Final

Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Hunters Point Shipyard
San Francisco, California

April 30, 2010

Prepared for:
Base Realignment and Closure
Program Management Office West
San Diego, California

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Final

Memorandum:
Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, California

Contract Task Order 0039
Contract Number N62473-07-D-3213

PREPARED FOR:

DEPARTMENT OF THE NAVY

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ACRONYMS AND ABBREVIATIONS

α_{sg}	Attenuation factor between soil gas and indoor air
ARIC	Area requiring institutional controls
ASG	Active soil gas
ATSDR	Agency for Toxic Substances and Disease Registry
BCT	Base Realignment and Closure Cleanup Team
bgs	Below ground surface
Cal/EPA	California Environmental Protection Agency
COC	Chemical of concern
EPA	U.S. Environmental Protection Agency
FS	Feasibility study
HEAST	Health Effects Assessment Summary Tables
HHRA	Human health risk assessment
HI	Hazard index
HPS	Hunters Point Shipyard
IRIS	Integrated Risk Information System
IUR	Inhalation unit risk
JEM	Johnson and Ettinger model
NCEA	National Center for Environmental Assessment
PCOPC	Preliminary chemical of potential concern
PPRTV	Provisional peer-reviewed toxicity values
RBC-IA	Risk-based concentration for indoor air
RBC-SG	Risk-based concentration for soil gas
RfC	Reference concentration
RL	Reporting limit
ROD	Record of decision
SAP	Sampling and analysis plan
SGAL	Soil gas action level
TCE	Trichloroethene

1.0 INTRODUCTION

This document describes the approach for establishing soil gas action levels (SGAL) for Hunters Point Shipyard (HPS) in San Francisco, California. The Navy used HPS starting around 1939 for shipbuilding, repair, and maintenance. In addition, the Navy continued to operate carrier overhaul and ship maintenance and repair facilities through the 1960s. HPS was deactivated in 1974 and remained largely unused until 1976. Between 1976 and 1986, the Navy leased most of HPS to Triple A Machine Shop, Inc., a private ship repair company. The Navy resumed occupancy of HPS in 1987. HPS consists of 866 acres divided among 10 parcels: B, C, D-1, D-2, E, E-2, F, G, UC-1, and UC-2.

HPS was included on the National Priorities List in 1989 and was designated for closure in 1991 under the Department of Defense Base Realignment and Closure program. Ongoing cleanup of HPS continues pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act. Coordination among the Navy as the lead agency, the U.S. Environmental Protection Agency (EPA) as the lead federal oversight agency, and the State of California is maintained through a federal facility agreement. Records of decision (ROD) are in place or in progress for Parcels B, C, D-1, D-2, G, UC-1, and UC-2. The methodology described in this document is intended to support remediation activities identified in these RODs and to aid planning for remediation at land-based parcels that are still undergoing feasibility studies (FS).

Future residential and industrial receptors at HPS may inhale volatile chemicals in soil and groundwater at HPS that migrate through the subsurface to indoor air. This pathway of exposure, known as vapor intrusion, was identified as potentially complete in the human health risk assessments (HHRA) for HPS (Barajas & Associates 2008; ChaduxTt 2007, ERRG and Shaw 2007; SulTech 2007, 2008). The HHRAs for HPS quantified risks for the vapor intrusion exposure pathway based on analytical data for volatile chemicals in groundwater, as soil gas data were not collected for the HHRAs. The HHRAs identified groundwater chemicals of concern (COC) for vapor intrusion and developed vapor intrusion-based remediation goals for these COCs.

Since the HHRAs were completed for HPS, more recent guidance documents for assessment of health risks from vapor intrusion have become available (Cal/EPA 2005; ITRC 2007; U.S. Air Force, U.S. Navy, and U.S. Army 2008). These documents all specify a preference for use of active soil gas (ASG) data to assess risks from vapor intrusion, as use of ASG data reduces the uncertainty associated with chemical transport models necessary to estimate partitioning of chemicals in groundwater or soil to the vapor phase. In addition, soil gas data represent vapors originating from sources in both groundwater and soil. As a result, the Navy and the HPS Base Realignment and Closure Cleanup Team (BCT) have agreed that the results from future ASG surveys at HPS will be used to refine the HHRA results and the COCs for vapor intrusion. The calculated vapor intrusion risks and COCs identified using ASG data will supersede the groundwater vapor intrusion risk estimates and COCs identified in the RODs for Parcels B, C, D-1, G, UC-1, and UC-2 and the FS report for Parcel E.

This memorandum describes the approach for developing SGALs for HPS. The SGALs can be used as health-based comparison benchmarks for the data generated from the future soil gas surveys. In addition, the SGALs can be used to identify where the initially specified areas requiring institutional controls (ARIC) for volatile chemicals may need modification. These benchmarks are termed "action levels" instead of "remediation goals" to avoid potential confusion. Although action may be necessary if results of future soil gas surveys exceed action levels, the action may include institutional controls (for example, access limitations) or engineering controls (such as a vapor barrier) and would not be limited to additional remediation, as might be implied by the term "remediation goal."

Future documents, including the sampling and analysis plan (SAP) for an ASG survey and the document summarizing the results of that survey, will describe in greater detail how the action levels for soil gas developed in this memorandum will be used.

The proposed approach for developing SGALs consists of four overall steps:

1. Calculation of risk-based concentrations for indoor air (RBC-IA)
2. Calculation of risk-based concentrations for soil gas (RBC-SG)
3. Identification of COCs for soil gas
4. Identification of SGALs for soil gas COCs.

The methods for each of these steps are detailed below. This memorandum includes preliminary calculated RBC-IAs, RBC-SGs, and SGALs. The RBC-IAs, RBC-SGs, and SGALs provided in this document are limited to chemicals previously detected in soil and in groundwater in the A-aquifer at Parcels B, C, D-1, E, G, and UC-2 that are considered sufficiently volatile and toxic to potentially pose a health risk from vapor intrusion exposure. The determination of sufficient toxicity and volatility was based on EPA (2002) and Cal/EPA (2005). These chemicals are considered preliminary chemicals of potential concern (PCOPC) for soil gas.

2.0 STEP 1: CALCULATION OF RISK-BASED CONCENTRATIONS FOR INDOOR AIR

The first step involves calculation of chemical-specific RBC-IAs for residential and industrial exposure. RBC-IAs are concentrations in indoor air that correspond to a target cancer risk and hazard quotient that are considered protective of human health. The method used for calculating RBC-IAs is similar to the EPA (2009a, 2009b) and California Environmental Protection Agency (Cal/EPA) (2005) methods used to calculate risk-based concentrations for screening sites. A target indoor air cancer risk of 10^{-6} and a noncancer hazard index of 1 were used for calculating cancer- and noncancer-based RBC-IAs. These target cancer and noncancer levels are consistent with the levels used to identify COCs in the HHRAs for HPS. Likewise, the exposure assumptions and hierarchy of toxicity criteria used to calculate RBC-IAs are consistent with those used in the HHRAs for HPS. The equations, exposure assumptions, and toxicity criteria for calculating RBC-IAs are described below.

2.1 RBC EQUATIONS FOR INDOOR AIR

RBC-IAs were calculated using the equations shown below. Separate RBC-IAs were calculated for residential and industrial exposure and for cancer and noncancer effects. Definitions for the terms contained in each equation are provided in Table 1.

Equation 2-1: Residential Exposure to Carcinogenic Chemicals in Indoor Air

$$RBC\text{-}IA_{residential,\,carcinogen}\ (\mu g/m^3) = \frac{TR \times AT_c}{ET_r \times EF_r \times ED_r \times IUR}$$

Equation 2-2: Residential Exposure to Noncarcinogenic Chemicals in Indoor Air

$$RBC\text{-}IA_{residential,\,noncarcinogen}\ (\mu g/m^3) = \frac{THQ \times RfC \times AT_{nc-r} \times CF}{ET_r \times EF_r \times ED_r}$$

Equation 2-3: Industrial Exposure to Carcinogenic Chemicals in Indoor Air

$$RBC\text{-}IA_{industrial,\,carcinogen}\ (\mu g/m^3) = \frac{TR \times AT_c}{ET_w \times EF_w \times ED_w \times IUR}$$

Equation 2-4: Industrial Exposure to Noncarcinogenic Chemicals in Indoor Air

$$RBC\text{-}IA_{industrial,\,noncarcinogen}\ (\mu g/m^3) = \frac{THQ \times RfC \times AT_{nc-w} \times CF}{ET_w \times EF_w \times ED_w}$$

2.2 EXPOSURE ASSUMPTIONS

RBC-IAs were calculated using the exposure assumptions shown in Table 1.

2.3 TOXICITY CRITERIA

Consistent with the toxicity criteria hierarchy used in the HHRAs for HPS (Barajas & Associates 2008; ChaduxTt 2007; ERRG and Shaw 2007; SulTech 2007, 2008), inhalation unit risks (IUR) and reference concentrations (RfC) for calculating RBC-IAs were obtained from the following hierarchy of sources. If the IUR from an EPA source (Tiers 2 through 4) is higher than the IUR from Cal/EPA, then the more conservative (higher) IUR was used. This hierarchy for toxicity criteria is generally consistent with the EPA (2003)-recommended hierarchy, except that the more health-protective of the Cal/EPA IURs and EPA IURs were used.

- Tier 1 – Cal/EPA's Office of Environmental Health Hazard Assessment's toxicity criteria database (Cal/EPA 2009b), which contains approved IURs. The IURs in this database have undergone review and are recognized toxicity values for evaluations in California.

- Tier 2 – EPA's Integrated Risk Information System (IRIS) (EPA 2009c). The IURs and RfCs in IRIS have undergone review and are recognized as agency-wide consensus information.

- Tier 3 – EPA's provisional peer-reviewed toxicity values (PPRTV), as cited in EPA (2009b). PPRTVs have undergone EPA review and are recognized as consensus information.

- Tier 4 – Other EPA values, as presented in EPA's regional screening level table (EPA 2009b), including values from:
    - EPA's Health Effects Assessment Summary Tables (HEAST) (EPA 1997).
    - EPA's National Center for Environmental Assessment (NCEA) papers (chemical-specific references). NCEA values are obtained from EPA (2009b).

- Tier 5 – For noncancer effects, non-EPA values from:
    - Cal/EPA Office of Environmental Health Hazard Assessment chronic inhalation reference exposure levels (Cal/EPA 2008).
    - Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk levels (ATSDR 2008).

IURs and RfCs used to calculate RBC-IAs for soil gas PCOPCs are summarized in Tables 2 and 3. Before the ASG results are evaluated, the Navy will verify the toxicity criteria in Tables 2 and 3 and will update the criteria and RBC-IAs, RBC-SGs, and SGALs as applicable. In addition, the following special considerations were adopted to obtain toxicity criteria for calculating RBC-IAs:

- Route-to-route extrapolation: As recommended by Cal/EPA (1992; 2009a), if an oral toxicity value is assigned for an organic compound but no inhalation toxicity value is available, then the oral toxicity value was used as the inhalation toxicity value. Although current EPA (2009a) inhalation risk assessment guidance generally does not support route-to-route extrapolations, these extrapolations were used for consistency with the HHRAs and risk-based remediation goals established for HPS (Barajas & Associates 2008; ChaduxTt 2007; ERRG and Shaw 2007; SulTech 2007, 2008).

- Chemical surrogates: Chemical surrogates were used to avoid data gaps in developing RBC-IAs because of a lack of toxicity criteria for some chemicals. Chemical surrogates were selected based on similar chemical structure, chemical activity, and mechanisms of toxicity. Table 4 summarizes the chemical surrogates used for the toxicity criteria.

- Trichloroethene (TCE): The inhalation IUR developed by Cal/EPA for TCE was used to calculate the cancer-based RBC-IA for TCE.

RBC-IAs calculated using route-extrapolated and surrogate toxicity values are considered preliminary. After the soil gas surveys for HPS are completed, the Navy will evaluate the soil gas results and assess on a chemical-specific basis whether the route-extrapolated and surrogate toxicity value-based RBC-IAs are appropriate for quantitative evaluation of soil gas results, or whether qualitative evaluation is may be warranted for some chemicals.

2.4 PRELIMINARY RBCs FOR INDOOR AIR

The preliminary RBC-IAs for soil gas PCOPCs are presented in Table 5.

3.0 STEP 2: CALCULATION OF RISK-BASED CONCENTRATIONS FOR SOIL GAS

The second step involves calculation of RBC-SGs using the calculated RBC-IAs. The calculation of RBC-SGs assumes a certain amount of attenuation and dilution of subsurface vapors through the vadose zone and building floor slab. The amount of attenuation and dilution between subsurface soil gas and indoor air is referred to as the attenuation factor (α_{sg}), as shown in the equation below.

$$\alpha_{sg} = \frac{C_{indoor\ air}}{C_{soil\ gas}}$$

where:

α_{sg}	=	Attenuation factor between soil gas and indoor air
$C_{indoor\ air}$	=	Concentration in indoor air
$C_{soil\ gas}$	=	Concentration in soil gas

Rearrangement of this equation and use of the calculated RBC-IAs to represent $C_{indoor\ air}$ (that is, target, not-to-exceed indoor air concentrations) results in the following equation that can be used to calculate chemical-specific, target risk-based concentrations for soil gas.

$$RBC\text{–}SG = \frac{RBC\text{–}IA}{\alpha_{sg}}$$

where:

RBC-SG	=	Target risk-based concentration in soil gas
RBC-IA	=	Target risk-based concentration in indoor air
α_{sg}	=	Attenuation factor between soil gas and indoor air

Attenuation factors can be based on a model or on empirical data. Generic α_{sg} values are provided in Cal/EPA (2005) and EPA (2002). The generic α_{sg} values provided in Cal/EPA (2005) were derived using the Johnson and Ettinger (1991) model (JEM) and incorporate assumptions that are likely to result in conservative, health-protective screening concentrations. These assumptions include a shallow source of vapors close to the building foundation, relatively permeable (sandy) soils, limited exchange between indoor and outdoor air, homogeneous vapor concentrations underlying the building footprint, constant source concentrations (for example, no decrease in chemical concentrations over time through biodegradation), under-pressurized buildings, single-story buildings, and lack of lateral vapor transport.

The generic α_{sg} values provided in EPA (2002) were derived using empirical data for 40 residences. The EPA (2002) evaluation of these data indicates for residences where shallow soil gas samples were obtained, α_{sg} values were greater than 0.1 for 15 percent of residences and α_{sg} values were smaller than 0.1 for 85 percent of residences. Shallow soil gas samples are defined as those obtained either from directly below the foundation or from depths less than 5 feet below the foundation level. Consequently, EPA identified an α_{sg} of 0.1 as generally reasonable upper-bound value for the case where soil gas is measured directly beneath a foundation (that is, subslab measurements) or where soil gas is measured at less than 5 feet below the foundation level. Deep soil gas samples (that is, samples obtained from just above the water table or from depths greater than 5 feet below the foundation level) represent a more direct measurement of the source vapor concentration and are subject to less variability than is observed for shallow soil gas samples. Therefore, EPA (2002) recommends an α_{sg} of 0.01 for screening deep soil gas results for residential buildings. EPA (2002) does not specifically provide α_{sg} recommendations for nonresidential buildings; however, EPA (2010) recommended an α_{sg} of 0.001 for screening deep soil gas results for industrial buildings at HPS.

The generic α_{sg} recommendations provided in Cal/EPA (2005) and in EPA (2002; 2010) were initially used to calculate RBC-SGs for HPS. The Cal/EPA-recommended α_{sg} values are taken from Table 2 of Cal/EPA (2005) and are for evaluation of future buildings with slab-on-grade construction. The assumption of slab-on-grade construction for calculating RBC-SGs is consistent with the approach used for HHRAs for HPS and is appropriate because groundwater is shallow at HPS (generally less than 10 feet below ground surface [bgs]). The nonsite-specific, generic α_{sg} values provided in Cal/EPA (2005) were initially used in lieu of site-specific vapor intrusion modeling because the site conditions at HPS (shallow source of vapors and coarse soils) are similar to the conditions accounted for in the Cal/EPA (2005) generic α_{sg} values (that is, shallow source of vapors and coarse soils).

The EPA-recommended α_{sg} values are based on deep soil gas; deep soil gas α_{sg} values were used to calculate preliminary RBC-SGs because soil gas surveys at HPS are scheduled to occur before HPS is redeveloped and future buildings are constructed. In the absence of constructed building foundations where subslab soil gas samples could be collected, samples will be collected from depths below 5 feet bgs, just above the water table. Details regarding the specific soil gas sampling methodology will be provided in a SAP for the soil gas surveys.

The following table summarizes the generic soil gas-to-indoor air attenuation factors that were used to calculate preliminary RBC-SGs for soil gas PCOPCs. The calculated RBC-SGs are provided in Table 6.

Building Type	Cal/EPA α_{sg}[1]	EPA α_{sg}[2]
Residential	0.0009	0.01
Industrial	0.0004	0.001

Source:
1 Cal/EPA (2005)
2 EPA (2002; 2010)

It is possible, depending on the ASG results and the risk estimates for vapor intrusion, that a further tier of evaluation using modeled, site-specific α_{sg} values for some chemicals may be warranted. This tiered approach is consistent with Cal/EPA (2005) and EPA (2002) recommendations if initial screening of soil gas results using generic α_{sg} values indicates that the vapor intrusion pathway may result in unacceptable indoor air inhalation risks. If needed, the JEM will be used to estimate site- and chemical-specific α_{sg} values, and the modeled α_{sg} values will be used to refine RBC-SGs. The Cal/EPA (2003) version of the JEM will be used for this evaluation, with modifications to include modeling assumptions recommended in Cal/EPA (2005). If an updated version of the JEM is available following the soil gas surveys, then the updated version will be used. Before site- and chemical-specific α_{sg} values are modeled, the Navy will provide proposed assumptions for soil and building properties to the BCT for review and approval.

4.0 STEP 3: IDENTIFICATION OF CHEMICALS OF CONCERN FOR SOIL GAS

The third step involves identification of COCs for soil gas. The BCT for HPS has agreed that future ASG samples can be used at HPS to refine the HHRA results and COCs for vapor intrusion. The specific details for the ASG survey will be provided in a SAP; the Navy will locate the ASG samples where existing analytical data for soil or groundwater suggest the potential presence of volatile chemicals in the subsurface.

After the ASG survey, the results may be compared with the RBC-SGs calculated in Step 2 to refine the list of COCs for soil gas. The ASG results will be compared with both the cancer- and noncancer-based RBC-SGs for chemicals with both cancer and noncancer effects. If the ASG result for a detected chemical exceeds its RBC-SG, then the chemical may be identified as a soil gas COC for vapor intrusion exposure. As indicated in Section 3.0, if warranted, site- and chemical-specific modeling may be used after the soil gas survey to refine RBC-SGs. COCs will be identified separately for each ASG sample location.

In addition to identifying COCs for soil gas, vapor intrusion risks estimated in the HHRAs for HPS (Barajas & Associates 2008; ChaduxTt 2007; ERRG and Shaw 2007; SulTech 2007, 2008) may be refined using the ASG results. Each ASG sample location will represent a separate exposure point location; vapor intrusion risks will be calculated separately for each detected chemical at each ASG location using the ratiometric approach employed in the HHRAs for HPS to evaluate vapor intrusion risks for groundwater (Barajas & Associates 2008; ChaduxTt 2007; ERRG and Shaw 2007; SulTech 2007, 2008). Comparison to RBC-SGs will not be used to exclude detected chemicals from the risk calculations; however, some detected chemicals may warrant exclusion from the risk calculations based on factors such as low detection frequency, spatial distribution, low concentration, and toxicity. Before risks are calculated, the Navy will identify whether these factors apply to any chemicals detected in the ASG samples and will consult with regulatory agency toxicologists if it proposes to exclude any of these chemicals from the vapor intrusion risk estimates.

Consistent with the approach used in the HHRAs for HPS, cumulative cancer risks, total noncancer hazard indices (HI), and segregated HIs will be calculated for vapor intrusion exposure. The presentation of vapor intrusion risk results will also include a discussion of potential inhalation risks associated with ambient sources. The Navy will also consider ambient data (for example, results of outdoor air samples that will be collected during the soil gas surveys and literature values) to ensure that the identified COCs and ARICs are related to soil gas affected by the site, rather than ambient sources.

The calculated vapor intrusion risks and COCs identified using soil gas data will supersede the groundwater vapor intrusion risk estimates and COCs identified in the RODs for Parcels B, C, D-1, G, UC-1, and UC-2 and the FS report for Parcel E.

5.0 STEP 4: IDENTIFICATION OF ACTION LEVELS FOR SOIL GAS CHEMICALS OF CONCERN

This fourth and final step involves identification of SGALs for soil gas COCs. As discussed in Section 1.0, the SGALs can be used to identify where the initial ARICs for volatile chemicals may need to be modified or where additional action may be needed. The RBC-SGs calculated in Step 2 and used in Step 3 to identify soil gas COCs can be used as SGALs for HPS. The RBC-SGs are appropriate to use as SGALs because the RBC-SGs represent concentrations in soil gas that correspond to target, not-to-exceed risk-based concentrations in indoor air.

Preliminary residential and industrial SGALs for the soil gas PCOPCs for HPS are provided in Table 7. Two sets of preliminary SGALs are provided: one based on the Cal/EPA (2005) generic α_{sg} recommendations, and the other based on EPA (2002; 2010) generic α_{sg} recommendations (see Section 3.0). The lowest of the cancer- and noncancer-based RBC-SGs is used as the SGAL for chemicals with both cancer and noncancer effects. The laboratory reporting limit (RL) is used as the SGAL when the RBC-SG is lower than the RL. RLs are chemical-specific and will depend on the specific analytical method that will be used for analysis for the soil gas samples; the specific analytical methods will be identified during development of the SAP for the soil gas survey. Possible analytical methods for the soil gas samples are listed in Table 7. Actual analytical methods will be identified during development of the SAP. If different analytical methods are identified, then revision to SGALs may be needed for chemicals for which the RL is used as the SGAL.

As indicated in Section 3.0, if warranted, site- and chemical-specific modeling may be used after the ASG survey to refine RBC-SGs. Additionally, after the ASG survey, the Navy will verify toxicity criteria (see Section 2.3) for chemicals detected in the survey and will update the criteria and RBC-SGs as applicable. The preliminary SGALs provided in Table 7 can be finalized after the RBC-SGs have been refined and updated and the specific analytical methods have been selected for the soil gas samples.

The final SGALs will supersede the groundwater remediation goals for vapor intrusion identified in the RODs for Parcels B, C, D-1, G, UC-1, and UC-2 and the FS report for Parcel E. Future actions and decisions to address areas with soil gas concentrations above SGALs will be based on soil gas data and the SGALs for HPS, rather than groundwater data and the previously developed groundwater remediation goals for vapor intrusion.

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EPA. 2010. Comments regarding Draft Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, CA, November 2009." From Sarah Kloss, Remedial Project Manager, Superfund Federal Facility Branch, EPA Region 9. To Keith Forman, U.S. Department of the Navy, BRAC Program Management Office - West.

TABLES

TABLE 1: EXPOSURE ASSUMPTIONS FOR CALCULATING RISK-BASED CONCENTRATIONS FOR INDOOR AIR

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Parameter		Value[1]
TR	Target cancer risk (unitless)	1E-06
THQ	Target hazard quotient (unitless)	1
ET_r	Exposure time – resident (hours/day)	24
ET_w	Exposure time – industrial worker (hours/day)	8
EF_r	Exposure frequency – resident (days/year)	350
EF_w	Exposure frequency – industrial worker (days/year)	250
ED_r	Exposure duration – resident (years)	30
ED_w	Exposure duration – industrial worker (years)	25
AT_c	Averaging time – carcinogens (hours)	613,200
AT_{nc-r}	Averaging time – noncarcinogens, resident (hours)	262,800
AT_{nc-w}	Averaging time – noncarcinogens, industrial worker (hours)	219,000
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	See Section 2.3
RfC	Inhalation reference concentration (mg/m^3)	See Section 2.3
CF	Conversion factor (µg/mg)	1,000

Notes:

1 Exposure assumptions listed are consistent with assumptions used in the HHRAs for HPS (Barajas & Associates 2008, ChaduxTt 2007, ERRG and Shaw 2007, SulTech 2007, SulTech 2008).

$\mu g/m^3$ Microgram per cubic meter
µg/mg Microgram per milligram
HHRA Human health risk assessment
HPS Hunters Point Shipyard
mg/m^3 Milligram per cubic meter

TABLE 2: INHALATION REFERENCE CONCENTRATIONS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Chronic Inhalation Reference Concentration		
		Value (mg/m^3)		Source
Metals				
MERCURY	7439976	3.00E-04		IRIS
Polycyclic Aromatic Hydrocarbons				
1-METHYLNAPHTHALENE	90120	2.45E-01	(RE)	ATSDR
2-METHYLNAPHTHALENE	91576	1.40E-02	(RE)	IRIS
ACENAPHTHENE	83329	2.10E-01	(RE)	IRIS
ACENAPHTHYLENE	208968	2.10E-01	(S)(RE)	IRIS
BENZO(B)FLUORANTHENE	205992	--		--
CHRYSENE	218019	--		--
FLUORENE	86737	1.40E-01	(RE)	IRIS
NAPHTHALENE	91203	3.00E-03		IRIS
1,6,7-TRIMETHYL-NAPHTHALENE	2245387	1.40E-02	(S)(RE)	IRIS
2,6-DIMETHYL-NAPHTHALENE	581420	1.40E-02	(S)(RE)	IRIS
PHENANTHRENE	85018	1.05E+00	(S)(RE)	IRIS
PYRENE	129000	1.05E-01	(RE)	IRIS
Pesticides				
2,4'-DDE	3424826	--		--
4,4'-DDE	72559	--		--
ALDRIN	309002	1.05E-04	(RE)	IRIS
ALPHA-BHC	319846	2.80E-02	(RE)	ATSDR
ALPHA-CHLORDANE	5103719	7.00E-04	(S)	IRIS
BETA-BHC	319857	--		--
DELTA-BHC	319868	--		--
DIELDRIN	60571	1.75E-04	(RE)	IRIS
ENDOSULFAN I	959988	2.10E-02	(S)(RE)	IRIS
ENDOSULFAN II	33213659	2.10E-02	(S)(RE)	IRIS
GAMMA-BHC (LINDANE)	58899	1.05E-03	(RE)	IRIS
GAMMA-CHLORDANE	5103742	7.00E-04	(S)	IRIS
HEPTACHLOR	76448	1.75E-03	(RE)	IRIS
METHOXYCHLOR	72435	1.75E-02	(RE)	IRIS
Semivolatile Organic Compounds				
2-CHLORONAPHTHALENE	91587	2.80E-01	(RE)	IRIS
2-CHLOROPHENOL	95578	1.75E-02	(RE)	IRIS
ACETOPHENONE	98862	3.50E-01	(RE)	IRIS
AZOBENZENE	103333	--		--
BIPHENYL	92524	1.75E-01	(RE)	IRIS
DIBENZOFURAN	132649	3.50E-03	(RE)	PPRTV
HEXACHLOROBENZENE	118741	2.80E-03	(RE)	IRIS
Volatile Organic Compounds				
1,1,1-TRICHLOROETHANE	71556	5.00E+00		IRIS
1,1,2,2-TETRACHLOROETHANE	79345	1.40E-02	(RE)	PPRTV
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76131	3.00E+01		HEAST
1,1,2-TRICHLOROETHANE	79005	1.40E-02	(RE)	IRIS
1,1-DICHLOROETHANE	75343	7.00E-01	(RE)	PPRTV
1,1-DICHLOROETHENE	75354	2.00E-01		IRIS

TABLE 2: INHALATION REFERENCE CONCENTRATIONS
Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Chronic Inhalation Reference Concentration		
		Value (mg/m^3)		Source
1,1-DICHLOROPROPENE	542756	2.00E-02		IRIS
1,2,3-TRICHLOROBENZENE	87616	2.80E-03	(RE)	PPRTV
1,2,3-TRICHLOROPROPANE	96184	3.00E-04		IRIS
1,2,4-TRICHLOROBENZENE	120821	2.00E-03		PPRTV
1,2,4-TRIMETHYLBENZENE	95636	7.00E-03		PPRTV
1,2-DICHLOROBENZENE	95501	2.00E-01		HEAST
1,2-DICHLOROETHANE	107062	4.00E-01		OEHHA
1,2-DICHLOROETHENE (TOTAL)	540590	3.15E-02	(RE)	HEAST
1,2-DICHLOROPROPANE	78875	4.00E-03		IRIS
1,3,5-TRIMETHYLBENZENE	108678	3.50E-02	(RE)	PPRTV
1,3-DICHLOROBENZENE	541731	2.00E-01	(S)	HEAST
1,4-DICHLOROBENZENE	106467	8.00E-01		IRIS
1,4-DIOXANE	123911	3.00E+00		OEHHA
2-BUTANONE	78933	5.00E+00		IRIS
2-HEXANONE	591786	3.00E-02		IRIS
4-METHYL-2-PENTANONE	108101	3.00E+00		IRIS
ACETONE	67641	3.10E+01		ATSDR
BENZALDEHYDE	100527	3.50E-01	(RE)	IRIS
BENZENE	71432	3.00E-02		IRIS
BROMODICHLOROMETHANE	75274	7.00E-02	(RE)	IRIS
BROMOFORM	75252	7.00E-02	(RE)	IRIS
BROMOMETHANE	74839	5.00E-03		IRIS
CARBON DISULFIDE	75150	7.00E-01		IRIS
CARBON TETRACHLORIDE	56235	4.00E-02		OEHHA
CHLOROBENZENE	108907	5.00E-02		PPRTV
CHLOROETHANE	75003	1.00E+01		IRIS
CHLOROFORM	67663	9.80E-02		ATSDR
CHLOROMETHANE	74873	9.00E-02		IRIS
CIS-1,2-DICHLOROETHENE	156592	3.50E-02	(RE)	PPRTV
CIS-1,3-DICHLOROPROPENE	10061015	2.00E-02	(S)	IRIS
CYCLOHEXANE	110827	6.00E+00		IRIS
DIBROMOCHLOROMETHANE	124481	7.00E-02	(RE)	IRIS
DICHLORODIFLUOROMETHANE	75718	2.00E-01		HEAST
ETHYLBENZENE	100414	1.00E+00		IRIS
HEXACHLOROETHANE	67721	3.50E-03	(RE)	IRIS
ISOPROPYLBENZENE	98828	4.00E-01		IRIS
M,P-XYLENES	108383, 106423	7.00E-01	(S)	OEHHA
METHYL ACETATE	79209	3.50E+00	(RE)	HEAST
METHYLCYCLOHEXANE	108872	6.00E+00	(S)	IRIS
METHYLENE CHLORIDE	75092	4.00E-01		OEHHA
N-BUTYLBENZENE	104518	4.00E-01	(S)	IRIS
O-XYLENE	95476	7.00E-01		OEHHA
PARA-ISOPROPYL TOLUENE	99876	4.00E-01	(S)	IRIS
PROPYLBENZENE	103651	1.00E+00		PPRTV
SEC-BUTYLBENZENE	135988	4.00E-01	(S)	IRIS

TABLE 2: INHALATION REFERENCE CONCENTRATIONS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Chronic Inhalation Reference Concentration		
		Value (mg/m^3)		Source
STYRENE	100425	1.00E+00		IRIS
TERT-BUTYL METHYL ETHER	1634044	3.00E+00		IRIS
TERT-BUTYLBENZENE	98066	4.00E-01	(S)	IRIS
TETRACHLOROETHENE	127184	3.50E-02		OEHHA
TOLUENE	108883	5.00E+00		IRIS
TRANS-1,2-DICHLOROETHENE	156605	6.00E-02		PPRTV
TRANS-1,3-DICHLOROPROPENE	10061026	2.00E-02	(S)	IRIS
TRICHLOROETHENE	79016	6.00E-01		OEHHA
TRICHLOROFLUOROMETHANE	75694	7.00E-01		HEAST
VINYL ACETATE	108054	2.00E-01		IRIS
VINYL CHLORIDE	75014	1.00E-01		IRIS
XYLENE (TOTAL)	1330207	1.00E-01		IRIS

Notes:

--	Not available; not applicable
ATSDR	Agency for Toxic Substances and Disease Registry (ATSDR 2008)
BHC	Benzene hexachloride
CAS	Chemical Abstract Service
DDE	Dichlorodiphenyldichloroethene
EPA	U.S. Environmental Protection Agency
HEAST	EPA Health Effects Assessment Summary Tables (EPA 1997)
IRIS	EPA Integrated Risk Information System (EPA 2009b)
mg/m^3	Milligram per cubic meter
OEHHA	California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, Cancer Potency List (Cal/EPA 2009)
PPRTV	EPA Provisional Peer-Reviewed Toxicity Values (As cited in EPA 2009a)
RE	Route-extrapolated from oral toxicity value
S	Toxicity value based on chemical surrogate (see Table 4)

References:

Agency for Toxic Substances and Disease Registry (ATSDR). 2008. Minimal Risk Levels. December. Available on-line at: http://www.atsdr.cdc.gov/mrls/pdfs/atsdr_mrls_december_2008.pdf

California Environmental Protection Agency (Cal/EPA). 2008. Chronic Reference Exposure Levels. Office of Environmental Health Hazard Assessment. December 18. Available on-line at: <http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html>

U.S. Environmental Protection Agency (EPA). 1997. "Health Effects Assessment Summary Tables (HEAST): Annual Update, FY 1997." EPA-540-R-97-036. National Center for Environmental Assessment, Office of Research and Development and Office of Emergency and Remedial Response. July.

EPA. 2009a. Risk-Based Concentration Table. Regional Screening Levels for Chemical Contaminants at Superfund Sites. December. Available on-line at: <http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm>.

EPA. 2009b. Integrated Risk Information System. On-line Database. Office of Research and Development, National Center for Environmental Assessment. Accessed 12/09/2009. Available on-line at: http://cfpub.epa.gov/ncea/iris/index.cfm>

TABLE 3: INHALATION UNIT RISKS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Inhalation Unit Risk		
		Value $(\mu g/m^3)^{-1}$		Source
Metals				
MERCURY	7439976	--		--
Polycyclic Aromatic Hydrocarbons				
1-METHYLNAPHTHALENE	90120	8.29E-06	(RE)	PPRTV
2-METHYLNAPHTHALENE	91576	--		--
ACENAPHTHENE	83329	--		--
ACENAPHTHYLENE	208968	--		--
BENZO(B)FLUORANTHENE	205992	1.10E-04		OEHHA
CHRYSENE	218019	1.10E-05		OEHHA
FLUORENE	86737	--		--
NAPHTHALENE	91203	3.40E-05		OEHHA
1,6,7-TRIMETHYL-NAPHTHALENE	2245387	--		--
2,6-DIMETHYL-NAPHTHALENE	581420	--		--
PHENANTHRENE	85018	--		--
PYRENE	129000	--		--
Pesticides				
2,4'-DDE	3424826	9.70E-05	(S)	OEHHA
4,4'-DDE	72559	9.70E-05		OEHHA
ALDRIN	309002	4.90E-03		IRIS
ALPHA-BHC	319846	1.80E-03		IRIS
ALPHA-CHLORDANE	5103719	1.00E-04	(S)	IRIS
BETA-BHC	319857	5.30E-04		IRIS
DELTA-BHC	319868	5.30E-04	(S)	IRIS
DIELDRIN	60571	4.60E-03		IRIS
ENDOSULFAN I	959988	--		--
ENDOSULFAN II	33213659	--		--
GAMMA-BHC (LINDANE)	58899	3.10E-04		OEHHA
GAMMA-CHLORDANE	5103742	1.00E-04	(S)	IRIS
HEPTACHLOR	76448	1.30E-03		IRIS
METHOXYCHLOR	72435	--		--
Semivolatile Organic Compounds				
2-CHLORONAPHTHALENE	91587	--		--
2-CHLOROPHENOL	95578	--		--
ACETOPHENONE	98862	--		--
AZOBENZENE	103333	3.10E-05		IRIS
BIPHENYL	92524	--		--
DIBENZOFURAN	132649	--		--
HEXACHLOROBENZENE	118741	4.60E-04		IRIS
Volatile Organic Compounds				
1,1,1-TRICHLOROETHANE	71556	--		--
1,1,2,2-TETRACHLOROETHANE	79345	5.80E-05		IRIS
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76131	--		--
1,1,2-TRICHLOROETHANE	79005	1.60E-05		IRIS
1,1-DICHLOROETHANE	75343	1.60E-06		OEHHA
1,1-DICHLOROETHENE	75354	--		--

TABLE 3: INHALATION UNIT RISKS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Inhalation Unit Risk		
		Value ($\mu g/m^3$)$^{-1}$		Source
1,1-DICHLOROPROPENE	542756	4.00E-06		IRIS
1,2,3-TRICHLOROBENZENE	87616	--		--
1,2,3-TRICHLOROPROPANE	96184	8.57E-03	(RE)	IRIS
1,2,4-TRICHLOROBENZENE	120821	8.29E-06	(RE)	PPRTV
1,2,4-TRIMETHYLBENZENE	95636	--		--
1,2-DICHLOROBENZENE	95501	--		--
1,2-DICHLOROETHANE	107062	2.60E-05		IRIS
1,2-DICHLOROETHENE (TOTAL)	540590	--		--
1,2-DICHLOROPROPANE	78875	1.00E-05		OEHHA
1,3,5-TRIMETHYLBENZENE	108678	--		--
1,3-DICHLOROBENZENE	541731	--		--
1,4-DICHLOROBENZENE	106467	1.10E-05		OEHHA
1,4-DIOXANE	123911	7.70E-06		OEHHA
2-BUTANONE	78933	--		--
2-HEXANONE	591786	--		--
4-METHYL-2-PENTANONE	108101	--		--
ACETONE	67641	--		--
BENZALDEHYDE	100527	--		--
BENZENE	71432	7.80E-06		IRIS
BROMODICHLOROMETHANE	75274	3.70E-05		OEHHA
BROMOFORM	75252	1.10E-06		IRIS
BROMOMETHANE	74839	--		--
CARBON DISULFIDE	75150	--		--
CARBON TETRACHLORIDE	56235	1.50E-05		IRIS
CHLOROBENZENE	108907	--		--
CHLOROETHANE	75003	--		--
CHLOROFORM	67663	2.30E-05		IRIS
CHLOROMETHANE	74873	--		--
CIS-1,2-DICHLOROETHENE	156592	--		--
CIS-1,3-DICHLOROPROPENE	10061015	4.00E-06	(S)	IRIS
CYCLOHEXANE	110827	--		--
DIBROMOCHLOROMETHANE	124481	2.70E-05		OEHHA
DICHLORODIFLUOROMETHANE	75718	--		--
ETHYLBENZENE	100414	2.50E-06		OEHHA
HEXACHLOROETHANE	67721	4.00E-06		IRIS
ISOPROPYLBENZENE	98828	--		--
M,P-XYLENES	108383, 106423	--		--
METHYL ACETATE	79209	--		--
METHYLCYCLOHEXANE	108872	--		--
METHYLENE CHLORIDE	75092	4.70E-07		IRIS
N-BUTYLBENZENE	104518	--		--
O-XYLENE	95476	--		--
PARA-ISOPROPYL TOLUENE	99876	--		--
PROPYLBENZENE	103651	--		--
SEC-BUTYLBENZENE	135988	--		--

TABLE 3: INHALATION UNIT RISKS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Inhalation Unit Risk	
		Value $(\mu g/m^3)^{-1}$	Source
STYRENE	100425	--	--
TERT-BUTYL METHYL ETHER	1634044	2.60E-07	OEHHA
TERT-BUTYLBENZENE	98066	--	--
TETRACHLOROETHENE	127184	5.90E-06	OEHHA
TOLUENE	108883	--	--
TRANS-1,2-DICHLOROETHENE	156605	--	--
TRANS-1,3-DICHLOROPROPENE	10061026	4.00E-06 (S)	IRIS
TRICHLOROETHENE	79016	2.00E-06	OEHHA
TRICHLOROFLUOROMETHANE	75694	--	--
VINYL ACETATE	108054	--	--
VINYL CHLORIDE	75014	4.40E-06	IRIS
XYLENE (TOTAL)	1330207	--	--

Notes:

--	Not available; not applicable
$\mu g/m^3$	Microgram per cubic meter
BHC	Benzene hexachloride
CAS	Chemical Abstract Service
DDE	Dichlorodiphenyldichloroethene
EPA	U.S. Environmental Protection Agency
HEAST	EPA Health Effects Assessment Summary Tables (EPA 1997)
IRIS	EPA Integrated Risk Information System (EPA 2009b)
OEHHA	California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, Cancer Potency List (Cal/EPA 2009)
PPRTVs	EPA Provisional Peer-Reviewed Toxicity Values (EPA 2009a)
RE	Route-to-route extrapolation
S	Toxicity value based on chemical surrogate (see Table 4)

References:

California Environmental Protection Agency (Cal/EPA). 2009. Cancer Potency List. Office of Environmental Health Hazard Assessment. July 21. Available on-line at: <http://www.oehha.ca.gov/risk/chemicalDB//index.asp>

U.S. Environmental Protection Agency (EPA). 1997. "Health Effects Assessment Summary Tables (HEAST): Annual Update, FY 1997." EPA-540-R-97-036. National Center for Environmental Assessment, Office of Research and Development and Office of Emergency and Remedial Response. July.

EPA. 2009a. Risk-Based Concentration Table. Regional Screening Levels for Chemical Contaminants at Superfund Sites. December. Available on-line at: <http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm>.

EPA. 2009b. Integrated Risk Information System. On-line Database. Office of Research and Development, National Center for Environmental Assessment. Accessed 12/09/2009. Available on-line at: <http://cfpub.epa.gov/ncea/iris/index.cfm>

TABLE 4: CHEMICAL SURROGATES

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical Lacking Toxicity Value	CAS Number	Chemical Surrogate Used for Toxicity Value	CAS Number
Polycyclic Aromatic Hydrocarbons			
ACENAPHTHYLENE	208968	ACENAPHTHENE	83329
1,6,7-TRIMETHYL-NAPHTHALENE	2245387	2-METHYLNAPHTHALENE	91576
2,6-DIMETHYL-NAPHTHALENE	581420	2-METHYLNAPHTHALENE	91576
PHENANTHRENE	85018	ANTHRACENE	120127
2,4'-DDE	3424826	4,4'-DDE	72559
Pesticides			
ALPHA-CHLORDANE	5103719	CHLORDANE	12789036
DELTA-BHC	319868	BETA-BHC	319857
ENDOSULFAN I	959988	ENDOSULFAN	115297
ENDOSULFAN II	33213659	ENDOSULFAN	115297
GAMMA-CHLORDANE	5103742	CHLORDANE	12789036
Volatile Organic Compounds			
1,3-DICHLOROBENZENE	541731	1,2-DICHLOROBENZENE	95501
CIS-1,3-DICHLOROPROPENE	10061015	1,3-DICHLOROPROPENE	542756
M,P-XYLENES	108383, 106423	M-XYLENE	108383
METHYLCYCLOHEXANE	108872	CYCLOHEXANE	110827
N-BUTYLBENZENE	104518	CUMENE	98828
PARA-ISOPROPYL TOLUENE	99876	CUMENE	98828
SEC-BUTYLBENZENE	135988	CUMENE	98828
TERT-BUTYLBENZENE	98066	CUMENE	98828
TRANS-1,3-DICHLOROPROPENE	10061026	1,3-DICHLOROPROPENE	542756

Notes:

BHC	Benzene hexachloride
CAS	Chemical Abstract Service
DDE	Dichlorodiphenyldichloroethene

TABLE 5: PRELIMINARY RISK-BASED CONCENTRATIONS FOR INDOOR AIR

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Residential Indoor Air RBC		Industrial Indoor Air RBC	
		Target Cancer Risk Level = 1E-06	Target Noncancer Hazard Index = 1	Target Cancer Risk Level = 1E-06	Target Noncancer Hazard Index = 1
Metals					
MERCURY	7439976	--	3.13E-01	--	1.31E+00
Polycyclic Aromatic Hydrocarbons					
1-METHYLNAPHTHALENE	90120	2.94E-01	2.56E+02	1.48E+00	1.07E+03
2-METHYLNAPHTHALENE	91576	--	1.46E+01	--	6.13E+01
ACENAPHTHENE	83329	--	2.19E+02	--	9.20E+02
ACENAPHTHYLENE	208968	--	2.19E+02	--	9.20E+02
BENZO(B)FLUORANTHENE	205992	2.21E-02	--	1.11E-01	--
CHRYSENE	218019	2.21E-01	--	1.11E+00	--
FLUORENE	86737	--	1.46E+02	--	6.13E+02
NAPHTHALENE	91203	7.16E-02	3.13E+00	3.61E-01	1.31E+01
1,6,7-TRIMETHYL-NAPHTHALENE	2245387	--	1.46E+01	--	6.13E+01
2,6-DIMETHYL-NAPHTHALENE	581420	--	1.46E+01	--	6.13E+01
PHENANTHRENE	85018	--	1.10E+03	--	4.60E+03
PYRENE	129000	--	1.10E+02	--	4.60E+02
Pesticides					
2,4'-DDE	3424826	2.51E-02	--	1.26E-01	--
4,4'-DDE	72559	2.51E-02	--	1.26E-01	--
ALDRIN	309002	4.97E-04	1.10E-01	2.50E-03	4.60E-01
ALPHA-BHC	319846	1.35E-03	2.92E+01	6.81E-03	1.23E+02
ALPHA-CHLORDANE	5103719	2.43E-02	7.30E-01	1.23E-01	3.07E+00
BETA-BHC	319857	4.59E-03	--	2.31E-02	--
DELTA-BHC	319868	4.59E-03	--	2.31E-02	--
DIELDRIN	60571	5.29E-04	1.83E-01	2.67E-03	7.67E-01
ENDOSULFAN I	959988	--	2.19E+01	--	9.20E+01
ENDOSULFAN II	33213659	--	2.19E+01	--	9.20E+01
GAMMA-BHC (LINDANE)	58899	7.85E-03	1.10E+00	3.96E-02	4.60E+00
GAMMA-CHLORDANE	5103742	2.43E-02	7.30E-01	1.23E-01	3.07E+00
HEPTACHLOR	76448	1.87E-03	1.83E+00	9.43E-03	7.67E+00
METHOXYCHLOR	72435	--	1.83E+01	--	7.67E+01
Semivolatile Organic Compounds					
2-CHLORONAPHTHALENE	91587	--	2.92E+02	--	1.23E+03
2-CHLOROPHENOL	95578	--	1.83E+01	--	7.67E+01
ACETOPHENONE	98862	--	3.65E+02	--	1.53E+03
AZOBENZENE	103333	7.85E-02	--	3.96E-01	--
BIPHENYL	92524	--	1.83E+02	--	7.67E+02
DIBENZOFURAN	132649	--	3.65E+00	--	1.53E+01
HEXACHLOROBENZENE	118741	5.29E-03	2.92E+00	2.67E-02	1.23E+01
Volatile Organic Compounds					
1,1,1-TRICHLOROETHANE	71556	--	5.21E+03	--	2.19E+04
1,1,2,2-TETRACHLOROETHANE	79345	4.20E-02	1.46E+01	2.11E-01	6.13E+01
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76131	--	3.13E+04	--	1.31E+05
1,1,2-TRICHLOROETHANE	79005	1.52E-01	1.46E+01	7.67E-01	6.13E+01
1,1-DICHLOROETHANE	75343	1.52E+00	7.30E+02	7.67E+00	3.07E+03

TABLE 5: PRELIMINARY RISK-BASED CONCENTRATIONS FOR INDOOR AIR

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Residential Indoor Air RBC		Industrial Indoor Air RBC	
		Target Cancer Risk Level = 1E-06	Target Noncancer Hazard Index = 1	Target Cancer Risk Level = 1E-06	Target Noncancer Hazard Index = 1
1,1-DICHLOROETHENE	75354	--	2.09E+02	--	8.76E+02
1,1-DICHLOROPROPENE	542756	6.08E-01	2.09E+01	3.07E+00	8.76E+01
1,2,3-TRICHLOROBENZENE	87616	--	2.92E+00	--	1.23E+01
1,2,3-TRICHLOROPROPANE	96184	2.84E-04	3.13E-01	1.43E-03	1.31E+00
1,2,4-TRICHLOROBENZENE	120821	2.94E-01	2.09E+00	1.48E+00	8.76E+00
1,2,4-TRIMETHYLBENZENE	95636	--	7.30E+00	--	3.07E+01
1,2-DICHLOROBENZENE	95501	--	2.09E+02	--	8.76E+02
1,2-DICHLOROETHANE	107062	9.36E-02	4.17E+02	4.72E-01	1.75E+03
1,2-DICHLOROETHENE (TOTAL)	540590	--	3.29E+01	--	1.38E+02
1,2-DICHLOROPROPANE	78875	2.43E-01	4.17E+00	1.23E+00	1.75E+01
1,3,5-TRIMETHYLBENZENE	108678	--	3.65E+01	--	1.53E+02
1,3-DICHLOROBENZENE	541731	--	2.09E+02	--	8.76E+02
1,4-DICHLOROBENZENE	106467	2.21E-01	8.34E+02	1.11E+00	3.50E+03
1,4-DIOXANE	123911	3.16E-01	3.13E+03	1.59E+00	1.31E+04
2-BUTANONE	78933	--	5.21E+03	--	2.19E+04
2-HEXANONE	591786	--	3.13E+01	--	1.31E+02
4-METHYL-2-PENTANONE	108101	--	3.13E+03	--	1.31E+04
ACETONE	67641	--	3.23E+04	--	1.36E+05
BENZALDEHYDE	100527	--	3.65E+02	--	1.53E+03
BENZENE	71432	3.12E-01	3.13E+01	1.57E+00	1.31E+02
BROMODICHLOROMETHANE	75274	6.58E-02	7.30E+01	3.31E-01	3.07E+02
BROMOFORM	75252	2.21E+00	7.30E+01	1.11E+01	3.07E+02
BROMOMETHANE	74839	--	5.21E+00	--	2.19E+01
CARBON DISULFIDE	75150	--	7.30E+02	--	3.07E+03
CARBON TETRACHLORIDE	56235	1.62E-01	4.17E+01	8.18E-01	1.75E+02
CHLOROBENZENE	108907	--	5.21E+01	--	2.19E+02
CHLOROETHANE	75003	--	1.04E+04	--	4.38E+04
CHLOROFORM	67663	1.06E-01	1.02E+02	5.33E-01	4.29E+02
CHLOROMETHANE	74873	--	9.39E+01	--	3.94E+02
CIS-1,2-DICHLOROETHENE	156592	--	3.65E+01	--	1.53E+02
CIS-1,3-DICHLOROPROPENE	10061015	6.08E-01	2.09E+01	3.07E+00	8.76E+01
CYCLOHEXANE	110827	--	6.26E+03	--	2.63E+04
DIBROMOCHLOROMETHANE	124481	9.01E-02	7.30E+01	4.54E-01	3.07E+02
DICHLORODIFLUOROMETHANE	75718	--	2.09E+02	--	8.76E+02
ETHYLBENZENE	100414	9.73E-01	1.04E+03	4.91E+00	4.38E+03
HEXACHLOROETHANE	67721	6.08E-01	3.65E+00	3.07E+00	1.53E+01
ISOPROPYLBENZENE	98828	--	4.17E+02	--	1.75E+03
M,P-XYLENES	108383, 106423	--	7.30E+02	--	3.07E+03
METHYL ACETATE	79209	--	3.65E+03	--	1.53E+04
METHYLCYCLOHEXANE	108872	--	6.26E+03	--	2.63E+04
METHYLENE CHLORIDE	75092	5.18E+00	4.17E+02	2.61E+01	1.75E+03
N-BUTYLBENZENE	104518	--	4.17E+02	--	1.75E+03
O-XYLENE	95476	--	7.30E+02	--	3.07E+03
PARA-ISOPROPYL TOLUENE	99876	--	4.17E+02	--	1.75E+03

TABLE 5: PRELIMINARY RISK-BASED CONCENTRATIONS FOR INDOOR AIR

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Residential Indoor Air RBC		Industrial Indoor Air RBC	
		Target Cancer Risk Level = 1E-06	Target Noncancer Hazard Index = 1	Target Cancer Risk Level = 1E-06	Target Noncancer Hazard Index = 1
PROPYLBENZENE	103651	--	1.04E+03	--	4.38E+03
SEC-BUTYLBENZENE	135988	--	4.17E+02	--	1.75E+03
STYRENE	100425	--	1.04E+03	--	4.38E+03
TERT-BUTYL METHYL ETHER	1634044	9.36E+00	3.13E+03	4.72E+01	1.31E+04
TERT-BUTYLBENZENE	98066	--	4.17E+02	--	1.75E+03
TETRACHLOROETHENE	127184	4.12E-01	3.65E+01	2.08E+00	1.53E+02
TOLUENE	108883	--	5.21E+03	--	2.19E+04
TRANS-1,2-DICHLOROETHENE	156605	--	6.26E+01	--	2.63E+02
TRANS-1,3-DICHLOROPROPENE	10061026	6.08E-01	2.09E+01	3.07E+00	8.76E+01
TRICHLOROETHENE	79016	1.22E+00	6.26E+02	6.13E+00	2.63E+03
TRICHLOROFLUOROMETHANE	75694	--	7.30E+02	--	3.07E+03
VINYL ACETATE	108054	--	2.09E+02	--	8.76E+02
VINYL CHLORIDE	75014	5.53E-01	1.04E+02	2.79E+00	4.38E+02
XYLENE (TOTAL)	1330207	--	1.04E+02	--	4.38E+02

Notes:

All concentrations in microgram per cubic meter.

--	Not available; not applicable
BHC	Benzene hexachloride
CAS	Chemical Abstract Service
DDE	Dichlorodiphenyldichloroethene
RBC	Risk-based concentration

TABLE 6: PRELIMINARY RISK-BASED CONCENTRATIONS FOR SOIL GAS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Residential Soil Gas RBC				Industrial Soil Gas RBC			
		Target Cancer Risk Level = 1E-06		Target Noncancer Hazard Index = 1		Target Cancer Risk Level = 1E-06		Target Noncancer Hazard Index = 1	
		Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001
Metals									
MERCURY	7439976	--	--	3.48E+02	3.13E+01	--	--	3.29E+03	1.31E+03
Polycyclic Aromatic Hydrocarbons									
1-METHYLNAPHTHALENE	90120	3.26E+02	2.94E+01	2.84E+05	2.56E+04	3.70E+03	1.48E+03	2.68E+06	1.07E+06
2-METHYLNAPHTHALENE	91576	--	--	1.62E+04	1.46E+03	--	--	1.53E+05	6.13E+04
ACENAPHTHENE	83329	--	--	2.43E+05	2.19E+04	--	--	2.30E+06	9.20E+05
ACENAPHTHYLENE	208968	--	--	2.43E+05	2.19E+04	--	--	2.30E+06	9.20E+05
BENZO(B)FLUORANTHENE	205992	2.46E+01	2.21E+00	--	--	2.79E+02	1.11E+02	--	--
CHRYSENE	218019	2.46E+02	2.21E+01	--	--	2.79E+03	1.11E+03	--	--
FLUORENE	86737	--	--	1.62E+05	1.46E+04	--	--	1.53E+06	6.13E+05
NAPHTHALENE	91203	7.95E+01	7.16E+00	3.48E+03	3.13E+02	9.02E+02	3.61E+02	3.29E+04	1.31E+04
1,6,7-TRIMETHYL-NAPHTHALENE	2245387	--	--	1.62E+04	1.46E+03	--	--	1.53E+05	6.13E+04
2,6-DIMETHYL-NAPHTHALENE	581420	--	--	1.62E+04	1.46E+03	--	--	1.53E+05	6.13E+04
PHENANTHRENE	85018	--	--	1.22E+06	1.10E+05	--	--	1.15E+07	4.60E+06
PYRENE	129000	--	--	1.22E+05	1.10E+04	--	--	1.15E+06	4.60E+05
Pesticides									
2,4'-DDE	3424826	2.79E+01	2.51E+00	--	--	3.16E+02	1.26E+02	--	--
4,4'-DDE	72559	2.79E+01	2.51E+00	--	--	3.16E+02	1.26E+02	--	--
ALDRIN	309002	5.52E-01	4.97E-02	1.22E+02	1.10E+01	6.26E+00	2.50E+00	1.15E+03	4.60E+02
ALPHA-BHC	319846	1.50E+00	1.35E-01	3.24E+04	2.92E+03	1.70E+01	6.81E+00	3.07E+05	1.23E+05
ALPHA-CHLORDANE	5103719	2.70E+01	2.43E+00	8.11E+02	7.30E+01	3.07E+02	1.23E+02	7.67E+03	3.07E+03
BETA-BHC	319857	5.10E+00	4.59E-01	--	--	5.78E+01	2.31E+01	--	--
DELTA-BHC	319868	5.10E+00	4.59E-01	--	--	5.78E+01	2.31E+01	--	--
DIELDRIN	60571	5.88E-01	5.29E-02	2.03E+02	1.83E+01	6.67E+00	2.67E+00	1.92E+03	7.67E+02
ENDOSULFAN I	959988	--	--	2.43E+04	2.19E+03	--	--	2.30E+05	9.20E+04
ENDOSULFAN II	33213659	--	--	2.43E+04	2.19E+03	--	--	2.30E+05	9.20E+04
GAMMA-BHC (LINDANE)	58899	8.72E+00	7.85E-01	1.22E+03	1.10E+02	9.89E+01	3.96E+01	1.15E+04	4.60E+03
GAMMA-CHLORDANE	5103742	2.70E+01	2.43E+00	8.11E+02	7.30E+01	3.07E+02	1.23E+02	7.67E+03	3.07E+03
HEPTACHLOR	76448	2.08E+00	1.87E-01	2.03E+03	1.83E+02	2.36E+01	9.43E+00	1.92E+04	7.67E+03

TABLE 6: PRELIMINARY RISK-BASED CONCENTRATIONS FOR SOIL GAS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Residential Soil Gas RBC				Industrial Soil Gas RBC			
		Target Cancer Risk Level = 1E-06		Target Noncancer Hazard Index = 1		Target Cancer Risk Level = 1E-06		Target Noncancer Hazard Index = 1	
		Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001
METHOXYCHLOR	72435	--	--	2.03E+04	1.83E+03	--	--	1.92E+05	7.67E+04
Semivolatile Organic Compounds									
2-CHLORONAPHTHALENE	91587	--	--	3.24E+05	2.92E+04	--	--	3.07E+06	1.23E+06
2-CHLOROPHENOL	95578	--	--	2.03E+04	1.83E+03	--	--	1.92E+05	7.67E+04
ACETOPHENONE	98862	--	--	4.06E+05	3.65E+04	--	--	3.83E+06	1.53E+06
AZOBENZENE	103333	8.72E+01	7.85E+00	--	--	9.89E+02	3.96E+02	--	--
BIPHENYL	92524	--	--	2.03E+05	1.83E+04	--	--	1.92E+06	7.67E+05
DIBENZOFURAN	132649	--	--	4.06E+03	3.65E+02	--	--	3.83E+04	1.53E+04
HEXACHLOROBENZENE	118741	5.88E+00	5.29E-01	3.24E+03	2.92E+02	6.67E+01	2.67E+01	3.07E+04	1.23E+04
Volatile Organic Compounds									
1,1,1-TRICHLOROETHANE	71556	--	--	5.79E+06	5.21E+05	--	--	5.48E+07	2.19E+07
1,1,2,2-TETRACHLOROETHANE	79345	4.66E+01	4.20E+00	1.62E+04	1.46E+03	5.29E+02	2.11E+02	1.53E+05	6.13E+04
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76131	--	--	3.48E+07	3.13E+06	--	--	3.29E+08	1.31E+08
1,1,2-TRICHLOROETHANE	79005	1.69E+02	1.52E+01	1.62E+04	1.46E+03	1.92E+03	7.67E+02	1.53E+05	6.13E+04
1,1-DICHLOROETHANE	75343	1.69E+03	1.52E+02	8.11E+05	7.30E+04	1.92E+04	7.67E+03	7.67E+06	3.07E+06
1,1-DICHLOROETHENE	75354	--	--	2.32E+05	2.09E+04	--	--	2.19E+06	8.76E+05
1,1-DICHLOROPROPENE	542756	6.76E+02	6.08E+01	2.32E+04	2.09E+03	7.67E+03	3.07E+03	2.19E+05	8.76E+04
1,2,3-TRICHLOROBENZENE	87616	--	--	3.24E+03	2.92E+02	--	--	3.07E+04	1.23E+04
1,2,3-TRICHLOROPROPANE	96184	3.15E-01	2.84E-02	3.48E+02	3.13E+01	3.58E+00	1.43E+00	3.29E+03	1.31E+03
1,2,4-TRICHLOROBENZENE	120821	3.26E+02	2.94E+01	2.32E+03	2.09E+02	3.70E+03	1.48E+03	2.19E+04	8.76E+03
1,2,4-TRIMETHYLBENZENE	95636	--	--	8.11E+03	7.30E+02	--	--	7.67E+04	3.07E+04
1,2-DICHLOROBENZENE	95501	--	--	2.32E+05	2.09E+04	--	--	2.19E+06	8.76E+05
1,2-DICHLOROETHANE	107062	1.04E+02	9.36E+00	4.63E+05	4.17E+04	1.18E+03	4.72E+02	4.38E+06	1.75E+06
1,2-DICHLOROETHENE (TOTAL)	540590	--	--	3.65E+04	3.29E+03	--	--	3.45E+05	1.38E+05
1,2-DICHLOROPROPANE	78875	2.70E+02	2.43E+01	4.63E+03	4.17E+02	3.07E+03	1.23E+03	4.38E+04	1.75E+04
1,3,5-TRIMETHYLBENZENE	108678	--	--	4.06E+04	3.65E+03	--	--	3.83E+05	1.53E+05
1,3-DICHLOROBENZENE	541731	--	--	2.32E+05	2.09E+04	--	--	2.19E+06	8.76E+05
1,4-DICHLOROBENZENE	106467	2.46E+02	2.21E+01	9.27E+05	8.34E+04	2.79E+03	1.11E+03	8.76E+06	3.50E+06
1,4-DIOXANE	123911	3.51E+02	3.16E+01	3.48E+06	3.13E+05	3.98E+03	1.59E+03	3.29E+07	1.31E+07

TABLE 6: PRELIMINARY RISK-BASED CONCENTRATIONS FOR SOIL GAS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Residential Soil Gas RBC				Industrial Soil Gas RBC			
		Target Cancer Risk Level = 1E-06		Target Noncancer Hazard Index = 1		Target Cancer Risk Level = 1E-06		Target Noncancer Hazard Index = 1	
		Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001
2-BUTANONE	78933	--	--	5.79E+06	5.21E+05	--	--	5.48E+07	2.19E+07
2-HEXANONE	591786	--	--	3.48E+04	3.13E+03	--	--	3.29E+05	1.31E+05
4-METHYL-2-PENTANONE	108101	--	--	3.48E+06	3.13E+05	--	--	3.29E+07	1.31E+07
ACETONE	67641	--	--	3.59E+07	3.23E+06	--	--	3.39E+08	1.36E+08
BENZALDEHYDE	100527	--	--	4.06E+05	3.65E+04	--	--	3.83E+06	1.53E+06
BENZENE	71432	3.47E+02	3.12E+01	3.48E+04	3.13E+03	3.93E+03	1.57E+03	3.29E+05	1.31E+05
BROMODICHLOROMETHANE	75274	7.31E+01	6.58E+00	8.11E+04	7.30E+03	8.29E+02	3.31E+02	7.67E+05	3.07E+05
BROMOFORM	75252	2.46E+03	2.21E+02	8.11E+04	7.30E+03	2.79E+04	1.11E+04	7.67E+05	3.07E+05
BROMOMETHANE	74839	--	--	5.79E+03	5.21E+02	--	--	5.48E+04	2.19E+04
CARBON DISULFIDE	75150	--	--	8.11E+05	7.30E+04	--	--	7.67E+06	3.07E+06
CARBON TETRACHLORIDE	56235	1.80E+02	1.62E+01	4.63E+04	4.17E+03	2.04E+03	8.18E+02	4.38E+05	1.75E+05
CHLOROBENZENE	108907	--	--	5.79E+04	5.21E+03	--	--	5.48E+05	2.19E+05
CHLOROETHANE	75003	--	--	1.16E+07	1.04E+06	--	--	1.10E+08	4.38E+07
CHLOROFORM	67663	1.18E+02	1.06E+01	1.14E+05	1.02E+04	1.33E+03	5.33E+02	1.07E+06	4.29E+05
CHLOROMETHANE	74873	--	--	1.04E+05	9.39E+03	--	--	9.86E+05	3.94E+05
CIS-1,2-DICHLOROETHENE	156592	--	--	4.06E+04	3.65E+03	--	--	3.83E+05	1.53E+05
CIS-1,3-DICHLOROPROPENE	10061015	6.76E+02	6.08E+01	2.32E+04	2.09E+03	7.67E+03	3.07E+03	2.19E+05	8.76E+04
CYCLOHEXANE	110827	--	--	6.95E+06	6.26E+05	--	--	6.57E+07	2.63E+07
DIBROMOCHLOROMETHANE	124481	1.00E+02	9.01E+00	8.11E+04	7.30E+03	1.14E+03	4.54E+02	7.67E+05	3.07E+05
DICHLORODIFLUOROMETHANE	75718	--	--	2.32E+05	2.09E+04	--	--	2.19E+06	8.76E+05
ETHYLBENZENE	100414	1.08E+03	9.73E+01	1.16E+06	1.04E+05	1.23E+04	4.91E+03	1.10E+07	4.38E+06
HEXACHLOROETHANE	67721	6.76E+02	6.08E+01	4.06E+03	3.65E+02	7.67E+03	3.07E+03	3.83E+04	1.53E+04
ISOPROPYLBENZENE	98828	--	--	4.63E+05	4.17E+04	--	--	4.38E+06	1.75E+06
M,P-XYLENES	108383, 10642	--	--	8.11E+05	7.30E+04	--	--	7.67E+06	3.07E+06
METHYL ACETATE	79209	--	--	4.06E+06	3.65E+05	--	--	3.83E+07	1.53E+07
METHYLCYCLOHEXANE	108872	--	--	6.95E+06	6.26E+05	--	--	6.57E+07	2.63E+07
METHYLENE CHLORIDE	75092	5.75E+03	5.18E+02	4.63E+05	4.17E+04	6.52E+04	2.61E+04	4.38E+06	1.75E+06
N-BUTYLBENZENE	104518	--	--	4.63E+05	4.17E+04	--	--	4.38E+06	1.75E+06
O-XYLENE	95476	--	--	8.11E+05	7.30E+04	--	--	7.67E+06	3.07E+06

TABLE 6: PRELIMINARY RISK-BASED CONCENTRATIONS FOR SOIL GAS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Residential Soil Gas RBC				Industrial Soil Gas RBC			
		Target Cancer Risk Level = 1E-06		Target Noncancer Hazard Index = 1		Target Cancer Risk Level = 1E-06		Target Noncancer Hazard Index = 1	
		Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001
PARA-ISOPROPYL TOLUENE	99876	--	--	4.63E+05	4.17E+04	--	--	4.38E+06	1.75E+06
PROPYLBENZENE	103651	--	--	1.16E+06	1.04E+05	--	--	1.10E+07	4.38E+06
SEC-BUTYLBENZENE	135988	--	--	4.63E+05	4.17E+04	--	--	4.38E+06	1.75E+06
STYRENE	100425	--	--	1.16E+06	1.04E+05	--	--	1.10E+07	4.38E+06
TERT-BUTYL METHYL ETHER	1634044	1.04E+04	9.36E+02	3.48E+06	3.13E+05	1.18E+05	4.72E+04	3.29E+07	1.31E+07
TERT-BUTYLBENZENE	98066	--	--	4.63E+05	4.17E+04	--	--	4.38E+06	1.75E+06
TETRACHLOROETHENE	127184	4.58E+02	4.12E+01	4.06E+04	3.65E+03	5.20E+03	2.08E+03	3.83E+05	1.53E+05
TOLUENE	108883	--	--	5.79E+06	5.21E+05	--	--	5.48E+07	2.19E+07
TRANS-1,2-DICHLOROETHENE	156605	--	--	6.95E+04	6.26E+03	--	--	6.57E+05	2.63E+05
TRANS-1,3-DICHLOROPROPENE	10061026	6.76E+02	6.08E+01	2.32E+04	2.09E+03	7.67E+03	3.07E+03	2.19E+05	8.76E+04
TRICHLOROETHENE	79016	1.35E+03	1.22E+02	6.95E+05	6.26E+04	1.53E+04	6.13E+03	6.57E+06	2.63E+06
TRICHLOROFLUOROMETHANE	75694	--	--	8.11E+05	7.30E+04	--	--	7.67E+06	3.07E+06
VINYL ACETATE	108054	--	--	2.32E+05	2.09E+04	--	--	2.19E+06	8.76E+05
VINYL CHLORIDE	75014	6.14E+02	5.53E+01	1.16E+05	1.04E+04	6.97E+03	2.79E+03	1.10E+06	4.38E+05
XYLENE (TOTAL)	1330207	--	--	1.16E+05	1.04E+04	--	--	1.10E+06	4.38E+05

Notes:

All concentrations are in microgram per cubic meter.

--	Not applicable
α_{sg}	Soil gas-to-indoor air attenuation factor
BHC	Benzene hexachloride
Cal/EPA	California Environmental Protection Agency
CAS	Chemical Abstract Service
DDE	Dichlorodiphenyldichloroethene
EPA	U.S. Environmental Protection Agency
RBC	Risk-based concentration

TABLE 7: PRELIMINARY SOIL GAS ACTION LEVELS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Soil Gas RBC (Lowest between Cancer- and Noncancer-Based RBC)				Soil Gas RBC Based on Surrogate Chemical for Toxicity Data	Soil Gas RBC Based on Oral Route Extrapolated Toxicity Data	Laboratory Reporting Limit		Reporting Limit Less Than Soil Gas RBC?		Preliminary Soil Gas Action Level (c)							
		Residential		Industrial						Cal/EPA	EPA	Residential				Industrial			
		Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001			Concentration (a)	Analytical Method (b)	Res α_{sg} = 0.0009 Ind α_{sg} = 0.0004	Res α_{sg} = 0.01 Ind α_{sg} = 0.001	Cal/EPA α_{sg} = 0.0009		EPA α_{sg} = 0.01		Cal/EPA α_{sg} = 0.0004		EPA α_{sg} = 0.001	
Metals																			
MERCURY	7439976	3.48E+02	3.13E+01	3.29E+03	1.31E+03			1.00E+00	NIOSH 6009	Yes	Yes	3.48E+02	nc	3.13E+01	nc	3.29E+03	nc	1.31E+03	nc
Polycyclic Aromatic Hydrocarbons																			
1-METHYLNAPHTHALENE	90120	3.26E+02	2.94E+01	3.70E+03	1.48E+03		X	1.60E+00	TO-13A	Yes	Yes	3.26E+02	ca	2.94E+01	ca	3.70E+03	ca	1.48E+03	ca
2-METHYLNAPHTHALENE	91576	1.62E+04	1.46E+03	1.53E+05	6.13E+04		X	1.60E+00	TO-13A	Yes	Yes	1.62E+04	nc	1.46E+03	nc	1.53E+05	nc	6.13E+04	nc
ACENAPHTHENE	83329	2.43E+05	2.19E+04	2.30E+06	9.20E+05		X	1.60E+00	TO-13A	Yes	Yes	2.43E+05	nc	2.19E+04	nc	2.30E+06	nc	9.20E+05	nc
ACENAPHTHYLENE	208968	2.43E+05	2.19E+04	2.30E+06	9.20E+05	X	X	1.60E+00	TO-13A	Yes	Yes	2.43E+05	nc	2.19E+04	nc	2.30E+06	nc	9.20E+05	nc
BENZO(B)FLUORANTHENE	205992	2.46E+01	2.21E+00	2.79E+02	1.11E+02			1.60E+00	TO-13A	Yes	Yes	2.46E+01	ca	2.21E+00	ca	2.79E+02	ca	1.11E+02	ca
CHRYSENE	218019	2.46E+02	2.21E+01	2.79E+03	1.11E+03			1.60E+00	TO-13A	Yes	Yes	2.46E+02	ca	2.21E+01	ca	2.79E+03	ca	1.11E+03	ca
FLUORENE	86737	1.62E+05	1.46E+04	1.53E+06	6.13E+05		X	1.60E+00	TO-13A	Yes	Yes	1.62E+05	nc	1.46E+04	nc	1.53E+06	nc	6.13E+05	nc
NAPHTHALENE	91203	7.95E+01	7.16E+00	9.02E+02	3.61E+02			1.60E+00	TO-13A	Yes	Yes	7.95E+01	ca	7.16E+00	ca	9.02E+02	ca	3.61E+02	ca
1,6,7-TRIMETHYL-NAPHTHALENE	2245387	1.62E+04	1.46E+03	1.53E+05	6.13E+04	X	X	NE	--	--	--	NE	--	NE	--	NE	--	NE	--
2,6-DIMETHYL-NAPHTHALENE	581420	1.62E+04	1.46E+03	1.53E+05	6.13E+04	X	X	NE	--	--	--	NE	--	NE	--	NE	--	NE	--
PHENANTHRENE	85018	1.22E+06	1.10E+05	1.15E+07	4.60E+06	X	X	1.60E+00	TO-13A	Yes	Yes	1.22E+06	nc	1.10E+05	nc	1.15E+07	nc	4.60E+06	nc
PYRENE	129000	1.22E+05	1.10E+04	1.15E+06	4.60E+05		X	1.60E+00	TO-13A	Yes	Yes	1.22E+05	nc	1.10E+04	nc	1.15E+06	nc	4.60E+05	nc
Pesticides																			
2,4'-DDE	3424826	2.79E+01	2.51E+00	3.16E+02	1.26E+02	X		NE	--	--	--	NE	--	NE	--	NE	--	NE	--
4,4'-DDE	72559	2.79E+01	2.51E+00	3.16E+02	1.26E+02			1.60E-01	TO-10A	Yes	Yes	2.79E+01	ca	2.51E+00	ca	3.16E+02	ca	1.26E+02	ca
ALDRIN	309002	5.52E-01	4.97E-02	6.26E+00	2.50E+00			1.60E-01	TO-10A	Yes	No (> Res)	5.52E-01	ca	1.60E-01	RL	6.26E+00	ca	2.50E+00	ca
ALPHA-BHC	319846	1.50E+00	1.35E-01	1.70E+01	6.81E+00			1.60E-01	TO-10A	Yes	No (> Res)	1.50E+00	ca	1.60E-01	RL	1.70E+01	ca	6.81E+00	ca
ALPHA-CHLORDANE	5103719	2.70E+01	2.43E+00	3.07E+02	1.23E+02	X		1.60E-01	TO-10A	Yes	Yes	2.70E+01	ca	2.43E+00	ca	3.07E+02	ca	1.23E+02	ca
BETA-BHC	319857	5.10E+00	4.59E-01	5.78E+01	2.31E+01			1.60E-01	TO-10A	Yes	Yes	5.10E+00	ca	4.59E-01	ca	5.78E+01	ca	2.31E+01	ca
DELTA-BHC	319868	5.10E+00	4.59E-01	5.78E+01	2.31E+01	X		1.60E-01	TO-10A	Yes	Yes	5.10E+00	ca	4.59E-01	ca	5.78E+01	ca	2.31E+01	ca
DIELDRIN	60571	5.88E-01	5.29E-02	6.67E+00	2.67E+00			1.60E-01	TO-10A	Yes	No (> Res)	5.88E-01	ca	1.60E-01	RL	6.67E+00	ca	2.67E+00	ca
ENDOSULFAN I	959988	2.43E+04	2.19E+03	2.30E+05	9.20E+04	X	X	1.60E-01	TO-10A	Yes	Yes	2.43E+04	nc	2.19E+03	nc	2.30E+05	nc	9.20E+04	nc
ENDOSULFAN II	33213659	2.43E+04	2.19E+03	2.30E+05	9.20E+04	X	X	1.60E-01	TO-10A	Yes	Yes	2.43E+04	nc	2.19E+03	nc	2.30E+05	nc	9.20E+04	nc
GAMMA-BHC (LINDANE)	58899	8.72E+00	7.85E-01	9.89E+01	3.96E+01			1.60E-01	TO-10A	Yes	Yes	8.72E+00	ca	7.85E-01	ca	9.89E+01	ca	3.96E+01	ca
GAMMA-CHLORDANE	5103742	2.70E+01	2.43E+00	3.07E+02	1.23E+02	X		1.60E-01	TO-10A	Yes	Yes	2.70E+01	ca	2.43E+00	ca	3.07E+02	ca	1.23E+02	ca
HEPTACHLOR	76448	2.08E+00	1.87E-01	2.36E+01	9.43E+00			1.60E-01	TO-10A	Yes	Yes	2.08E+00	ca	1.87E-01	ca	2.36E+01	ca	9.43E+00	ca
METHOXYCHLOR	72435	2.03E+04	1.83E+03	1.92E+05	7.67E+04		X	NE	--	--	--	NE	--	NE	--	NE	--	NE	--
Semivolatile Organic Compounds																			
2-CHLORONAPHTHALENE	91587	3.24E+05	2.92E+04	3.07E+06	1.23E+06		X	1.60E+00	TO-13A	Yes	Yes	3.24E+05	nc	2.92E+04	nc	3.07E+06	nc	1.23E+06	nc
2-CHLOROPHENOL	95578	2.03E+04	1.83E+03	1.92E+05	7.67E+04		X	8.00E+00	TO-13A	Yes	Yes	2.03E+04	nc	1.83E+03	nc	1.92E+05	nc	7.67E+04	nc
ACETOPHENONE	98862	4.06E+05	3.65E+04	3.83E+06	1.53E+06		X	NE	--	--	--	NE	--	NE	--	NE	--	NE	--
AZOBENZENE	103333	8.72E+01	7.85E+00	9.89E+02	3.96E+02			NE	--	--	--	NE	--	NE	--	NE	--	NE	--
BIPHENYL	92524	2.03E+05	1.83E+04	1.92E+06	7.67E+05		X	NE	--	--	--	NE	--	NE	--	NE	--	NE	--
DIBENZOFURAN	132649	4.06E+03	3.65E+02	3.83E+04	1.53E+04		X	1.60E+00	TO-13A	Yes	Yes	4.06E+03	nc	3.65E+02	nc	3.83E+04	nc	1.53E+04	nc
HEXACHLOROBENZENE	118741	5.88E+00	5.29E-01	6.67E+01	2.67E+01			1.60E+00	TO-13A	Yes	No (> Res)	5.88E+00	ca	1.60E+00	RL	6.67E+01	ca	2.67E+01	ca

TABLE 7: PRELIMINARY SOIL GAS ACTION LEVELS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Soil Gas RBC (Lowest between Cancer- and Noncancer-Based RBC)				Soil Gas RBC Based on Surrogate Chemical for Toxicity Data	Soil Gas RBC Based on Oral Route Extrapolated Toxicity Data	Laboratory Reporting Limit		Reporting Limit Less Than Soil Gas RBC?		Preliminary Soil Gas Action Level (c)							
		Residential		Industrial								Residential				Industrial			
		Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001			Concentration (a)	Analytical Method (b)	Cal/EPA Res α_{sg} = 0.0009 Ind α_{sg} = 0.0004	EPA Res α_{sg} = 0.01 Ind α_{sg} = 0.001	Cal/EPA α_{sg} = 0.0009		EPA α_{sg} = 0.01		Cal/EPA α_{sg} = 0.0004		EPA α_{sg} = 0.001	
Volatile Organic Compounds																			
1,1,1-TRICHLOROETHANE	71556	5.79E+06	5.21E+05	5.48E+07	2.19E+07			1.76E-01	TO-15	Yes	Yes	5.79E+06	nc	5.21E+05	nc	5.48E+07	nc	2.19E+07	nc
1,1,2,2-TETRACHLOROETHANE	79345	4.66E+01	4.20E+00	5.29E+02	2.11E+02			2.24E-01	TO-15	Yes	Yes	4.66E+01	ca	4.20E+00	ca	5.29E+02	ca	2.11E+02	ca
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANI	76131	3.48E+07	3.13E+06	3.29E+08	1.31E+08			1.23E+00	TO-15	Yes	Yes	3.48E+07	nc	3.13E+06	nc	3.29E+08	nc	1.31E+08	nc
1,1,2-TRICHLOROETHANE	79005	1.69E+02	1.52E+01	1.92E+03	7.67E+02			1.76E-01	TO-15	Yes	Yes	1.69E+02	ca	1.52E+01	ca	1.92E+03	ca	7.67E+02	ca
1,1-DICHLOROETHANE	75343	1.69E+03	1.52E+02	1.92E+04	7.67E+03			1.30E-01	TO-15	Yes	Yes	1.69E+03	ca	1.52E+02	ca	1.92E+04	ca	7.67E+03	ca
1,1-DICHLOROETHENE	75354	2.32E+05	2.09E+04	2.19E+06	8.76E+05			6.40E-02	TO-15	Yes	Yes	2.32E+05	nc	2.09E+04	nc	2.19E+06	nc	8.76E+05	nc
1,1-DICHLOROPROPENE	542756	6.76E+02	6.08E+01	7.67E+03	3.07E+03			NA - NS	TO-15 (NS)	ND	ND	ND	--	ND	--	ND	--	ND	--
1,2,3-TRICHLOROBENZENE	87616	3.24E+03	2.92E+02	3.07E+04	1.23E+04		X	NA - NS	TO-15 (NS)	ND	ND	ND	--	ND	--	ND	--	ND	--
1,2,3-TRICHLOROPROPANE	96184	3.15E-01	2.84E-02	3.58E+00	1.43E+00		X	NA - NS	TO-15 (NS)	ND	ND	ND	--	ND	--	ND	--	ND	--
1,2,4-TRICHLOROBENZENE	120821	3.26E+02	2.94E+01	3.70E+03	1.48E+03		X	5.92E+00	TO-15	Yes	Yes	3.26E+02	ca	2.94E+01	ca	3.70E+03	ca	1.48E+03	ca
1,2,4-TRIMETHYLBENZENE	95636	8.11E+03	7.30E+02	7.67E+04	3.07E+04			7.84E-01	TO-15	Yes	Yes	8.11E+03	nc	7.30E+02	nc	7.67E+04	nc	3.07E+04	nc
1,2-DICHLOROBENZENE	95501	2.32E+05	2.09E+04	2.19E+06	8.76E+05			9.60E-01	TO-15	Yes	Yes	2.32E+05	nc	2.09E+04	nc	2.19E+06	nc	8.76E+05	nc
1,2-DICHLOROETHANE	107062	1.04E+02	9.36E+00	1.18E+03	4.72E+02			1.30E-01	TO-15	Yes	Yes	1.04E+02	ca	9.36E+00	ca	1.18E+03	ca	4.72E+02	ca
1,2-DICHLOROETHENE (TOTAL)	540590	3.65E+04	3.29E+03	3.45E+05	1.38E+05		X	4.79E-01	TO-15	Yes	Yes	3.65E+04	nc	3.29E+03	nc	3.45E+05	nc	1.38E+05	nc
1,2-DICHLOROPROPANE	78875	2.70E+02	2.43E+01	3.07E+03	1.23E+03			7.36E-01	TO-15	Yes	Yes	2.70E+02	ca	2.43E+01	ca	3.07E+03	ca	1.23E+03	ca
1,3,5-TRIMETHYLBENZENE	108678	4.06E+04	3.65E+03	3.83E+05	1.53E+05		X	7.84E-01	TO-15	Yes	Yes	4.06E+04	nc	3.65E+03	nc	3.83E+05	nc	1.53E+05	nc
1,3-DICHLOROBENZENE	541731	2.32E+05	2.09E+04	2.19E+06	8.76E+05	X		9.60E-01	TO-15	Yes	Yes	2.32E+05	nc	2.09E+04	nc	2.19E+06	nc	8.76E+05	nc
1,4-DICHLOROBENZENE	106467	2.46E+02	2.21E+01	2.79E+03	1.11E+03			9.60E-01	TO-15	Yes	Yes	2.46E+02	ca	2.21E+01	ca	2.79E+03	ca	1.11E+03	ca
1,4-DIOXANE	123911	3.51E+02	3.16E+01	3.98E+03	1.59E+03			8.00E+00	TO-15	Yes	Yes	3.51E+02	ca	3.16E+01	ca	3.98E+03	ca	1.59E+03	ca
2-BUTANONE	78933	5.79E+06	5.21E+05	5.48E+07	2.19E+07			4.64E-01	TO-15	Yes	Yes	5.79E+06	nc	5.21E+05	nc	5.48E+07	nc	2.19E+07	nc
2-HEXANONE	591786	3.48E+04	3.13E+03	3.29E+05	1.31E+05			3.20E+00	TO-15	Yes	Yes	3.48E+04	nc	3.13E+03	nc	3.29E+05	nc	1.31E+05	nc
4-METHYL-2-PENTANONE	108101	3.48E+06	3.13E+05	3.29E+07	1.31E+07			6.56E-01	TO-15	Yes	Yes	3.48E+06	nc	3.13E+05	nc	3.29E+07	nc	1.31E+07	nc
ACETONE	67641	3.59E+07	3.23E+06	3.39E+08	1.36E+08			1.92E+00	TO-15	Yes	Yes	3.59E+07	nc	3.23E+06	nc	3.39E+08	nc	1.36E+08	nc
BENZALDEHYDE	100527	4.06E+05	3.65E+04	3.83E+06	1.53E+06		X	NE	--	--	--	NE	--	NE	--	NE	--	NE	--
BENZENE	71432	3.47E+02	3.12E+01	3.93E+03	1.57E+03			2.56E-01	TO-15	Yes	Yes	3.47E+02	ca	3.12E+01	ca	3.93E+03	ca	1.57E+03	ca
BROMODICHLOROMETHANE	75274	7.31E+01	6.58E+00	8.29E+02	3.31E+02			1.07E+00	TO-15	Yes	Yes	7.31E+01	ca	6.58E+00	ca	8.29E+02	ca	3.31E+02	ca
BROMOFORM	75252	2.46E+03	2.21E+02	2.79E+04	1.11E+04			1.60E+00	TO-15	Yes	Yes	2.46E+03	ca	2.21E+02	ca	2.79E+04	ca	1.11E+04	ca
BROMOMETHANE	74839	5.79E+03	5.21E+02	5.48E+04	2.19E+04			6.24E-01	TO-15	Yes	Yes	5.79E+03	nc	5.21E+02	nc	5.48E+04	nc	2.19E+04	nc
CARBON DISULFIDE	75150	8.11E+05	7.30E+04	7.67E+06	3.07E+06			2.56E+00	TO-15	Yes	Yes	8.11E+05	nc	7.30E+04	nc	7.67E+06	nc	3.07E+06	nc
CARBON TETRACHLORIDE	56235	1.80E+02	1.62E+01	2.04E+03	8.18E+02			1.01E+00	TO-15	Yes	Yes	1.80E+02	ca	1.62E+01	ca	2.04E+03	ca	8.18E+02	ca
CHLOROBENZENE	108907	5.79E+04	5.21E+03	5.48E+05	2.19E+05			7.36E-01	TO-15	Yes	Yes	5.79E+04	nc	5.21E+03	nc	5.48E+05	nc	2.19E+05	nc
CHLOROETHANE	75003	1.16E+07	1.04E+06	1.10E+08	4.38E+07			4.16E-01	TO-15	Yes	Yes	1.16E+07	nc	1.04E+06	nc	1.10E+08	nc	4.38E+07	nc
CHLOROFORM	67663	1.18E+02	1.06E+01	1.33E+03	5.33E+02			7.84E-01	TO-15	Yes	Yes	1.18E+02	ca	1.06E+01	ca	1.33E+03	ca	5.33E+02	ca
CHLOROMETHANE	74873	1.04E+05	9.39E+03	9.86E+05	3.94E+05			3.36E-01	TO-15	Yes	Yes	1.04E+05	nc	9.39E+03	nc	9.86E+05	nc	3.94E+05	nc
CIS-1,2-DICHLOROETHENE	156592	4.06E+04	3.65E+03	3.83E+05	1.53E+05		X	1.26E-01	TO-15	Yes	Yes	4.06E+04	nc	3.65E+03	nc	3.83E+05	nc	1.53E+05	nc
CIS-1,3-DICHLOROPROPENE	10061015	6.76E+02	6.08E+01	7.67E+03	3.07E+03	X		7.20E-01	TO-15	Yes	Yes	6.76E+02	ca	6.08E+01	ca	7.67E+03	ca	3.07E+03	ca
CYCLOHEXANE	110827	6.95E+06	6.26E+05	6.57E+07	2.63E+07			5.44E-01	TO-15	Yes	Yes	6.95E+06	nc	6.26E+05	nc	6.57E+07	nc	2.63E+07	nc
DIBROMOCHLOROMETHANE	124481	1.00E+02	9.01E+00	1.14E+03	4.54E+02			1.36E+00	TO-15	Yes	Yes	1.00E+02	ca	9.01E+00	ca	1.14E+03	ca	4.54E+02	ca

TABLE 7: PRELIMINARY SOIL GAS ACTION LEVELS

Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard

Chemical	CAS Number	Soil Gas RBC (Lowest between Cancer- and Noncancer-Based RBC)				Soil Gas RBC Based on Surrogate Chemical for Toxicity Data	Soil Gas RBC Based on Oral Route Extrapolated Toxicity Data	Laboratory Reporting Limit		Reporting Limit Less Than Soil Gas RBC?		Preliminary Soil Gas Action Level (c)							
		Residential		Industrial								Residential				Industrial			
		Cal/EPA α_{sg} = 0.0009	EPA α_{sg} = 0.01	Cal/EPA α_{sg} = 0.0004	EPA α_{sg} = 0.001			Concentration (a)	Analytical Method (b)	Cal/EPA Res α_{sg} = 0.0009 Ind α_{sg} = 0.0004	EPA Res α_{sg} = 0.01 Ind α_{sg} = 0.001	Cal/EPA α_{sg} = 0.0009		EPA α_{sg} = 0.01		Cal/EPA α_{sg} = 0.0004		EPA α_{sg} = 0.001	
DICHLORODIFLUOROMETHANE	75718	2.32E+05	2.09E+04	2.19E+06	8.76E+05			7.84E-01	TO-15	Yes	Yes	2.32E+05	nc	2.09E+04	nc	2.19E+06	nc	8.76E+05	nc
ETHYLBENZENE	100414	1.08E+03	9.73E+01	1.23E+04	4.91E+03			1.39E-01	TO-15	Yes	Yes	1.08E+03	ca	9.73E+01	ca	1.23E+04	ca	4.91E+03	ca
HEXACHLOROETHANE	67721	6.76E+02	6.08E+01	7.67E+03	3.07E+03			1.60E+00	TO-13A	Yes	Yes	6.76E+02	ca	6.08E+01	ca	7.67E+03	ca	3.07E+03	ca
ISOPROPYLBENZENE	98828	4.63E+05	4.17E+04	4.38E+06	1.75E+06			NA - NS	TO-15 (NS)	ND	ND	ND	--	ND	--	ND	--	ND	--
M,P-XYLENES	108383, 106423	8.11E+05	7.30E+04	7.67E+06	3.07E+06	X		2.72E-01	TO-15	Yes	Yes	8.11E+05	nc	7.30E+04	nc	7.67E+06	nc	3.07E+06	nc
METHYL ACETATE	79209	4.06E+06	3.65E+05	3.83E+07	1.53E+07		X	NA - NS	TO-15 (NS)	ND	ND	ND	--	ND	--	ND	--	ND	--
METHYLCYCLOHEXANE	108872	6.95E+06	6.26E+05	6.57E+07	2.63E+07	X		3.20E+00	TO-15	Yes	Yes	6.95E+06	nc	6.26E+05	nc	6.57E+07	nc	2.63E+07	nc
METHYLENE CHLORIDE	75092	5.75E+03	5.18E+02	6.52E+04	2.61E+04			1.10E+00	TO-15	Yes	Yes	5.75E+03	ca	5.18E+02	ca	6.52E+04	ca	2.61E+04	ca
N-BUTYLBENZENE	104518	4.63E+05	4.17E+04	4.38E+06	1.75E+06	X		4.32E+00	TO-15	Yes	Yes	4.63E+05	nc	4.17E+04	nc	4.38E+06	nc	1.75E+06	nc
O-XYLENE	95476	8.11E+05	7.30E+04	7.67E+06	3.07E+06			1.39E-01	TO-15	Yes	Yes	8.11E+05	nc	7.30E+04	nc	7.67E+06	nc	3.07E+06	nc
PARA-ISOPROPYL TOLUENE	99876	4.63E+05	4.17E+04	4.38E+06	1.75E+06	X		NE	--	--	--	NE	--	NE	--	NE	--	NE	--
PROPYLBENZENE	103651	1.16E+06	1.04E+05	1.10E+07	4.38E+06			7.84E-01	TO-15	Yes	Yes	1.16E+06	nc	1.04E+05	nc	1.10E+07	nc	4.38E+06	nc
SEC-BUTYLBENZENE	135988	4.63E+05	4.17E+04	4.38E+06	1.75E+06	X		NA - NS	TO-15 (NS)	ND	ND	ND	--	ND	--	ND	--	ND	--
STYRENE	100425	1.16E+06	1.04E+05	1.10E+07	4.38E+06			6.72E-01	TO-15	Yes	Yes	1.16E+06	nc	1.04E+05	nc	1.10E+07	nc	4.38E+06	nc
TERT-BUTYL METHYL ETHER	1634044	1.04E+04	9.36E+02	1.18E+05	4.72E+04			NE	--	--	--	NE	--	NE	--	NE	--	NE	--
TERT-BUTYLBENZENE	98066	4.63E+05	4.17E+04	4.38E+06	1.75E+06	X		NA - NS	TO-15 (NS)	ND	ND	ND	--	ND	--	ND	--	ND	--
TETRACHLOROETHENE	127184	4.58E+02	4.12E+01	5.20E+03	2.08E+03			2.24E-01	TO-15	Yes	Yes	4.58E+02	ca	4.12E+01	ca	5.20E+03	ca	2.08E+03	ca
TOLUENE	108883	5.79E+06	5.21E+05	5.48E+07	2.19E+07			1.20E-01	TO-15	Yes	Yes	5.79E+06	nc	5.21E+05	nc	5.48E+07	nc	2.19E+07	nc
TRANS-1,2-DICHLOROETHENE	156605	6.95E+04	6.26E+03	6.57E+05	2.63E+05			6.40E-01	TO-15	Yes	Yes	6.95E+04	nc	6.26E+03	nc	6.57E+05	nc	2.63E+05	nc
TRANS-1,3-DICHLOROPROPENE	10061026	6.76E+02	6.08E+01	7.67E+03	3.07E+03	X		7.20E-01	TO-15	Yes	Yes	6.76E+02	ca	6.08E+01	ca	7.67E+03	ca	3.07E+03	ca
TRICHLOROETHENE	79016	1.35E+03	1.22E+02	1.53E+04	6.13E+03			1.76E-01	TO-15	Yes	Yes	1.35E+03	ca	1.22E+02	ca	1.53E+04	ca	6.13E+03	ca
TRICHLOROFLUOROMETHANE	75694	8.11E+05	7.30E+04	7.67E+06	3.07E+06			8.96E-01	TO-15	Yes	Yes	8.11E+05	nc	7.30E+04	nc	7.67E+06	nc	3.07E+06	nc
VINYL ACETATE	108054	2.32E+05	2.09E+04	2.19E+06	8.76E+05			2.88E+00	TO-15	Yes	Yes	2.32E+05	nc	2.09E+04	nc	2.19E+06	nc	8.76E+05	nc
VINYL CHLORIDE	75014	6.14E+02	5.53E+01	6.97E+03	2.79E+03			4.16E-02	TO-15	Yes	Yes	6.14E+02	ca	5.53E+01	ca	6.97E+03	ca	2.79E+03	ca
XYLENE (TOTAL)	1330207	1.16E+05	1.04E+04	1.10E+06	4.38E+05			2.57E-01	TO-15	Yes	Yes	1.16E+05	nc	1.04E+04	nc	1.10E+06	nc	4.38E+05	nc

Notes:

All concentrations are in microgram per cubic meter.

a Reporting limits were adjusted by a factor of 1.6 to account for dilution from pressurization of a 6-liter Summa canister

b The analytical methods listed are a few among several possible methods for soil gas analysis; final analytical methods will be identified in the sampling and analysis plan.

c The prelminary SGAL is based on the lowest concentration between the cancer- and noncancer-based soil gas RBC. If the soil gas RBC is less than the laboratory RL, then the laboratory RL is used as the SGAL.

--	Not applicable	DDE	Dichlorodiphenyldichloroethene	NS	Non-standard analysis
α_{sg}	Soil gas-to-indoor air attenuation factor	EPA	U.S. Environmental Protection Agency	RBC	Risk-based concentration
>Res	Exceeds residential soil gas RBC	Ind	Industrial	Res	Residential
BHC	Benzene hexachloride	NA	Not available	RL	Reporting limit
ca	Cancer risk	nc	Noncancer effects	SGAL	Soil gas action level
Cal/EPA	California Environmental Protection Agency	ND	Not determined		
CAS	Chemical Abstract Service	NE	Not evaluated; analysis not available for analytical method shown		

APPENDIX A
RESPONSES TO COMMENTS ON THE DRAFT MEMORANDUM

TABLE 1: RESPONSES TO COMMENTS FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY ON THE DRAFT APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30, 2009

The table below contains the responses to comments received from the U.S. Environmental Protection Agency (EPA) on the "Draft Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, California," dated November 30, 2009. The comments addressed below were received from EPA on January 4, 2010. Throughout this table, *italicized* text represents additions to the document and ~~strikeout~~ text indicates locations of deletions. Also throughout this table, references to page, section, table, and figure numbers pertain to the new document unless indicated otherwise.

No.	Page	Comment	Response
Responses to Comments from EPA (Sarah Kloss)			
GENERAL COMMENTS			
1.	---	**Attenuation Factors:** The attenuation factors should be more conservative. The proposal follows California guidance derived using specific model inputs to the Johnson and Ettinger vapor intrusion model. In following EPA Vapor Intrusion Guidance (EPA 2002) the first step would be to use generic attenuation factors of 0.01 for residential exposures and 0.001 for industrial. These attenuation factors are based on empirical data collected at existing vapor intrusion sites. The default model inputs are not consistent with the empirical observations and are less protective. Please revise the report to include these more conservative attenuation factors.	The memorandum was revised to include additional soil gas action levels (SGAL) based on EPA (2002)-recommended soil-gas-to indoor air attenuation factors of 0.01 (residential use) and 0.001 (industrial use). Discussion on the EPA (2002) attenuation factors was added to Section 3 of the memorandum; calculated risk-based concentrations for soil gas (RBC-SG) and preliminary SGAL are provided in Tables 5 and 6 of the memorandum.
2.	---	**Area Represented by Single Sampling Point:** The Navy should clarify either in this proposal or the SAP, the assumed area represented by each sampling point.	A 100-foot grid spacing will be used to place soil gas sample locations for larger areas, such as above a groundwater plume. Soil gas samples will be collected where previous soil samples indicated a detection of a volatile chemical in soil, except in certain cases. No soil gas samples will be collected where a previous soil sample was collected at a depth of less than 2 feet below ground surface based on the likelihood that the soil gas sample was contaminated from the ambient atmosphere. No soil gas samples will be collected where a previous soil sample was collected below the current water table. In general, the area represented by each soil gas sample will depend greatly on the results of the overall soil gas survey. Large areas with soil gas concentrations less than SGALs may allow large areas between samples to be confidently represented by widely spaced samples. However, widespread detections above SGALs over broad areas may require additional discussion of the area represented by each soil gas sample and whether additional, more closely spaced, samples may be needed. The

TABLE 1: RESPONSES TO COMMENTS FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY ON THE DRAFT APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30, 2009 (CONTINUED)

No.	Page	Comment	Response
			sampling and analysis plan (SAP) and the document summarizing the results of the soil gas survey will include further discussion of the area represented by each soil gas sampling point. The memorandum was not changed as a result of this comment.
3.	---	**Comparison of Measured Concentrations to Risk-Based Concentrations:** Please describe in more detail how measured soil gas concentrations will be compared to the calculated risk-based concentrations (RBC) for purposes of making decisions. A decision tree would be helpful.	In general terms, large areas with soil gas concentrations less than SGALs may allow a reduction in the size of the area requiring institutional controls (ARIC) for volatile organic compound (VOC) vapors. Widespread detections above SGALs over broad areas may require additional discussion on whether an ARIC may be reduced. Additional details on how decisions will be made with the soil gas data will be included in the decision rules in the SAP.
MINOR COMMENT			
1.	---	Equation 2-2 has a typo in the denominator. Please change one of the exposure frequency variables to exposure duration.	Equation 2-2 was revised as requested.

TABLE 2: RESPONSES TO COMMENTS FROM THE DEPARTMENT OF TOXIC SUBSTANCES CONTROL ON THE DRAFT APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30, 2009

The table below contains the responses to comments received from the Department of Toxic Substances Control (DTSC) on the "Draft Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, California," dated November 30, 2009. The comments addressed below were received from DTSC on January 11, 2010. Throughout this table, *italicized* text represents additions to the document and ~~strikeout~~ text indicates locations of deletions. Also throughout this table, references to page, section, table, and figure numbers pertain to the new document unless indicated otherwise.

No.	Page	Comment	Response
Response to Comment from DTSC (Ryan Miya)			
GENERAL COMMENT			
1.	---	The text states that contaminants of concern will be identified separately for each future active soil gas (ASG) sample location, and that each location will also represent a separate exposure point location. Please provide additional details describing the general process and technical basis upon with individual ASG sampling locations exceeding action level benchmarks will be carried through to identify area(s) requiring institutional controls for volatile chemicals.	In general terms, large areas with soil gas concentrations less than SGALs may allow a reduction in the size of the ARIC for VOC vapors. Widespread detections over broad areas may require additional discussion on whether an ARIC may be reduced. Additional details on how decisions will be made with the soil gas data will be included in the decision rules in the SAP.
Responses to Comments from DTSC (Kimberly Day, Human and Ecological Risk Office [HERO])			
GENERAL COMMENTS			
1.	---	Toxicity Criteria.	Header.
1a.	---	The hierarchy of toxicity criteria selection should state that the more health-protective of the Cal/EPA OEHHA toxicity criteria and the USEPA IRIS value is used instead of "**Cal/EPA IURs (inhalation unit risks) are the first tier of the hierarchy, rather than the EPA IURs.**" Please update the memorandum to reflect this.	The last sentence of the first paragraph of Section 2.3 was revised as follows: *"This hierarchy for toxicity criteria is generally consistent with the EPA (2003)-recommended hierarchy, except that the more health-protective of the Cal/EPA IURs and the EPA IURs were used."*
1b.	---	Chemical Surrogates. Please note that when selecting chemical surrogates, selection should be based not only on similar chemical structure but also on chemical activity and mechanism of toxicity. Please update the memorandum to reflect this.	The seventh bullet of Section 2.3 was revised as follows: *"Chemical surrogates were selected based on similar chemical structure, chemical activity, and mechanisms of toxicity."*
2.	---	Selection of Chemicals of Concern (COCs). HERO does not agree with the procedure proposed to eliminate chemicals of concern (COCs) in this	Please refer to the following responses.

TABLE 2: RESPONSES TO COMMENTS FROM THE DEPARTMENT OF TOXIC SUBSTANCES CONTROL ON THE DRAFT APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30, 2009 (CONTINUED)

No.	Page	Comment	Response
		memorandum based on presence below the calculated risk-based concentration for soil gas (RBC-SG).	
2a.	---	In general, HERO does not allow chemicals to be screened out of a risk assessment and all detected compounds should be included. Chemicals cannot be dropped out of a risk assessment solely based on presence below screening levels. The development of modern computerized spreadsheets facilitates carrying a larger number of chemicals through a risk assessment. Exceptions can be made for laboratory chemical artifacts as described in USEPA's Risk Assessment Guidance for Superfund Part A (RAGS) (http://www.epa.gov/oswer/riskassessment/ragsa/pdf/rags-vol1-pta_complete.pdf).	As stated in the third paragraph of Section 4.0, vapor intrusion risks will be calculated for each detected chemical at each ASG location. That is, comparison to screening levels will not be used to exclude chemicals from the risk evaluation. The following text was inserted after the second sentence of this paragraph to provide clarification: *"Comparison to RBC-SGs will not be used to exclude detected chemicals from the risk calculations..."* However, as indicated in the response to DTSC comment 2b, several factors may warrant the exclusion of some chemicals from the risk calculations.
2b.	---	Additionally, in some instances chemicals present at very low concentrations and detection frequency may be dropped after consultation with the HERO toxicologist. Factors needing to be weighed in dropping a chemical include the historical use of the chemical on site, the frequency of detection, detection limits, chemical toxicity, concentration detected, potential for bioaccumulation, spatial distribution, and essential nutrient status. HERO encourages that a list of chemicals be provided to HERO that are proposed to be excluded from the detailed risk assessment. Preferably this would occur at the risk assessment work plan stage or before revising a risk assessment. DTSC and toxicologists for the responsible party can then review this list prior to preparing the risk assessment report.	The following text was added to third paragraph of Section 4.0: *"Comparison to RBC-SGs will not be used to exclude detected chemicals from the risk calculations; however, some detected chemicals may warrant exclusion from the risk calculations based on factors such as low detection frequency, spatial distribution, low concentration, and toxicity. Before risks are calculated, the Navy will identify whether these factors apply to any chemicals detected in the ASG samples and will consult with regulatory agency toxicologists if it proposes to exclude any of these chemicals from the vapor intrusion risk estimates."*
3.	---	The Navy need not respond to this comment; it is intended as a recommendation for the forthcoming human health risk assessment that will include risk from vapor intrusion into indoor air. HERO recommends using the DTSC's modified version of the J&E model modified to include California Health Criteria when evaluating risk from vapor intrusion into indoor air risk. The DTSC modified version of the J&E model can be found at the following website: http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm.	Section 3.0 was revised to indicate that the Cal/EPA (2005) and EPA (2002) generic soil gas-to-indoor air attenuation factors would *initially* be used to calculate RBC-SGs. Section 3.0 was also revised to include the following statement: *"It is possible, depending on the ASG results and the risk estimates for vapor intrusion, that a further tier of evaluation using modeled, site-specific α_{sg} values for some chemicals may be warranted. This tiered approach is consistent with Cal/EPA (2005) and EPA (2002) recommendations if initial screening of soil gas results using generic α_{sg}*

TABLE 2: RESPONSES TO COMMENTS FROM THE DEPARTMENT OF TOXIC SUBSTANCES CONTROL ON THE DRAFT APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30, 2009 (CONTINUED)

No.	Page	Comment	Response
			values indicates that the vapor intrusion pathway may result in unacceptable indoor air inhalation risks. If needed, the JEM will be used to estimate site- and chemical-specific α_{sg} values, and the modeled α_{sg} values will be used to refine the RBC-SGs. Before site- and chemical-specific α_{sg} values are modeled, the Navy will provide proposed assumptions for soil and building properties to the BCT for review and approval."

TABLE 3: RESPONSES TO COMMENTS FROM THE SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD ON THE DRAFT APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30, 2009

The table below contains the response to the comment received from the San Francisco Bay Regional Water Quality Control Board (Water Board) on the "Draft Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, California," dated November 30, 2009. The comment addressed below was received from the Water Board on January 12, 2010.

No.	Page	Comment	Response
Response to Comment from Water Board			
GENERAL COMMENT			
1.	---	I reviewed the *Draft Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard.* I also reviewed the comments provided by: the California Department of Toxic Substances Control (DTSC) dated January 11, 2010; the U.S. Environmental Protection Agency (EPA) dated January 4, 2010; and the San Francisco City and County Department of Public Health (SFDPH) dated January 4, 2010. I concur with these comments provided by the DTSC, EPA, and SFDPH and have no further comments.	Comment noted.

TABLE 4: RESPONSES TO COMMENTS FROM THE CITY AND COUNTY OF SAN FRANCISCO ON THE DRAFT APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30, 2009

The table below contains the response to the comment received from the City and County of San Francisco Department of Public Health (SFDPH) on the "Draft Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, California," dated November 30, 2009. The comment addressed below was received from SFDPH on January 4, 2010. Throughout this table, *italicized* text represents additions to the document and ~~strikeout~~ text indicates locations of deletions. Also throughout this table, references to page, section, table, and figure numbers pertain to the new document unless indicated otherwise.

No.	Page	Comment	Response
Responses to Comments from SFDPH			
SPECIFIC COMMENTS			
1.	1	**Section 1.0, first sentence:** This sentence states, "This document describes the approach for establishing action levels for soil gas at Hunters Point Shipyard…". Please expand this paragraph to list the anticipated uses for the action levels such as "right-sizing" of soil gas ARICs, selecting appropriate institutional controls (ICs), and/or any others that may apply.	This information is provided later in Section 1.0. The fifth paragraph of Section 1.0 contains several of the anticipated uses of the SGALs, including modification of the ARICs for VOC vapors, identification of other ICs, and consideration of engineering controls to mitigate vapor intrusion into indoor air. The memorandum was not changed as a result of this comment.
2.	1	**Section 1.0, fourth paragraph:** Consider expanding this paragraph to note that a focus will be to use the results from the "refined" HHRA results and COCs for vapor intrusion to replace the groundwater remediation goals for vapor intrusion that were specified in the RODs.	The text was expanded to include the following: "*The calculated vapor intrusion risks and COCs identified using ASG data will supersede the groundwater vapor intrusion risk estimates and COCs identified in the RODs for Parcels B, C, D-1, G, UC-1, and UC-2 and the FS report for Parcel E.*"
3.	2	**Section 1.0, paragraph 5, first sentence:** States, "Although action may be considered…". Please change this wording to "Although action may be necessary…"	The sentence was revised as recommended.
4.	2	**Section 2.0, Step 1: Calculation of Risk-Based Concentrations in Indoor Air:** We would like to call the Navy's attention to the fact that the California DTSC has not officially adopted the Part F approach (*Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment), USEPA, January 2009*). The use of the Part F approach will result in the calculation of less-conservative non-residential Risk Based Concentrations for indoor air (RBC-IA) and soil gas (RBC-SG) than if the California approach were used. For example, the commercial indoor air RBCs calculated using the Part F approach will be approximately three times less stringent than the California	DTSC did not take issue with the RAGS Part F approach for this memorandum. In addition, the Navy has used the RAGS Part F approach at other Navy installations in California without comment from DTSC. The memorandum was not changed as a result of this comment.

TABLE 4: RESPONSES TO COMMENTS FROM THE CITY AND COUNTY OF SAN FRANCISCO ON THE DRAFT APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30, 2009 (CONTINUED)

No.	Page	Comment	Response
		Human Health Screening Levels (CHHSLs) that are typically applied at DTSC sites.	
5.	5	**Section 2.3, Toxicity Criteria (p. 5):** The hierarchy of toxicity criteria presented in Section 2.3 does not treat Cal/EPA carcinogenic and non-carcinogenic criteria consistently. For carcinogens, the Cal/EPA Office of Environmental Health Hazard Assessment (OEHHA) database is identified as the Tier 1 source. Then, EPA toxicity criteria are cited as Tier 2, 3, and 4 sources for both carcinogens and non-carcinogens, followed by the Cal/EPA OEHHA chronic inhalation reference exposure levels for non-carcinogens (Cal/EPA 2008). Please clarify the reasons for this hierarchy, specifically why the Tier 5 Cal/EPA source is not considered as Tier 2.	The proposed toxicity criteria hierarchy is consistent with the hierarchy for the human health risk assessments (HHRA) for Hunters Point Shipyard (HPS). Based on discussions with DTSC toxicologists for HPS and other Navy installations in California, the OEHHA chronic reference exposure levels (REL) for noncarcinogens have not received the same level of Cal/EPA peer review as the OEHHA inhalation unit risks for carcinogens. For this reason, the RELs are recommended for use only if EPA-based inhalation toxicity criteria for noncarcinogens are not available. The memorandum was not changed as a result of this comment.
6.	5	**Section 2.3, Toxicity Criteria, bottom of p. 5:** Route-to-route extrapolation discussion references a 1992 CalEPA document regarding the use of oral toxicity values for inhalation toxicity factors (when the inhalation value is not available). We suggest also referencing the CalEPA 2009 technical note since that is the most recent documentation on this issue.	The sixth bullet of Section 2.3 was revised to additionally cite the Cal/EPA (2009) HHRA note number 4.
7.	6	**Section 2.3, Toxicity Criteria (p. 6):** This section states that for trichloroethylene (TCE) the inhalation unit rate (IUR) developed by Cal/EPA for TCE will be used to calculate the cancer-based Risk-Based Concentration for Indoor Air (RBC-IA). Please note that on 3 November 2009, the EPA published a Federal Register notice releasing the External Review Draft of its Toxicological Review of Trichloroethylene for public review and comment. While this document is still in the public review process, the toxicity value proposed by the EPA is approximately two times more stringent than the Cal/EPA inhalation IUR. We recommend that Navy calculate RBCs/SGALs using the current CalEPA values (as proposed) ***and*** RBCs based on the proposed values, as our current assessment is that these values will eventually be made final.	If the EPA draft toxicity criteria for TCE are finalized before the ASG survey results are evaluated, then the criteria will be incorporated into the RBC-SGs and SGALs as applicable, following the toxicity value hierarchy outlined in Section 2.3 of the memorandum. The Navy acknowledges that toxicity criteria for some chemicals may require revision after the ASG survey has been completed. The following sentence was added to the third paragraph of Section 5.0 to address potential changes to toxicity criteria: *"Additionally, after the ASG survey, the Navy will verify toxicity criteria (see Section 2.3) for chemicals detected in the survey and will update the criteria and RBC-SGs as applicable."*
8.	6	**Section 3.0, Page 6, second paragraph:** Please clarify that the sampling locations at which the "target, not-to-exceed indoor air concentrations" are ***not*** exceeded will be used to establish the area ***outside*** of any soil gas ARIC.	The Navy agrees that soil gas data that indicate concentrations that are below SGALs may be used in the decision to modify the size of the ARIC for VOC vapors. However, the discussion in Section 3.0 on page 6 is simply related to the method for mathematically computing RBC-SGs, and

Table 4: Responses to Comments from the City and County of San Francisco on the Draft Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, California, November 30, 2009 (Continued)

No.	Page	Comment	Response
			not to the use of RBC-SG values, which is discussed later in the document. The memorandum was not changed as a result of this comment.
9.	7	**Section 3.0, Page 7, 3rd line of first paragraph:** Please indicate what model will be used (e.g., the USEPA version of the Johnson and Ettinger (J/E) 1991 model).	Please see the response to DTSC comment 3.
10.	7	**Section 3.0, Page 7, last line of first paragraph:** Please expand the analysis beyond slab-on-grade construction. Redevelopment may include full or partial basements (e.g., parking garage). Please expand the analysis to the extent practicable, so that redevelopment options remain as broad as possible.	The Base Realignment and Closure Cleanup Team (BCT) agreed that slab-on-grade construction was appropriate for estimating vapor intrusion risks because groundwater is shallow at HPS. The assumption of slab-on-grade construction for developing SGALs follows the approach used consistently for all HHRAs for HPS. Section 3.0 was revised to include this information.
11.	7	**Section 3.0, Page 7, Table:** We do not object to the use of the generic soil-to-gas air attenuation factors provided here for residential slab-on-grade and industrial slab-on-grade building construction. However, in our experience, chemical-specific factors for the soil-to-gas attenuation values are usually calculated and we recommend that this be done here. We suggest that it at least be acknowledged that chemical-specific values can be calculated. Please also note that the default attenuation factors have an assumed depth of the soil gas probe. If the depth of the soil gas samples is going to be variable, then it may make sense to calculate depth-specific (as well as chemical-specific) attenuation factors.	Please see the response to DTSC comment 3.
12.	---	**Section 4.0, General Comments:** In this section, there is no discussion regarding how chemicals with non-detected concentrations will be evaluated. Please provide such a discussion. Normally, RBCs are calculated for all chemicals detected in soil gas, which would then be called COPCs for the VI pathway. Since you are calculating cumulative risks, you don't want to exclude COPCs simply because they are below the RBC (if 5 chemicals are at 90% of their respective RBCs, you probably will need to deal with them).	Please see the response to DTSC comment 2a; the response clarifies that detected chemicals will not be excluded from vapor intrusion risk estimates on the basis of comparison to RBC-SGs. Nondetected chemicals will not be compared with RBC-SGs and will be excluded from the cumulative risk estimates. As indicated in Section 2.0, a target cancer risk of 10^{-6} and a target noncancer hazard index of 1 will be used to calculate RBCs. This approach is consistent with the approach used to develop risk-based remediation goals for all soil and groundwater COCs identified at HPS. RBCs will not

TABLE 4: RESPONSES TO COMMENTS FROM THE CITY AND COUNTY OF SAN FRANCISCO ON THE DRAFT APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30, 2009 (CONTINUED)

No.	Page	Comment	Response
		It is not clear that the SGALs will incorporate the cumulative risks. There may be cases where you will not simply use the RBCs as the SGALs. This really depends on whether or not you have one, single primary risk-driving chemical. It may be appropriate to leave this flexible and acknowledge that SGALs may be less than the RBCs.	be adjusted by the number of chemicals identified as COCs.
13.	7	**Section 4.0, first paragraph:** Please note that existing soil gas data from some locations may be very old. Soil vapor can move laterally away from old sources (e.g., impacted soils) or with a source that has been remobilized and/or changed direction (e.g., impacted groundwater). Please take into account these potential effects.	Active soil gas survey samples are proposed at locations where previous soil samples indicated a detection of a volatile chemical. The Navy agrees that degradation of chemicals is likely to occur over time. However, the age of the previous soil sample was not considered in the selection of active soil gas survey sample locations as a conservative measure. The fact that soil vapors may migrate laterally will be taken into account in the sampling strategy during preparation of the SAP for the active soil gas survey. The memorandum was not changed as a result of this comment.
14.	7	**Section 4.0, first paragraph:** The Navy may want to consider using all active soil gas (ASG) locations to develop an upper confidence limit to represent an exposure point concentration rather than using each individual ASG location as a separate exposure point location.	Use of individual ASG locations to represent separate exposure points is a protective approach because the specific locations of future buildings at HPS are not known. In addition, Cal/EPA (2005) recommends that maximum soil gas concentrations for each exposure point be used to evaluate vapor intrusion for future buildings. The memorandum was not changed as a result of this comment.
15.	8	**Section 4.0, Page 8, first paragraph:** There is a statement that "… vapor intrusion risks will be calculated separately for each detected chemical at each ASG location using the ratiometric approach employed in the HHRAs for HPS to evaluate vapor intrusion risks for groundwater." The text here should specify whether chemicals with detected values below RBC-SGs will be included in the calculation of risk. In accordance with EPA and Cal/EPA guidance, all detected chemicals should be included in the quantitative risk assessment.	Please see the responses to DTSC comments 2a and 2b.
16.	8	**Section 4.0, Page 8, end of first paragraph:** There is a statement that "the Navy will also consider ambient data (for example, results of outdoor air samples that will be collected during the soil gas surveys and literature values) to ensure that the identified COCs and ARICs are related to site-impacted soil gas, rather than ambient sources." We agree with this	The objective of the memorandum is provide the Navy's approach for developing action levels for soil gas, identify COCs associated with exposure from vapor intrusion, and refine ARICs that address vapor intrusion. The Navy will address specific factors that may contribute to uncertainty with the identified COCs and ARICs after the soil gas survey is

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No.	Page	Comment	Response
		approach; however we recommend that this discussion be part of a broader discussion of uncertainty, possibly in a separate section, that discusses various potential sources of under- or over-estimation of risks, as there may be other contributors to uncertainty that are more significant than ambient air effects.	completed and soil gas COCs are identified.
17.	8	**Section 5.0, end of the second paragraph:** Please take into consideration that the specified analytical methods need to be sensitive enough to give results below expected criteria. Also, please explain whether decisions will be made based on one sampling event or whether locations that pass or fail marginally will be sampled a second time.	The memorandum was revised to include calculations for preliminary RBC-SGs and SGALs for volatile chemicals previously detected in soil and groundwater at HPS. Specifically, Table 7 compares the calculated RBC-SGs with possible laboratory reporting limits for the soil gas survey and indicates whether the preliminary SGAL is based on the RBC-SG or reporting limit. If the preliminary SGAL is based on the reporting limit, then the analytical method may not be not sensitive enough to achieve the RBC-SG. The SAP for the soil gas survey will discuss the number of sampling events planned and specific laboratory analytical methods.
18.	8	**Section 5.0, p. 8, third paragraph:** Please rephrase the second sentence to read as follows: "Future actions and decisions to address areas with soil gas concentrations above SGALs will be based on soil gas data collected in the future rather than groundwater data and the previously developed groundwater remediation goals for vapor intrusion."	The sentence was reworded as suggested.
MINOR COMMENTS			
1.	1	**Section 1.0, second sentence of fifth paragraph:** Suggest rewording as follows: "The action levels can be used as health-based comparison benchmarks for the data generated from future soil gas surveys."	The sentence was reworded as suggested.
2.	1	**Section 1.0, third sentence of fifth paragraph:** Suggest using the description "initially specified areas" instead of "initial areas."	The sentence was reworded as suggested:

REFERENCES

California Environmental Protection Agency (Cal/EPA). 2005. "Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air." Interim Final. Department of Toxic Substances Control. February 7. Available on-line at: <http://www.dtsc.ca.gov/AssessingRisk/upload/HERD_POL_Eval_Subsurface_Vapor_Intrusion_interim_final.pdf>

Cal/EPA. 2008. Chronic Reference Exposure Levels. Office of Environmental Health Hazard Assessment. December 18. Available on-line at: <http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html>

Cal/EPA. 2009. "Screening Level Human Health Risk Assessments." Department of Toxic Substances Control, Human and Ecological Risk Division (HERD). HERD Note 4. June 24. Available on-line at: <http://www.dtsc.ca.gov/AssessingRisk/upload/HHRA-Note-4.pdf>

U.S. Environmental Protection Agency (EPA). 2002. "Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)." Draft Federal Register. November 29. Available on-line at: <http://www.epa.gov/waste/hazard/correctiveaction/eis/vapor.htm>.

EPA. 2003. "Human Health Toxicity Values in Superfund Risk Assessments." Memorandum from Michael B. Cook, Director, to Superfund National Policy Managers, Regions 1 – 10. Office of Solid Waste and Emergency Response. OSWER Directive 9285.7-53. December 5. Available on-line at: <http://www.epa.gov/swerrims/riskassessment/pdf/hhmemo.pdf>

APPENDIX B
RESPONSES TO COMMENTS ON THE DRAFT FINAL MEMORANDUM

TABLE 1: RESPONSE TO COMMENT FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY ON THE DRAFT FINAL APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, FEBRUARY 26, 2010

The table below contains the response to the comment received from the U.S. Environmental Protection Agency (USEPA) on the "Draft Final Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, California," dated February 26, 2010. The comment addressed below was received from EPA on March 28, 2010.

No.	Page	Comment	Response
Response to Comment from USEPA (Sarah Kloss)			
GENERAL COMMENT			
1.	---	I have reviewed the draft final document. All our previous comments have been addressed and we have no further comments.	Comment noted.

TABLE 2: RESPONSES TO COMMENTS FROM THE DEPARTMENT OF TOXIC SUBSTANCES CONTROL ON THE DRAFT FINAL APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, FEBRUARY 26, 2010

The table below contains the responses to comments received from the Department of Toxic Substances Control (DTSC) on the "Draft Final Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, California," dated February 26, 2010. The comments addressed below were received from DTSC on March 23, 2010. Throughout this table, *italicized* text represents additions to the document and ~~strikeout~~ text indicates locations of deletions. Also throughout this table, references to page, section, table, and figure numbers pertain to the new document unless indicated otherwise.

No.	Page	Comment	Response
Response to Comment from DTSC (Ryan Miya)			
GENERAL COMMENT			
1.	---	All comments have been adequately addressed with the exception of one minor clarification as presented in the enclosed memorandum from the Department of Toxic Substances Control's Human and Ecological Risk Office.	See the responses to the comments below.
Responses to Comments from DTSC (Kimberly Day, Human and Ecological Risk Office [HERO])			
GENERAL COMMENTS			
1.	---	Navy's Response to HERO's January 11 2010 General Comment 1a-b – Toxicity Criteria. The Navy has agreed to revise Section 2.3 to reflect that the more health protective of the Cal/EPA [California Environmental Protection Agency] OEHHA [Office of Environmental Health Hazard Assessment] toxicity criteria and the USEPA IRIS [Integrated Risk Information System] value will be used. The Navy has also agreed to revise the document to reflect that chemical surrogates were selected based on "similar chemical structure, chemical activity, and mechanisms of toxicity." HERO concurs with the Navy's suggested revisions and the Navy need not respond to this comment.	Comment noted.
2.	---	Navy's Response to HERO's January 11, 2010 General Comment 2a-b – Selection of Chemicals of Concern (COCs). The Navy has agreed to revise the text in the third paragraph of Section 4.0. HERO concurs with the Navy's	Comment noted.

TABLE 2: RESPONSES TO COMMENTS FROM THE DEPARTMENT OF TOXIC SUBSTANCES CONTROL ON THE DRAFT FINAL APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, FEBRUARY 26, 2010 (CONTINUED)

No.	Page	Comment	Response
		suggested revisions and the Navy need not respond to this comment	
3.	---	Navy's Response to HERO's January 11, 2010 General Comment 3. The Navy has agreed to revise the text in Section 3.0 to include further detail regarding vapor intrusion, gas-to-indoor air attenuation factors and the use of the J&E [Johnson and Ettinger] Model. HERO requests clarification as to which J&E Model the Navy is referring to in their response, "the JEM [Johnson and Ettinger] will be used to estimate site-and chemical-specific α_{sg} [soil gas-to-indoor air attenuation] values." Otherwise, HERO concurs with the Navy's suggested revisions.	The following information was added to the last paragraph of Section 3.0: *"The Cal/EPA (2003) version of the JEM will be used for this evaluation, with modifications to include modeling assumptions recommended in Cal/EPA (2005). If an updated version of the JEM is available following the soil gas surveys, then the updated version will be used."*

TABLE 3: RESPONSE TO COMMENT FROM THE SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD ON THE DRAFT FINAL APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, FEBRUARY 26, 2010

The table below contains the response to the comment received from the San Francisco Bay Regional Water Quality Control Board (Water Board) on the "Draft Final Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, California," dated February 26, 2010. The comment addressed below was received from the Water Board on March 29, 2010.

No.	Page	Comment	Response
Response to Comment from Water Board			
GENERAL COMMENT			
1.	---	I reviewed the *Draft Final Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard* and have no substantive comments.	Comment noted.

TABLE 4: RESPONSE TO COMMENT FROM THE CITY AND COUNTY OF SAN FRANCISCO ON THE DRAFT FINAL APPROACH FOR DEVELOPING SOIL GAS ACTION LEVELS FOR VAPOR INTRUSION EXPOSURE AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA, FEBRUARY 26, 2010

The table below contains the response to the comment received from the City and County of San Francisco Department of Public Health (SFDPH) on the "Draft Final Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, San Francisco, California," dated February 26, 2010. The comment addressed below was received from SFDPH on March 31, 2010.

No.	Page	Comment	Response
Response to Comment from SFDPH			
SPECIFIC COMMENT			
1.	1	We would like to direct the Navy's attention to the document "Advisory – Active Soil Gas Investigation", dated March 2010, issued by the California Environmental Protection Agency. This advisory is currently out for public comment until April 15, 2010. Although it is still in the public comment phase, it does provide an indication of DTSC and RWQCB [Regional Water Quality Control Board] intentions. The draft advisory can be downloaded from the DTSC's website: http://dtsc.ca.gov/SiteCleanup/Vapor_Intrusion.cfm	Comment noted.

REFERENCES

California Environmental Protection Agency (Cal/EPA). 2003. "Advanced-Level Model for Soil Gas Contamination." SG-ADV Version 2.0. February.

Cal/EPA. 2005. "Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air." Interim Final. Department of Toxic Substances Control. February 7. Available on-line at: <http://www.dtsc.ca.gov/AssessingRisk/upload/HERD_POL_Eval_Subsurface_Vapor_Intrusion_interim_final.pdf>