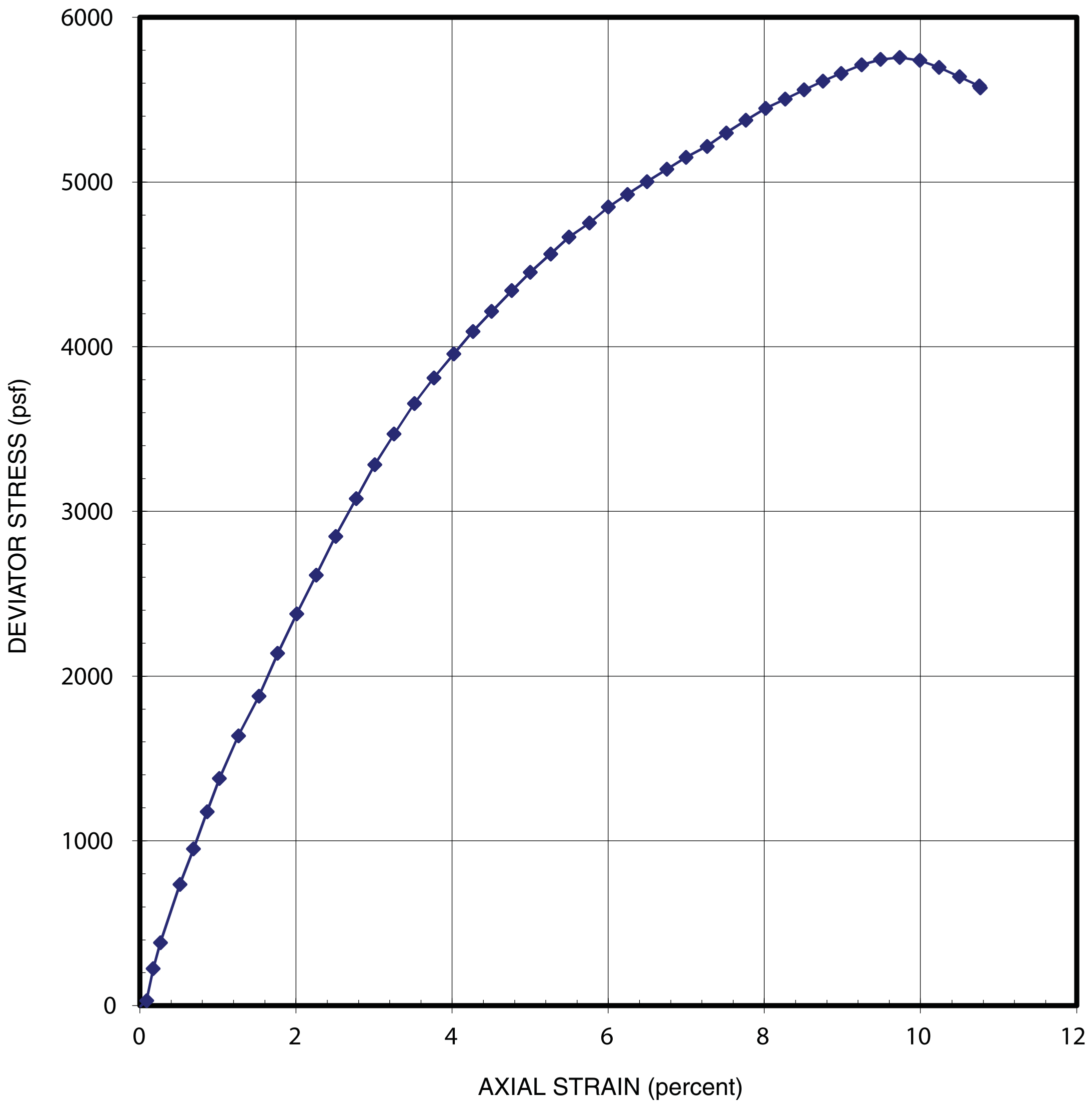
SAMPLER TYPE Sprague and Henwood		SHEAR STRENGTH	2,400 psf
DIAMETER (in.) 2.40	HEIGHT (in.) 5.17	STRAIN AT FAILURE	7.7 %
MOISTURE CONTENT	16 %	CONFINING PRESSURE	500 psf
DRY DENSITY	111 pcf	STRAIN RATE	1 % / min.
DESCRIPTION CLAY with SAND (CL), light brown			SOURCE B-1 at 5.0 feet

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 08/31/15 | Project No. 15-905 | Figure B-5



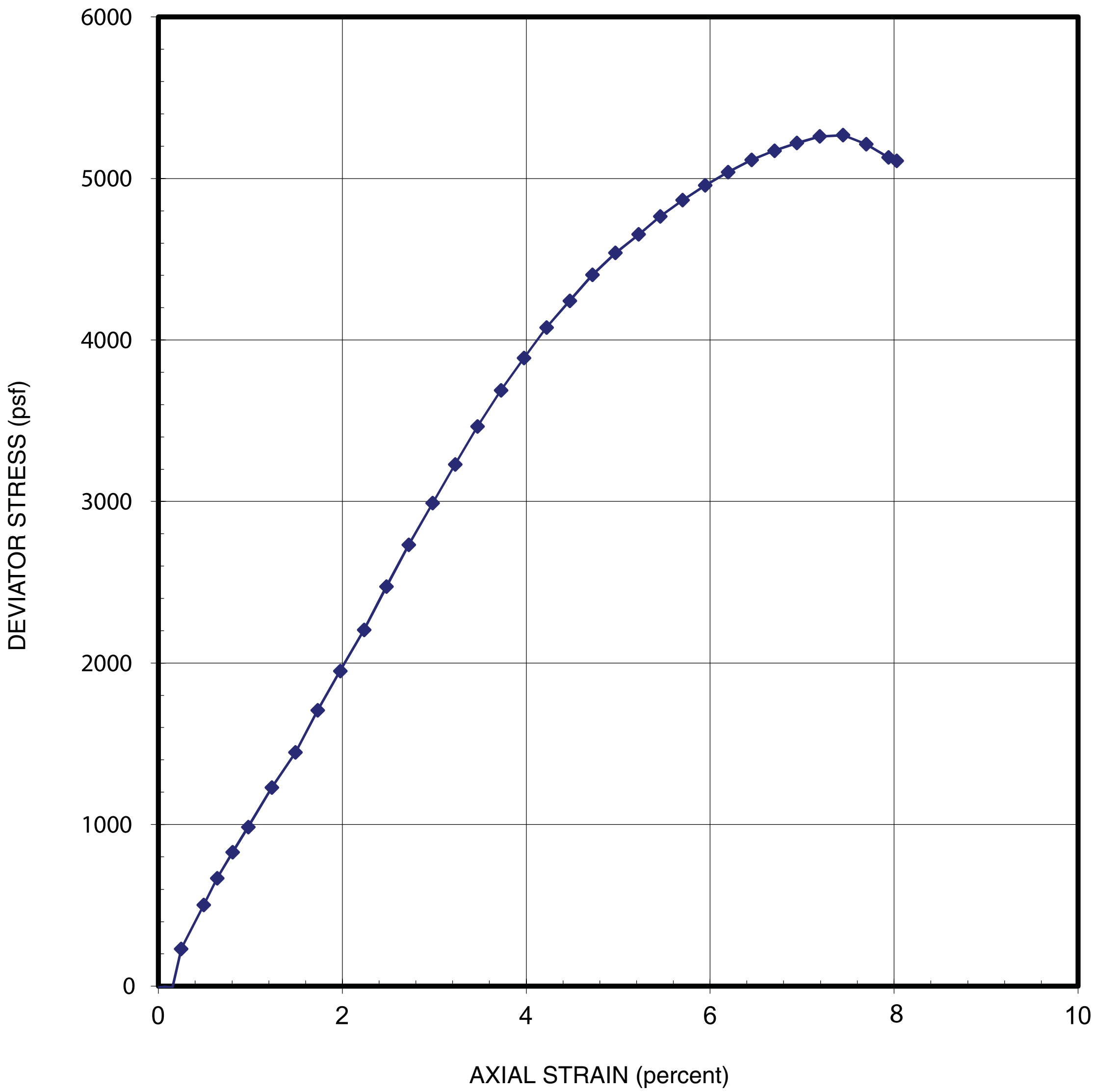
SAMPLER TYPE Sprague and Henwood		SHEAR STRENGTH	2,880 psf
DIAMETER (in.) 2.39	HEIGHT (in.) 5.56	STRAIN AT FAILURE	9.7 %
MOISTURE CONTENT	18 %	CONFINING PRESSURE	550 psf
DRY DENSITY	112 pcf	STRAIN RATE	1 % / min.
DESCRIPTION CLAY with SAND (CL), light brown			SOURCE B-1 at 5.5 feet

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

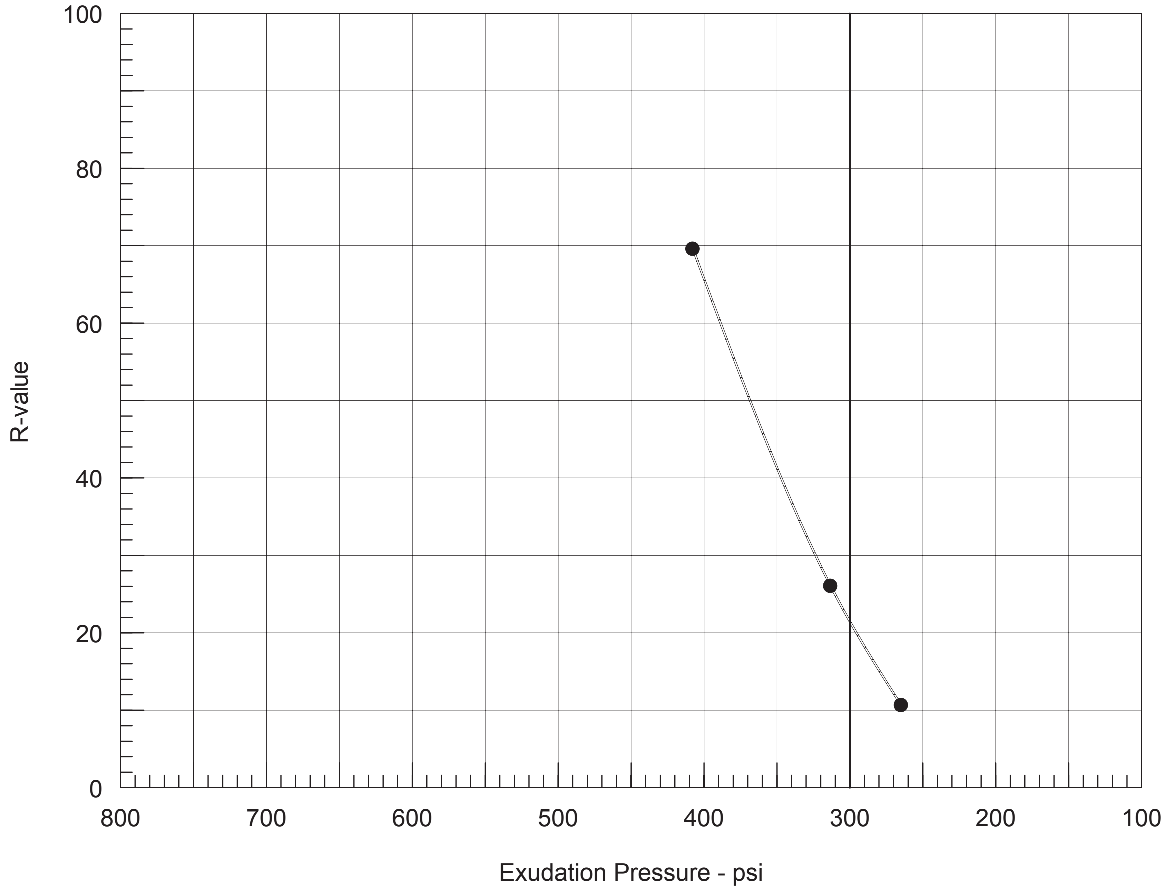
UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 08/31/15	Project No. 15-905	Figure B-6



SAMPLER TYPE Sprague and Henwood		SHEAR STRENGTH	2,630 psf
DIAMETER (in.) 2.40	HEIGHT (in.) 5.99	STRAIN AT FAILURE	7.5 %
MOISTURE CONTENT 16 %		CONFINING PRESSURE	1,300 psf
DRY DENSITY 112 pcf		STRAIN RATE	1 % / min.
DESCRIPTION SILTY CLAY with SAND (CL), brown		SOURCE	B-7 at 15.5 feet

STATE STREET AND CAPITOL AVENUE Fremont, California	**UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST**		
ROCKRIDGE GEOTECHNICAL	Date 08/31/15	Project No. 15-905	Figure B-7



Resistance R-Value and Expansion Pressure - Cal Test 301

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	85	233.2	7.1	0.00	130	2.56	265	10.2	10.6
2	250	139.3	3.8	0.00	40	2.48	407	69.5	69.5
3	210	132.7	5.0	0.00	103	2.53	313	26.0	26.0

Test Results	Material Description
R-Value at 300 psi exudation pressure = 21.5	CLAY with SAND (CL), black
	Sample Source: Onsite Depth: 0'-3' Sample Number: 1

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

R-VALUE TEST REPORT

Date 08/31/15 | Project No. 15-905 | Figure B-8

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 07/01/2015
Date Submitted 06/24/2015

To: Katie Dickinson
Rockridge Geotechnical, Inc.
270 Grand Ave
Oakland, CA 94610

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 15-905 STATE+CAPITOL Site ID : B-7-7 @ 12 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 69809-145416.

EVALUATION FOR SOIL CORROSION

Soil pH	7.71		
Moisture	11.9 %		
Minimum Resistivity	1.19 ohm-cm (x1000)		
Chloride	36.7 ppm	00.00367	%
Sulfate	49.2 ppm	00.00492	%
Redox Potential	(+) 178 mv		
Sulfides	Presence - TRACE		

METHODS
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422
Redox Potential ASTM G-200, Sulfides AWWA C105/A25.5

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 07/01/2015
Date Submitted 06/24/2015

To: Katie Dickinson
Rockridge Geotechnical, Inc.
270 Grand Ave
Oakland, CA 94610

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : 15-905 STATE+CAPITOL Site ID : B-7-7 @ 12 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 69809-145417.

Extractable Sulfide Analysis

TYPE OF TEST	RESULTS	UNITS
Sulfide	0.10	mg/kg

DETECTION LIMITS
Sulfide 0.05

Method 9031m, ND = Below Detection Limits

Sunland Analytical

11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 07/01/2015
Date Submitted 06/24/2015

To: Katie Dickinson
Rockridge Geotechnical, Inc.
270 Grand Ave
Oakland, CA 94610

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 15-905 STATE+CAPITOL Site ID : B-2-3 @ 3 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 69809-145418.

EVALUATION FOR SOIL CORROSION

Soil pH	7.22		
Moisture	12.3 %		
Minimum Resistivity	1.35 ohm-cm (x1000)		
Chloride	19.8 ppm	00.00198	%
Sulfate	75.7 ppm	00.00757	%
Redox Potential	(-) 86 mv		
Sulfides	Presence - POSITIVE		

METHODS
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422
Redox Potential ASTM G-200, Sulfides AWWA C105/A25.5

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 07/01/2015
Date Submitted 06/24/2015

To: Katie Dickinson
Rockridge Geotechnical, Inc.
270 Grand Ave
Oakland, CA 94610

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : 15-905 STATE+CAPITOL Site ID : B-2-3 @ 3 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 69809-145419.

Extractable Sulfide Analysis

TYPE OF TEST	RESULTS	UNITS
Sulfide	0.48	mg/kg

DETECTION LIMITS
Sulfide 0.05

Method 9031m, ND = Below Detection Limits

ATTACHMENT D

SITE-SPECIFIC SCREENING LEVELS FOR SOIL VAPOR

SITE-SPECIFIC SCREENING LEVELS FOR SOIL VAPOR

This section describes the methods used to estimate Site-specific screening levels (SLs) for soil vapor for future onsite resident and commercial worker receptors for the property at 39155 and 39183 State Street in Fremont, California (the Site). The San Francisco Regional Water Quality Control Board (SFRWQCB) soil vapor Environmental Screening Levels (ESLs) are based on Department of Toxic Substances Control (DTSC) default attenuation factors that likely overestimate the attenuation from soil vapor to indoor air for this Site because Site conditions are more reflective of less permeable silts and clays. Therefore, the DTSC modified version of the Johnson and Ettinger (1991; J/E) model (DTSC, 2014) was used to estimate Site-specific SLs that take into account Site-specific geotechnical data. The conceptual approach to vapor intrusion modeling and model input parameters used in the development of the Site-specific SLs is presented in Attachment E of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report.

Using DTSC default soil properties for loamy sand and sandy clay loam, the DTSC J/E model (2014) was used to evaluate volatilization of chemicals from soil vapor, migration of vapors to the ground surface, and mixing with indoor air for the future onsite receptors. This model estimates vapor concentrations in indoor air directly from source vapor concentrations, accounting for advection and diffusion in the vadose zone and building foundation and mixing in the building interior. Vapor emissions were modeled for the Site using source concentrations from soil vapor ($EPC_{soil\ vapor}$). The following table summarizes the Site-specific and chemical-specific properties input into the DTSC J/E model (DTSC, 2014) for vapor migration from soil vapor to indoor air.

Model Variables – Vapor Migration from Soil Vapor to Indoor Air		
Properties	**Symbol**	**Assumed Value**
Depth Below Grade to Bottom of Enclosed Space Floor (default)	L_F	15 centimeters
Soil Vapor Sampling Depth Below Grade (5 feet)	L_S	152 centimeters
Average Soil Temperature (default)	T_s	24°C
Vadose Zone SCS Soil Type (Site-specific)	- -	Loamy Sand (LS)
Vadose Zone Soil Dry Bulk Density (Site-specific)	ρ_b	1.62 g/cm^3
Vadose Zone Soil Total Porosity (Site-specific)	θ_T	0.390
Vadose Zone Soil Water-Filled Porosity (Site-specific)	θ_w	0.076
Vadose Zone SCS Soil Type (Site-specific)	- -	Sandy Clay Loam (SCL)
Vadose Zone Soil Dry Bulk Density (Site-specific)	ρ_b	1.63 g/cm^3
Vadose Zone Soil Total Porosity (Site-specific)	θ_T	0.384
Vadose Zone Soil Water-Filled Porosity (Site-specific)	θ_w	0.146
Average Vapor Flow Rate into Building (default)	Q_{soil}	5 L/min
Residential Exposure Scenario		
Averaging Time for Carcinogens	AT_C	70 years
Averaging Time for Noncarcinogens	AT_{NC}	26 years
Exposure Duration	ED	26 years
Exposure Frequency	EF	350 days/year
Exposure Time	ET	24 hours/day
Air Exchange Rate	ACH	0.5 $hour^{-1}$

Model Variables – Vapor Migration from Soil Vapor to Indoor Air (Continued)		
Properties	**Symbol**	**Assumed Value**
Commercial Exposure Scenario		
Averaging Time for Carcinogens	AT_C	70 years
Averaging Time for Noncarcinogens	AT_{NC}	25 years
Exposure Duration	ED	25 years
Exposure Frequency	EF	250 days/year
Exposure Time	ET	8 hours/day
Air Exchange Rate	ACH	1 $hour^{-1}$

g/cm^3 = gram per cubic centimeter
L/min = liter per minute

The spreadsheets containing the input parameters and results of the DTSC J/E model (DTSC, 2014) for subsurface vapor intrusion into buildings for the residential and commercial exposure scenarios are provided in Attachments E1 through E4 of Attachment E of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report.

Toxicity Assessment

Toxicity values are combined with exposure factors to estimate adverse noncancer health effects and excess cancer risks. Toxicity values include inhalation reference concentrations (RfCs) and inhalation unit risk factors (IURs). As presented on Table 5 of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report, toxicity values supplied by the DTSC J/E model (2014) were used.

Risk Characterization

The risk characterization process incorporates data from the exposure and toxicity assessments to estimate noncancer adverse health effects and excess cancer risks. To estimate noncancer effects, the chronic daily intake is divided by the RfC. The resulting value is referred to as a hazard quotient (HQ). A HQ less than or equal to 1 indicates that no adverse noncancer health effects are expected to occur (USEPA, 1989). Consistent with USEPA (1989) risk assessment guidelines, carcinogenic effects are typically evaluated by multiplying the IUR by the chronic daily intake averaged over 70 years to estimate lifetime excess cancer risk. The resulting values are referred to as excess cancer risks. These potential excess cancer risks are compared to the CalEPA risk management range of one-in-one-million (1×10^{-6}) to one-in-ten thousand (1×10^{-4}).

Consistent with USEPA (1989; 1991) guidelines, the following general equations were used to estimate excess cancer risks and noncancer adverse health effects (expressed as a HQ):

For carcinogens:

$$Risk = \frac{EPC_{indoor\ air} x EF x ED x ET x IUR}{AT_c}$$

For noncarcinogens:

$$HQ = \frac{EPC_{indoor\ air} x EF x ED x ET x \frac{1}{RfC}}{AT_n}$$

Where:

$EPC_{indoor\ air}$	=	*Exposure point concentration in indoor air ($EPC_{indoor\ air}$; micrograms per cubic meter [μg/m^3]).*
EF	=	*Exposure frequency (days/year).*
ED	=	*Exposure duration (years).*
ET	=	*Exposure time (hours/day).*
AT	=	*Averaging time (days).* *For noncarcinogenic effects (hours), AT = ED x 365 days/year x 24 hours/day.* *For carcinogenic effects, AT (hours) = 70 years x 365 days/year x 24 hours/day.*
IUR	=	*Inhalation unit risk for carcinogenic chemicals (μg/m^3)$^{-1}$.*
RfC	=	*Inhalation reference concentration for noncarcinogenic chemicals (μg/m^3).*

The HQ and excess cancer risk for VOCs in soil vapor were estimated by using the exposure factors presented in the table above and toxicity values supplied by the DTSC J/E model in the equations above. Risk characterization of inhalation of VOCs volatilizing from soil vapor into indoor air for the future onsite resident and commercial worker receptors are presented in Tables 1 through 4 of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report.

Site-Specific Screening Levels

The development of Site-specific SLs was based on the methods presented previously in this attachment. The Site-specific SLs were estimated for the following hypothetical human receptors:

- Future Onsite Resident Receptor; and
- Future Onsite Commercial Worker Receptor.

Using the HQ and excess cancer risk estimates, source EPCs, and USEPA and CalEPA target HI and target excess cancer risk, a Site-specific SL was estimated using the equations in the following sections. Site-specific SLs based on noncarcinogenic effects used a target HI of one. Site-specific SLs based on carcinogenic effects used a target excess cancer risk of 1 x 10^{-6}, which represents the lower end (most stringent) of the CalEPA's risk management range and is the point of departure for risk management decisions for all receptors

Site-Specific SL – Noncarcinogenic Effects

$$Site - Specific\ SL_{nc} = \frac{HQ_T \times EPC_{i,p}}{HQ_{i,p}}$$

Where:

Site-specific SL_{nc}	=	*Site-specific SL for noncarcinogenic effects for chemical i via pathway p (μg/m^3);*
HQ_T	=	*Target hazard quotient (1), a HQ less than or equal to 1 indicates that no adverse noncancer health effects are expected to occur (USEPA, 1989; unitless);*
$EPC_{i,p}$	=	*Exposure point concentration for source for chemical i via pathway p (μg/m^3); and*
$HQ_{i,p}$	=	*Hazard quotient for chemical i via pathway p (unitless).*

Site-Specific SL – Carcinogenic Effects

$$Site - Specific\ SL_c = \frac{CR_T \times EPC_{i,p}}{CR_{i,p}}$$

Where:

Site-specific SL_c =Site-specific SL for carcinogenic effects for chemical i via pathway p (µg/m^3);
CR_T = Target excess cancer risk (1 x 10^{-6}), the upper end (most stringent) of CalEPA's risk management range of one-in-ten thousand (1 x 10^{-4}) to one-in-one-million (1 x 10^{-6});
$EPC_{i,p}$ = Exposure point concentration for source for chemical i via pathway p (µg/m^3); and
$CR_{i,p}$ = Excess cancer risk for chemical i via pathway p (unitless).

The Site-specific SLs for soil vapor based on loamy sand and sandy clay loam for residential and commercial exposure scenarios are presented in Tables 1 through 4 of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report.

References

Department of Toxic Substances Control (DTSC). 2014. DTSC Screening-Level Model for Soil Gas Contamination. California Environmental Protection Agency. Last Modified December.

Johnson, P.C. and R.A. Ettinger. 1991. Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings. Environmental Science and Technology. Vol. 25, No. 8, pp. 1445-52.

U.S. Environmental Protection Agency (USEPA). 1989. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A. Interim Final. Solid Waste and Emergency Response. December.

USEPA. 1991. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Interim. Office of Emergency and Remedial Response, Washington D.C., Publication 9285.7-01B. December.

ATTACHMENT E

FATE AND TRANSPORT FOR VAPOR EMISSIONS FROM SOIL VAPOR INTO OUTDOOR AND INDOOR AIR

FATE AND TRANSPORT FOR VAPOR EMISSIONS FROM SOIL VAPOR INTO OUTDOOR AND INDOOR AIR

In support of the development of Site-specific screening levels for soil vapor and the evaluation of exposure in outdoor and indoor air, this attachment presents the methodology for fate and transport modeling used to estimate exposure point concentrations (EPCs) in air resulting from volatilization of volatile organic compounds (VOCs) from subsurface sources at the property at 39155 and 39183 State Street in Fremont, California (the Site). According to the U.S. Environmental Protection Agency (USEPA, 2016), a compound is assumed to be volatile if it has a Henry's Law constant greater than 1×10^{-5} and a molecular weight less than 200 grams per mole (g/mole).

The fate and transport modeling incorporates Site-specific data into analytical models that simulate vapor migration of VOCs. The following analytical models were used:

- An emission rate model to estimate flux as recommended by American Society for Testing and Materials (ASTM, 1995) and a box model to convert the emission rate to a concentration in ambient air as recommended by Department of Toxic Substances Control (DTSC, 1994); and
- The Johnson and Ettinger (1991) model, recommended and provided by the Department of Toxic Substances Control (DTSC, 2014), was used to estimate vapor emissions from soil vapor into indoor air

The conceptual approach to modeling, the calculations, and the modeling results are described in the following sections.

CONCEPTUAL MODEL

Volatile compounds can be released from the subsurface into indoor and outdoor air resulting in an indirect exposure to contaminants in the subsurface. The modeling addresses chemical sources in soil vapor under future site conditions for a reasonable maximum exposure (RME) scenario. Specifically, the modeling included calculations for the following exposure pathways:

- Volatilization of chemicals from soil vapor, migration of vapors to the soil surface and mixing with outdoor air.
- Volatilization of chemicals from soil vapor, migration of vapors to the soil surface, and mixing with indoor air.

Most of the soil vapor samples were collected above the water table in the vadose zone, at approximately 5 feet below ground surface (bgs), which is consistent with the DTSC (2011) recommended sampling depth. Some soil vapor samples were collected at deeper depths to specifically evaluate exposures in the planned elevator shaft and exposures offsite associated with the sewer lateral along State Street. The soil vapor samples were analyzed for VOCs only. The soil vapor data used in this HHRA are presented in previous reports prepared by PES (2015, 2016a,b). For the purposes of fate and transport modeling, all onsite soil vapor data collected from 0 to 13 feet bgs were included in the soil vapor dataset. The maximum detected concentration for each VOC was used at the soil vapor exposure point concentration *($EPC_{soil\ vapor}$)*. Within this soil vapor dataset, the maximum detected concentrations were all detected at 5 feet bgs.

Using the soil vapor data, the fate and transport modeling was performed and a concentration in ambient air for each VOC was estimated. Site conditions were generalized to create a simplified conceptual model to estimate vapor concentration in outdoor and indoor air. Details of the approach and assumptions used for each hypothetical source and transport mechanism are discussed below.

Sources of VOC Vapors

Vapor sources were modeled based on the following assumptions:

- VOCs are uniformly distributed in soil vapor; and
- The concentrations of VOCs remain constant over time.

These assumptions are highly conservative because the distribution of VOCs is likely more limited than was assumed, and because the mass of the source will deplete over time as natural attenuation processes occur, thereby lowering actual concentrations in the source over time.

Chemical Transport Mechanisms

The models simulate the following transport mechanisms:

- Chemical partitioning between phases;
- Vapor migration from soil vapor to the ground surface; and
- Mixing of soil vapor emissions with ambient (indoor and outdoor) air.

Chemicals are assumed to partition between soil vapor ($EPC_{soil\ vapor}$) and ambient air under equilibrium conditions.

Vapor Migration from Soil Vapor to Ground Surface

Vertical migration of chemicals in soil vapor to the soil surface was assumed to occur by steady-state diffusion induced by a chemical concentration gradient between the soil-vapor source and the soil surface. For the outdoor air pathway, an emission rate model (ASTM, 1995) was used to estimate fluxes of VOCs at the soil surface. The indoor air pathway analysis accounted for the effects of steady-state advection induced by an assumed pressure differential between the exterior and interior of the building. Chemical diffusion of soil vapor through the vadose zone and building foundations (indoor only) was characterized by effective diffusion coefficients, D_s^{eff} (vadose zone) and D_f^{eff} (building foundations). Advection of chemicals dissolved in soil moisture was assumed to be negligible. This assumption is conservative because soil moisture tends to migrate downward, decreasing the overall flux of chemical toward the surface. Chemical and biological transformations were conservatively assumed not to occur during migration to the surface.

Mixing of Soil Vapor Emissions with Ambient (Indoor and Outdoor) Air

Different methods were used to simulate dispersion and mixing of vapors in outdoor and indoor air after vapors were emitted from subsurface sources. For outdoor air, a box model (DTSC, 1994) was used to convert the emission rate at the soil surface to a concentration in outdoor air. The analysis of indoor air simulated vapor-phase advection and diffusion of chemicals near the building foundation. Vapor diffusion of chemicals upward was assumed to occur through a foundation. Advective transport through a region generated by the pressure differential between inside (lower pressure) and outside (higher pressure) of the building was simulated. Such underpressurization is generally induced by temperature differentials, wind loading, and operation of devices such as furnaces and exhaust fans. Underpressurization is highly variable over time, but was conservatively assumed to be constant in modeling. This approach is highly conservative for periods when structures are neutrally or positively pressurized, as these conditions will inhibit migration of soil vapor into the building. The mixing of vapor-phase chemicals with ambient indoor air was simulated using a building of volume (V_b) that is ventilated at a constant exchange rate (*ER*), resulting in an indoor air concentration ($C_{building}$ or $EPC_{indoor\ air}$).

CALCULATIONS

This section presents the equations, input parameters, and model assumptions used as inputs to calculate vapor emissions.

Vapor Migration from Soil Vapor to Outdoor Air

Vapor concentrations in outdoor air from soil vapor were estimated using an emission rate model and box model. The resulting outdoor air concentrations from soil vapor are presented in Table E1. For vapor migration from soil vapor to outdoor air, concentrations in outdoor air were estimated based on the following equations from DTSC (1994) and ASTM (1995), respectively:

$$EPC_{outdoor\ air} = \frac{E}{LS \times V \times MH}$$

where:

$EPC_{outdoor\ air}$	=	*Concentration of VOC in outdoor air (milligram per cubic meter [mg/m^3]);*
E	=	*Emission rate of chemical over site (milligram per second [mg/sec]);*
LS	=	*Length of side of site, taken to be [Area]$^{0.5}$ (meter);*
V	=	*Average wind velocity (default = 2.25 square meters per second [m^2/sec]); and*
MH	=	*Mixing height (default = 2 meters).*

$$E = \frac{C_{soil\ gas} A}{L_s} \times \left[D_{a,i} \frac{\theta_a^{10/3}}{n^2} + D_{w,i} \frac{\theta_w^{10/3}}{H' n^2} \right] \times 10^{-5} \frac{m^2}{cm^2} \times 10^2 \frac{L}{m^3} \times 10^{-4} \frac{mg}{\mu g}$$

where:

E	=	*Emission rate of chemical over site (mg/sec);*
$C_{soil\ vapor}$	=	*Measured vapor phase concentration immediately above the vapor source (microgram per liter [µg/L]);*
A	=	*Area of site (square meters [m^2]);* *Value for the exposed surface area is equal to 5,000 square feet (484 m^2), the approximate dimensions of area* covered with a paver system
L_s	=	*Depth to contamination (meter);*
$D_{a,I}$	=	*Diffusion coefficient of i in air (square centimeter per second [cm^2/s]);*
θ_a	=	*Air-filled porosity of soil (liter$_{air}$/liter$_{soil}$);*
n	=	*Total porosity of soil (liter$_{air}$/liter$_{soil}$);*
$D_{w,I}$	=	*Diffusion coefficient of i in water (cm^2/s);*
θ_w	=	*Water-filled porosity of soil (liter$_{water}$/liter$_{soil}$); and*
H'	=	*Dimensionless Henry's Law constant (unitless).*

The following sections discuss the input parameters used in the fate and transport modeling of vapor migration from soil vapor to outdoor air.

Source Concentrations

Vapor emissions were modeled for the Site using source concentrations from soil vapor ($EPC_{soil\ vapor}$; Table E1). Onsite source concentrations in soil vapor (i.e., soil vapor EPCs) represent the maximum detected concentration from soil vapor collected from 0 to 13 feet bgs. The soil vapor EPCs are presented in Table E1.

Site-Specific Properties

Site-specific geotechnical analyses were conducted by Rockridge Geotechnical (Rockridge, 2015). Rockridge (2015) describes the subsurface conditions as:

> …the Site is blanketed by stiff to hard clay with varying sand content that extends to depths ranging from approximately 5 to 11-1/2 feet bgs…Beneath the surficial clay layer are heterogeneous alluvial deposits consisting of loose to very dense silty sand, medium dense to very dense sand with varying gravel content, medium dense clayey sand, stiff to very stiff, non-plastic sandy silt, and stiff to very stiff clay with varying sand content.

Rockridge collected 4 soil samples near the soil vapor sample depth of 5 feet bgs. Based on Rockridge's boring logs and particle size distribution analyses for the four soil samples collected from 3.5 to 8 feet bgs (B-1 at 8 feet bgs, B-3 at 7.5 feet bgs, B-5 at 3.5 feet bgs, and B-6 at 6 feet bgs), the soil ranged from 50 to 62-percent sand (coarse grain) with 38 to 50-percent silt/clay (fine grain). In accordance with the U.S. Soil Conservation Service (USCS) classification chart (Figure 3 of USEPA, 2004), the results from the particle size distribution analyses were used to determine the appropriate USCS soil textural classification within the Site. Assuming the particle size distribution analysis indicates that Site soils are approximately 50-percent sand and 50-percent silts and clay, with predominantly more clay based on boring logs, the USCS soil textural classification is likely "sandy clay loam". As a result, sandy clay loam (SCL) was selected as the vadose zone input parameter for the fate and transport modeling. The DTSC (2014) default values for SCL for total porosity (0. 384), and water-filled porosity (0.146) were used as model input parameters. The Rockridge geotechnical report is provided in Attachment C of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report.

The Site-specific and soil properties used in the fate and transport model for vapor migration from soil vapor to outdoor air are summarized in the table below.

Model Variables – Vapor Migration from Soil vapor to Outdoor Air		
Properties	**Symbol**	**Assumed Value**
Area of site Value for the exposed surface area is equal to 5,000 square feet (484 m^2), the approximate dimensions of area covered with a paver system.	A	484 m^2
Length of side of site, taken to be $[Area]^{0.5}$	LS	22 meters
Depth to contamination (5 feet bgs)	L	1.52 meters
Soil Total porosity	n	0.384
Soil Water-filled porosity	θ_w	0.146
Soil Air-filled porosity	θ_a	0.238

Chemical-Specific Properties

The values for the dimensionless Henry's Law constant and molecular diffusion coefficients in air and water ($D_{a,i}$ and $D_{w,i}$), were obtained from USEPA (2016).

The input parameters and results of the emission rate model and box model used to estimate vapor emissions from soil vapor to outdoor air are presented in Table E1.

Vapor Migration from Soil vapor to Indoor Air

Using the DTSC version of the Johnson and Ettinger (1991) model (DTSC, 2014), vapor concentrations in indoor air from soil vapor were estimated for the future onsite resident and commercial worker receptors. This model estimates vapor concentrations in indoor air directly from concentrations in soil vapor, accounting for advection and diffusion in the vadose zone and building foundation and mixing in the building interior.

As presented by USEPA (2004), for vapor migration from soil vapor to indoor air, concentrations in indoor air were estimated based on the following equations:

$$C_{building} = C_{source} \times \propto \qquad \text{or} \qquad EPC_{indoor\ air} = EPC_{soil\ vapor} \times \propto$$

where:

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

where:

$C_{building}/EPC_{indoor\ air}$ = *EPC in indoor air (microgram per cubic meter [$\mu g/m^3$]);*
$C_{source}/EPC_{soil\ vapor}$ = *EPC in soil vapor ($\mu g/m^3$);*
α = *Steady-state attenuation coefficient (unitless);*
D_T^{ef} = *Total overall effective diffusion coefficient (cm^2/s);*
A_B = *Area of enclosed space below grade (cm^2);*
$Q_{building}$ = *Building ventilation rate (cubic centimeter per second [cm^3/s]);*
L_T = *Source-building separation (centimeter [cm]);*
Q_{soil} = *Volumetric flow rate of soil vapor into the enclosed space (cm^3/s);*
L_{crack} = *Enclosed space foundation or slab thickness (cm);*
A_{crack} = *Area of total cracks (cm^2); and*
D_{crack} = *Effective diffusion coefficient through the cracks (cm^2/s)*
(assumed equivalent to D_i^{eff} of soil layer (i) in contact with the floor).

A more detailed description of the equations and input parameters used in this model are provided in the *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (USEPA, 2004).

The following sections discuss the input parameters used in the fate and transport modeling for vapor migration from soil vapor to indoor air.

Source Concentrations

Vapor emissions were modeled for the Site using source concentrations from soil vapor ($EPC_{soil\ vapor}$). Source concentrations in soil vapor represent the maximum detected concentration. Soil vapor EPCs and the resulting modeled indoor air EPCs ($EPC_{indoor\ air}$) based on loamy sand and sandy clay loam for the residential and commercial exposure scenarios are presented in Tables 1 through 4 of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report, respectively.

Site-Specific Properties

As discussed in Attachment A of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report, based on Site-specific soil property data and soil boring logs, the DTSC (2014) default soil properties for loamy sand (LS) and sandy clay loam (SCL) were used in the fate and transport model for vapor migration from soil vapor to indoor air.

Chemical-Specific Properties

The values for the dimensionless Henry's Law constant, organic carbon-water partition coefficient (K_{oc}), and molecular diffusion coefficients in air and water, D_i and D_w, for each soil vapor VOC were obtained from DTSC (2014).

The properties used in the fate and transport model (DTSC, 2014) for vapor migration from soil vapor to indoor air are summarized in the table below.

Model Variables – Vapor Migration from Soil Vapor to Indoor Air		
Properties	**Symbol**	**Assumed Value**
Depth Below Grade to Bottom of Enclosed Space Floor (default)	L_F	15 centimeters
Soil Vapor Sampling Depth Below Grade (5 feet)	L_S	152 centimeters
Average Soil Temperature (default)	T_s	24°C
Vadose Zone SCS Soil Type (Site-specific)	- -	Loamy Sand (LS)
Vadose Zone Soil Dry Bulk Density (Site-specific)	ρ_b	1.62 g/cm^3
Vadose Zone Soil Total Porosity (Site-specific)	θ_T	0.390
Vadose Zone Soil Water-Filled Porosity (Site-specific)	θ_w	0.076
Vadose Zone SCS Soil Type (Site-specific)	- -	Sandy Clay Loam (SCL)
Vadose Zone Soil Dry Bulk Density (Site-specific)	ρ_b	1.63 g/cm^3
Vadose Zone Soil Total Porosity (Site-specific)	θ_T	0.384
Vadose Zone Soil Water-Filled Porosity (Site-specific)	θ_w	0.146
Average Vapor Flow Rate into Building (default)	Q_{soil}	5 L/min

g/cm^3 = gram per cubic centimeter
L/min = liter per minute

The spreadsheets containing the input parameters and results of the Johnson and Ettinger (1991) model, for subsurface vapor intrusion into buildings (DTSC, 2014) based on loamy sand and sandy clay loam for the residential and commercial exposure scenarios are provided in Attachments E1 through E4.

Following a discussion of uncertainties in the next section, the results are summarized, which may have influenced the estimation of vapor emission estimates and corresponding EPCs and health risks.

UNCERTAINTY ANALYSIS

The procedures used in evaluating vapor migration and estimating EPCs are subject to various degrees of uncertainty. A significant amount of conservatism has been incorporated into the fate and transport modeling process to address this uncertainty. Specifically, the Johnson and Ettinger (1991) model employs a series of simplified, analytical solutions to chemical transport, often resulting in overestimation of EPCs. The conservatism inherent to the formulation of these models is supplemented by additional conservatism associated with selection of model input data and conceptualization of site conditions imposed by model users. As a result of this multilevel conservatism, actual EPCs and corresponding health risks are likely to be significantly lower than were estimated for the inhalation exposure pathway. These conservative aspects of the fate and transport modeling process are further discussed below.

Model Formulation

The conservative aspects of the vapor migration models include simplified representation or complete omission of the following processes that affect transport, for example:

- Loss mechanisms - The absence of loss mechanisms such as biodegradation and vapor-phase adsorption result in overestimation of vapor emissions to outdoor and indoor air, yielding higher EPCs.

- Depleting contaminant source - The use of a nondepleting, constant source results in an unlimited supply of contaminated vapor and an overestimation of vapor emissions to outdoor and indoor air, yielding higher EPCs.

- Water movement - The assumed absence of water (and dissolved chemical) movement through unsaturated soil results in an overestimation of chemical mass in vapor-phase available for transport to outdoor and indoor air, yielding higher EPCs.

- Neutral or positive pressurization - The assumption of continuously under-pressurized buildings neglects significant periods where neutral or positive pressurized conditions exist, thereby over-estimating advective transport of contaminated vapors to indoor air, yielding higher EPCs.

- One-dimensional transport - The assumption of vapor transport under a single (vertical) dimension ignores the potential for vapor migration in multiple directions away from the source area, resulting in an over-estimation of vapor emissions and higher EPCs.

Under actual field conditions, the combined effect of these processes typically results in significantly lower EPCs than those estimated in this assessment.

Model Input Data

As previously indicated, various model input data characterizing soil physical properties and building parameters used in this analysis correspond to conservative default values adopted by DTSC (1994 and 2014). Use of conservative default values for the above-mentioned parameters also likely results in over-estimation of vapor emissions to outdoor and indoor air, maximizing estimates of EPCs.

Conceptualization of Site Conditions

As previously indicated, site conditions were generalized to create a simplified conceptual model for simulation of vapor emissions at the Site. As a result, many components of this conceptualization are based on highly conservative assumptions, including:

- Outdoor and indoor points of exposure are assumed to directly overlie locations of maximum detected VOC concentrations in soil vapor.
- VOCs are assumed to be uniformly distributed in soil vapor, with no spatial and temporal changes in concentrations.

As a result of this conservative conceptualization, estimated vapor emissions to outdoor and indoor air are maximized, yielding higher EPCs. As stated in Hers, et al. (2003), "If there is information only on contamination depth, the range in [vapor attenuation] can vary 3-4 orders of magnitude. When information on soil properties is also available, the uncertainty…is reduced resulting in [vapor attenuation] that vary over two orders of magnitude. When good quality Site-specific data is available for both soil properties (e.g., moisture content) and building properties (e.g., ventilation rate, mixing height), it may be possible to reduce the uncertainty…to approximately one order of magnitude."

RESULTS

The soil vapor EPCs and their respective outdoor and indoor air concentrations were used to estimate noncancer adverse health effects and excess cancer risks from assumed exposure to VOCs migrating from soil vapor to ambient air. The soil vapor and indoor air EPCs based on loamy sand and sandy clay loam for the residential and commercial exposure scenarios are presented in Tables 1 through 4 of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report, respectively. The results of the emission rate model and box model used to estimate vapor emissions from soil vapor to outdoor air are presented in Table E1 and Table 5 of the *Revised Human Health Risk Evaluation of Subsurface Data* letter report.

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American Society for Testing and Materials (ASTM). 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. ASTM Designation E 1739-95.

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TABLE E1

ESTIMATION OF OUTDOOR AIR CONCENTRATIONS FROM VOLATILE ORGANIC COMPOUNDS VOLATILIZING FROM SOIL VAPOR

Table E1

Estimation of Outdoor Air Concentrations from Volatile Organic Compounds Volatilizing from Soil Vapor

39155 and 39183 State Street

Fremont, California

Emission Rate of Volatile Organic Compound (VOC)[1]

$$E = \frac{C_{v,i} \times A}{d} \times \left(D_{a,i} \times \frac{\theta_a^{10/3}}{\theta_t^2} + D_{w,i} \times \frac{\theta_w^{10/3}}{H'\theta_t^2} \right) \times 10^{-4} \frac{m^2}{cm^2} \times 10^3 \frac{L}{m^3} \times 10^{-3} \frac{mg}{\mu g}$$

Concentration in Outdoor Air via Box Model[2]

$$EPC_{outdoor\ air} = \frac{E}{LS \times V \times MH}$$

Parameter		Units	Benzene	Chloroform	Ethylbenzene	Freon 11	Freon 12	Tetrachloroethene	Toluene	m,p-Xylene	o-Xylene
Vapor Phase Concentration Above Source $EPC_{soil\ vapor}$	$C_{v,i}$	(µg/L)	7.10E-01	1.60E-01	2.80E-01	2.30E+00	6.40E+00	8.50E+00	1.50E+00	1.10E+00	3.50E-01
Area of Site[3]	A	(m^2)	4.84E+02	4.84E+02	4.84E+02	4.84E+02	4.84E+02	4.84E+02	4.84E+02	4.84E+02	4.84E+02
Depth to Contamination[4]	d	(m)	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00
Total Soil Porosity[5]	n	(L_{pore}/L_{soil})	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01
Water-Filled Soil Porosity[5]	θ_w	(L_{water}/L_{soil})	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01
Air-Filled Soil Porosity[6]	θ_a	(L_{air}/L_{soil})	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01
Diffusivity in Air[7]	$D_{a,i}$	(cm^2/s)	8.95E-02	7.69E-02	6.85E-02	6.54E-02	7.60E-02	5.05E-02	7.78E-02	6.84E-02	6.89E-02
Diffusivity in Water[7]	$D_{w,i}$	(cm^2/s)	1.03E-05	1.09E-05	8.46E-06	1.00E-05	1.08E-05	9.46E-06	9.20E-06	8.44E-06	8.53E-06
Dimensionless Henry's Law Constant[7]	H'	(unitless)	2.27E-01	1.50E-01	3.22E-01	3.97E+00	1.40E+01	7.24E-01	2.71E-01	2.94E-01	2.12E-01
Emission Rate over Entire Site	E	(mg/sec)	1.15E-04	2.22E-05	3.46E-05	2.71E-04	8.78E-04	7.74E-04	2.11E-04	1.36E-04	4.35E-05
Length of Side of Site (taken as $Area^{0.5}$) [8]	LS	(m)	2.20E+01	2.20E+01	2.20E+01	2.20E+01	2.20E+01	2.20E+01	2.20E+01	2.20E+01	2.20E+01
Average Wind Velocity[8]	V	(m/sec)	2.25E+00	2.25E+00	2.25E+00	2.25E+00	2.25E+00	2.25E+00	2.25E+00	2.25E+00	2.25E+00
Mixing Height[8]	MH	(m)	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00
Concentration in Outdoor Air ($EPC_{outdoor\ air}$)		**(mg/m^3)**	**1.16E-06**	**2.24E-07**	**3.49E-07**	**2.74E-06**	**8.87E-06**	**7.82E-06**	**2.13E-06**	**1.37E-06**	**4.40E-07**

Notes:

µg/L = micrograms per liter.

m^2 = square meter.

m = meter

L = liter

cm^2/s = square centimeter per second.

mg/sec = milligrams per second.

m^2/sec = square meters per second.

mg/m^3 = milligrams per cubic meter.

[1] Equations for the emission rate (flux from subsurface vapor source) are from ASTM (1995).

[2] Equations for the box model are from DTSC (1994).

[3] The value for the planned paver system area is approximately 5,000 square feet (484 m^2).

[4] Vapor phase concentrations estimated from soil gas concentrations. Depth to soil vapor is approximately 5 feet below ground surface or 1.52 meters.

[5] Values for total and water-filled porosity are default values for a "sandy clay loam" (DTSC, 2014).

[6] Air-filled porosity is equal to total soil porosity minus water-filled porosity.

[7] Chemical-specific properties were obtained from USEPA (2016).

[8] Default value from DTSC (1994).

[9] Attenuation factor is the concentration in outdoor air divided by the concentration in soil gas.

Reference:

ASTM. 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. American Society for Testing and Materials, Designation E1739-95. November.

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ATTACHMENT E1

DTSC J/E MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS FOR THE RESIDENTIAL EXPOSURE SCENARIO, LOAMY SAND

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Tetrachloroethylene

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
8.50E+03	9.4E-04	8.0E+00	1.7E-05	2.2E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
127184	8.50E+03			Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Benzene

Results Summary				
Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
7.10E+02	1.3E-03	9.1E-01	9.4E-06	2.9E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
71432	7.10E+02			Benzene

MESSAGE: See VLOOKUP table comments on chemical properties and/or toxicity criteria for this chemical.

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Toluene

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.50E+03	1.2E-03	1.8E+00	NA	5.7E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108883	1.50E+03			Toluene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Ethylbenzene

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
2.80E+02	1.1E-03	3.1E-01	2.8E-07	3.0E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
100414	2.80E+02			Ethylbenzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **m-Xylene**

Results Summary				
Soil Gas Conc. (μg/m^3)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m^3)	Cancer Risk	Noncancer Hazard
1.10E+03	1.1E-03	1.2E+00	NA	1.2E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m^3)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108383	1.10E+03			m-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **o-Xylene**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
3.50E+02	1.1E-03	3.9E-01	NA	3.8E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
95476	3.50E+02			o-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Trichlorofluoromethane**

Reset to Defaults

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
2.30E+03	1.1E-03	2.5E+00	NA	3.4E-03

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75694	2.30E+03			Trichlorofluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Dichlorodifluoromethane**

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
6.40E+03	1.2E-03	7.6E+00	NA	7.3E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75718	6.40E+03			Dichlorodifluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Residential**
Chemical: **Chloroform**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
1.60E+02	1.2E-03	1.9E-01	1.6E-06	1.9E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
67663	1.60E+02			Chloroform

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Carbon tetrachloride

Results Summary

Soil Gas Conc. (µg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (µg/m³)	Cancer Risk	Noncancer Hazard
1.00E+02	1.0E-03	1.0E-01	1.5E-06	2.4E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (µg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
56235	1.00E+02			Carbon tetrachloride

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: Residential
Chemical: 1,2-Dichloroethane

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
1.00E+02	1.3E-03	1.3E-01	1.2E-06	1.7E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
107062	1.00E+02			1,2-Dichloroethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: 1,1,2-Trichloroethane

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	1.1E-03	1.1E-01	6.3E-07	5.3E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
79005	1.00E+02			1,1,2-Trichloroethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **1,1,2,2-Tetrachloroethane**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	**9.2E-04**	**9.2E-02**	**1.9E-06**	**1.3E-03**

MESSAGE: Risk and/or hazard quotient is based on route-to-route extrapolation.

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
79345	1.00E+02			**1,1,2,2-Tetrachloroethane**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

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December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Residential**
Chemical: **Vinyl chloride (chloroethene)**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	1.4E-03	1.4E-01	3.9E-06	1.3E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75014	1.00E+02			Vinyl chloride (chloroethene)

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

ATTACHMENT E2

DTSC J/E MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS
FOR THE COMMERCIAL EXPOSURE SCENARIO, LOAMY SAND

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Commercial
Chemical: Tetrachloroethylene

Results Summary				
Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
8.50E+03	4.7E-04	4.0E+00	1.9E-06	2.6E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
127184	8.50E+03			Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Commercial**
Chemical: **Benzene**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (μg/m^3)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m^3)	Cancer Risk	Noncancer Hazard
7.10E+02	6.4E-04	4.6E-01	1.1E-06	3.5E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m^3)		ENTER Soil gas conc., C_g (ppmv)	Chemical
71432	7.10E+02	OR		Benzene

MESSAGE: See VLOOKUP table comments on chemical properties and/or toxicity criteria for this chemical.

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS	OR	

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Commercial**
Chemical: **Toluene**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
1.50E+03	6.0E-04	9.0E-01	NA	6.8E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108883	1.50E+03			Toluene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Ethylbenzene**

Results Summary				
Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
2.80E+02	5.6E-04	1.6E-01	3.2E-08	3.6E-05

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
100414	2.80E+02			Ethylbenzene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	LS		

MORE

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Commercial**
Chemical: **m-Xylene**

DATA ENTRY SHEET

Results Summary				
Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.10E+03	**5.6E-04**	**6.1E-01**	**NA**	**1.4E-03**

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108383	1.10E+03			**m-Xylene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **o-Xylene**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
3.50E+02	5.6E-04	2.0E-01	NA	4.5E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
95476	3.50E+02			o-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Trichlorofluoromethane**

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
2.30E+03	5.4E-04	1.3E+00	NA	4.1E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75694	2.30E+03			Trichlorofluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Dichlorodifluoromethane**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
6.40E+03	5.9E-04	3.8E+00	NA	8.6E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75718	6.40E+03			Dichlorodifluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Commercial**
Chemical: **Chloroform**

DATA ENTRY SHEET

Results Summary				
Soil Gas Conc. (μg/m^3)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m^3)	Cancer Risk	Noncancer Hazard
1.60E+02	5.9E-04	9.5E-02	1.8E-07	2.2E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m^3)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
67663	1.60E+02			Chloroform

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Commercial
Chemical: Carbon tetrachloride

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	5.0E-04	5.0E-02	1.7E-07	2.9E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
56235	1.00E+02			Carbon tetrachloride

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **1,2-Dichloroethane**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	6.3E-04	6.3E-02	1.3E-07	2.0E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
107062	1.00E+02			1,2-Dichloroethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Commercial**
Chemical: **1,1,2-Trichloroethane**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (μg/m^3)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m^3)	Cancer Risk	Noncancer Hazard
1.00E+02	5.5E-04	5.5E-02	7.2E-08	6.3E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m^3)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
79005	1.00E+02			1,1,2-Trichloroethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Commercial
Chemical: 1,1,2,2-Tetrachloroethane

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	**4.6E-04**	**4.6E-02**	**2.2E-07**	**1.5E-04**

MESSAGE: Risk and/or hazard quotient is based on route-to-route extrapolation.

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
79345	1.00E+02			**1,1,2,2-Tetrachloroethane**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Commercial
Chemical: Vinyl chloride (chloroethene)

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	7.0E-04	7.0E-02	4.4E-07	1.6E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75014	1.00E+02			Vinyl chloride (chloroethene)

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	LS		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
LS	1.62	0.39	0.076	5

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

ATTACHMENT E3

DTSC J/E MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS FOR THE RESIDENTIAL EXPOSURE SCENARIO, SANDY CLAY LOAM

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Tetrachloroethylene

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
8.50E+03	4.9E-04	4.2E+00	8.8E-06	1.2E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
127184	8.50E+03			Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Residential**
Chemical: **Benzene**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
7.10E+02	7.6E-04	5.4E-01	5.6E-06	1.7E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
71432	7.10E+02			Benzene

MESSAGE: See VLOOKUP table comments on chemical properties and/or toxicity criteria for this chemical.

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Toluene

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
1.50E+03	6.9E-04	1.0E+00	NA	3.3E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108883	1.50E+03			Toluene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Ethylbenzene

Results Summary

Soil Gas Conc. (μg/m^3)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m^3)	Cancer Risk	Noncancer Hazard
2.80E+02	6.3E-04	1.8E-01	1.6E-07	1.7E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m^3)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
100414	2.80E+02			Ethylbenzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Residential**
Chemical: **m-Xylene**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.10E+03	6.3E-04	6.9E-01	NA	6.6E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108383	1.10E+03			m-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: Residential
Chemical: o-Xylene

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (µg/m^3)	Attenuation Factor (unitless)	Indoor Air Conc. (µg/m^3)	Cancer Risk	Noncancer Hazard
3.50E+02	6.3E-04	2.2E-01	NA	2.1E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (µg/m^3)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
95476	3.50E+02			o-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Trichlorofluoromethane**

Results Summary				
Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
2.30E+03	**6.0E-04**	**1.4E+00**	**NA**	**1.9E-03**

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75694	2.30E+03			Trichlorofluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Dichlorodifluoromethane**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
6.40E+03	6.8E-04	4.3E+00	NA	4.1E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75718	6.40E+03			Dichlorodifluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Chloroform**

Results Summary				
Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.60E+02	6.8E-04	1.1E-01	8.9E-07	1.1E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
67663	1.60E+02			Chloroform

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Residential**
Chemical: **Carbon tetrachloride**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
1.00E+02	5.5E-04	5.5E-02	8.2E-07	1.3E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
56235	1.00E+02			Carbon tetrachloride

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: Residential
Chemical: 1,2-Dichloroethane

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (μg/m^3)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m^3)	Cancer Risk	Noncancer Hazard
1.00E+02	7.4E-04	7.4E-02	6.8E-07	1.0E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m^3)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
107062	1.00E+02			1,2-Dichloroethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: 1,1,2-Trichloroethane

Results Summary

Soil Gas Conc. (μg/m^3)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m^3)	Cancer Risk	Noncancer Hazard
1.00E+02	6.2E-04	6.2E-02	3.5E-07	3.0E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m^3)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
79005	1.00E+02			1,1,2-Trichloroethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **1,1,2,2-Tetrachloroethane**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	**4.8E-04**	**4.8E-02**	**1.0E-06**	**6.6E-04**

MESSAGE: Risk and/or hazard quotient is based on route-to-route extrapolation.

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
79345	1.00E+02			**1,1,2,2-Tetrachloroethane**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Vinyl chloride (chloroethene)

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	8.6E-04	8.6E-02	2.4E-06	8.2E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75014	1.00E+02			Vinyl chloride (chloroethene)

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

ATTACHMENT E4

DTSC J/E MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS FOR THE COMMERCIAL EXPOSURE SCENARIO, SANDY CLAY LOAM

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Tetrachloroethylene**

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
8.50E+03	**2.5E-04**	**2.1E+00**	**1.0E-06**	**1.4E-02**

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
127184	8.50E+03			**Tetrachloroethylene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Benzene**

Results Summary

Soil Gas Conc. (μg/m3)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m3)	Cancer Risk	Noncancer Hazard
7.10E+02	3.8E-04	2.7E-01	6.4E-07	2.1E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
71432	7.10E+02			Benzene

MESSAGE: See VLOOKUP table comments on chemical properties and/or toxicity criteria for this chemical.

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Commercial**
Chemical: **Toluene**

DATA ENTRY SHEET

Results Summary				
Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
1.50E+03	3.4E-04	5.2E-01	NA	3.9E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108883	1.50E+03			Toluene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
Lookup Soil Parameters				
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Commercial**
Chemical: **Ethylbenzene**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
2.80E+02	3.1E-04	8.8E-02	1.8E-08	2.0E-05

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
100414	2.80E+02			Ethylbenzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **m-Xylene**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.10E+03	3.1E-04	3.4E-01	NA	7.9E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108383	1.10E+03			m-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Commercial
Chemical: o-Xylene

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
3.50E+02	3.1E-04	1.1E-01	NA	2.5E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
95476	3.50E+02			o-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Trichlorofluoromethane**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
2.30E+03	3.0E-04	7.0E-01	NA	2.3E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75694	2.30E+03			Trichlorofluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Dichlorodifluoromethane**

Results Summary				
Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
6.40E+03	3.4E-04	2.2E+00	NA	4.9E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75718	6.40E+03			Dichlorodifluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Commercial**
Chemical: **Chloroform**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (µg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (µg/m³)	Cancer Risk	Noncancer Hazard
1.60E+02	3.4E-04	5.5E-02	1.0E-07	1.3E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (µg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
67663	1.60E+02			Chloroform

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Commercial**
Chemical: **Carbon tetrachloride**

DATA ENTRY SHEET

Results Summary				
Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	2.7E-04	2.7E-02	9.3E-08	1.6E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
56235	1.00E+02			Carbon tetrachloride

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **1,2-Dichloroethane**

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
1.00E+02	3.7E-04	3.7E-02	7.8E-08	1.2E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
107062	1.00E+02			1,2-Dichloroethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Commercial
Chemical: 1,1,2-Trichloroethane

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	3.1E-04	3.1E-02	4.0E-08	3.5E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
79005	1.00E+02			1,1,2-Trichloroethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **1,1,2,2-Tetrachloroethane**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	2.4E-04	2.4E-02	1.1E-07	7.9E-05

MESSAGE: Risk and/or hazard quotient is based on route-to-route extrapolation.

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
79345	1.00E+02			1,1,2,2-Tetrachloroethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
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Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Commercial**
Chemical: **Vinyl chloride (chloroethene)**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.00E+02	4.3E-04	4.3E-02	2.7E-07	9.8E-05

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75014	1.00E+02			Vinyl chloride (chloroethene)

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

ATTACHMENT F

FATE AND TRANSPORT FOR VAPOR EMISSIONS OF CHLOROFORM FROM SOIL VAPOR INTO INDOOR AIR (ELEVATOR SHAFT SCENARIO) - DTSC J/E MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS FOR THE RESIDENTIAL EXPOSURE SCENARIO

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Chloroform**

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
1.90E+02	6.8E-04	1.3E-01	1.1E-06	1.3E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
67663	1.90E+02			Chloroform

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END