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Technical Memorandum

To: Ms. Olivia Jacobs, REA; President/CEO
Clearwater Group
229 Tewksbury Ave
Pt. Richmond, California 94801

From: Teri Copeland, DABT, Kurt Fehling, Jim Van de Water, PG, CHG, and Steve Jones, Ph.D.

Date: November 8, 2011

Re: Technical Review of ***Proposed Low-Threat UST Closure Policy*** (SWRCB Low-Threat UST Closure Policy Task Force, July 14, 2011)

At your request, we have completed our review of the Proposed Low-Threat UST Closure Policy (LT-UCP) documents (including the associated technical support documents) for general issues regarding consistency with current regulatory policy and risk assessment guidance. Our general comments are outlined in the Executive Summary below, and our specific comments are listed by section of the Closure Policy document afterwards.

Executive Summary

We have reviewed all four of the documents that present a streamlined approach for addressing volatile organic compounds (VOCs) at leaking underground fuel tanks (LUFT). Specifically, we have critically reviewed:

1. Proposed Low-Threat UST Closure Policy (SWRCB Low-Threat UST Closure Policy Task Force, July 14, 2011)
2. Technical Justification for Soil Screening Levels for Direct Contact and Outdoor Air Exposure Pathways (SWRCB Low-Threat UST Closure Policy Task Force, Final July 16, 2011)
3. Technical Justification for Groundwater Plume Lengths, Indicator Constituents, Concentrations, and Buffer Distances (Separation Distances) to Receptors (SWRCB Low-Threat UST Closure Policy Task Force, Final July 12, 2011)
4. Technical Justification for Low-Threat Closure Scenarios for Petroleum Vapor Intrusion Pathway (SWRCB Low-Threat UST Closure Policy Task Force, Final June 30, 2011)

These documents collectively present a comprehensive concept for addressing contaminated soil and potential impacts to groundwater at LUFT sites. While we applaud the SWRCB efforts to streamline the current process to address these sites, we find the proposed approach to be incomplete and/or technically flawed in several ways that detract from the intended goals of this new guidance.

The proposed approach falls short of providing clear and unambiguous guidance on the methodology and decision criteria for defining low-threat LUFT sites. As currently presented, the data needs and data collection techniques are not well defined, and the methods and criteria for assessing data adequacy/usability need further clarification. The proposed streamlined approach inherently places a greater burden of transparency and data accuracy on the process, and further clarifications on the methods and decision criteria are necessary to avoid misunderstandings or arbitrary decision-making as the new guidance is implemented.

There are several elements of the proposed methodology that contain technical flaws and/or are apparently in conflict with relevant federal or California regulatory agency guidance. In some cases, there are errors in the specified calculation methods and/or input parameters that will alter the decision criteria. In other cases the underlying modeling procedures are not clearly identified and require better transparency and validation. The current methods also fail to consider certain chemicals that may be present at LUFT sites and that should be carried through the site evaluation process consistent with standard risk assessment guidance. These technical flaws and inconsistencies need to be addressed before the new guidance is implemented.

We applaud the efforts of SWRCB to identify appropriate methods for more efficient investigation, assessment and closure of less problematic LUFT sites. However, the proposed methodology must be reasonably comprehensive and unambiguous to avoid potential errors during implementation. Thus, we strongly recommend that SWRCB address the specific comments identified below prior to finalizing its Low-Threat UST Closure Policy.

1.0 DRAFT Low-Threat UST Closure Policy (SWRCB Low-Threat UST Closure Policy Task Force, 2011a)

Our review of this document focused on the following key issues:

Clarity of data needs required to implement the draft policy, adequacy of the limited list(s) of indicator chemicals, approach for determining cumulative risk, and deviation from current guidance

Comment 1.1: For the benefit of all stakeholders, and especially the responsible parties and their consultants, it is recommended that the draft guidance provide a table or list of data needs required under (a) existing guidance and (b) the draft policy. Data needs associated with characterization and remediation should be provided. In addition to providing direction to the stakeholders regarding budgeting and scheduling, this will also allow for a straightforward assessment regarding (a) the definitiveness of the draft policy and (b) the potential benefits/cost savings associated with the draft policy.

Comment 1.2: The indicator chemicals are inadequate. The draft policy relies upon benzene, naphthalene, polynuclear aromatic hydrocarbons (PAHs), and methy tertiary butyl ether (MTBE). As the draft policy is intended for fuels (a mixture of numerous chemicals), additional chemicals should be included. Specifically, toluene, ethylbenzene, xylenes should be addressed at a minimum. Inclusion of additional chemicals will provide some consistency with existing guidance regarding cumulative risk (*i.e.*, consistent with existing USEPA and CalEPA guidance, the contribution of all chemicals to the total risk posed by a site should be quantified).

2.0 Technical Justification for Soil Screening Levels for Direct Contact and Outdoor Air Exposure Pathways (SWRCB Low-Threat UST Closure Policy Task Force, Final July 16, 2011)

Our review focused on the parameters, equations, and general human health risk assessment concepts relied upon in the draft guidance. Our comments are as follows:

SSL equations (Tables 1, 2, 3)

Comments to Table 1

Comment 2.1: In the age-adjusted inhalation rate equation there is an extraneous AF_a term in the numerator. This variable is associated with the dermal contact rate and not the inhalation rate and needs to be deleted.

Comment 2.2: For the non-carcinogenic hazard index, the averaging time term was not included, which is inconsistent with risk assessment guidance (USEPA, 1989). The averaging time should be included in the equation.

Comments to Table 2

Comment 2.3: See Comment 2.2.

Comments to Table 3

Comment 2.4: See Comment 2.2.

Exposure Parameters (Table 4)

Comment 2.5: The units on the skin surface area factor (SAS) need to be changed to cm^2/day to be consistent with USEPA guidance for dermal risk assessment (USEPA, 2004). Without this correction, the units do not properly cancel.

VFs (values listed in Tables 5, 6, and Figure 2)

Comment 2.6: While the parameter values in these tables appear reasonable and are the generally the standard default values, neither the text nor tables present the actual calculations for the volatilization factor (VF) and as a consequence, the VF values could not be confirmed. All formulas should be clearly presented.

Toxicity Criteria (Table 7)

Comment 2.7: The toxicity criteria listed in this Table 7 appear to have been obtained from the San Francisco Regional Water Quality Control Board's Environmental Screening Levels. Several of these toxicity values are out of date and should be obtained from the CalEPA's Office of Environmental Health Hazard Assessment (available at: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp). Specifically, RfCs should be used rather than inhalation RfDs and the RfCs for benzene and naphthalene should be 60 µg/m^3 and 9 µg/m^3, respectively rather than the inhalation RfDs listed in Table 7.

Formulae/calculations of SSLs (Table 8, 9).

Comment 2.8: We were unable to mathematically confirm the residential surface or subsurface soil screening level for benzene or naphthalene in Table 9 but were able to mathematically confirm the residential value for PAHs. Because the guidance does not present the VF values for these chemicals in any of the other tables, we cannot confirm where the difference lies. Any revisions or updates to the guidance should clearly present all parameters and equations used in the calculation of the Soil Screening Levels.

3.0 Technical Justification for Groundwater Plume Lengths, Indicator Constituents, Concentrations, and Buffer Distances [Separation Distances] to Receptors (Tech. Just.-GPL) (SWQCB Low-Threat UST Closure Policy Task Force, 2011c)

In our review of the Tech. Just.-GPL, we evaluated the following components:

1. Selection of indicator chemicals;
2. Studies cited to support proposed policy;
3. Criteria for defining "low threat groundwater scenarios";
4. Basis of biodegradation rates;
5. Proposals regarding free product;
6. Confirmation that the potential capture zone(s)/wellhead protection area(s) is/are not greater than the "Service Area of Public Water System";
7. The manner in which "plume stability" and "plume extent" are quantified;

8. The manner in which the amount of time required for natural attenuation to attain water quality objectives is determined; and
9. Basis of plume concentration value (*e.g.*, MCL or other value) used to establish plume stability and extent.

Selection of Indicator Chemicals

The indicator chemicals selected for groundwater plume lengths in the Tech. Just.-GPL are benzene, methyl tertiary butyl ether (MTBE), and total petroleum hydrocarbons as gasoline (TPHg). The carbon chain range for TPHg is approximately C_5 through C_{12}. The reasons stated for choosing these three constituents as the indicator chemicals are as follows:

- Benzene: Has the highest toxicity
- MTBE: Typically has longest plume lengths
- TPHg: Represents additional dissolved hydrocarbons that may be present due to a typical petroleum release.

To further support their selection of benzene and MTBE as indicator chemicals, the Tech. Just.-GPL states that benzene and MTBE are used in research studies as key indicator chemicals for the threat (human health risk and nuisance) posed by groundwater plumes from petroleum releases because:

- Benzene has the highest toxicity of the soluble petroleum constituents, and
- MTBE typically has the longest groundwater plume lengths and has a low secondary maximum contaminant level (secondary MCL; taste and odor threshold of 5 micrograms/liter [µg/L]).

<u>Comment 3.1:</u> It is recommended that other carcinogenic constituents of gasoline releases and diesel releases be considered. For leaded gasoline releases, carcinogenic constituents may include 1,2-dichloroethane (1,2-DCA) and ethylene dibromide (EDB). Ethylbenzene should also be considered for both leaded and unleaded gasoline releases. For diesel releases, naphthalene should be considered. Consideration of these additional carcinogenic constituents is consistent with the idea that high toxicity constituents should be used as indicator chemicals for groundwater plume length. The primary MCLs for these constituents are as follows:[1]

- 1,2-DCA 0.5 µg/L (California)
- EDB: 0.05 µg /L (Federal)
- Ethylbenzene: 300 µg /L (California)

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[1] California MCLs taken from http://www.cdph.ca.gov/certlic/drinkingwater/Documents/DWdocuments/EPAandCDPH-11-28-2008.pdf.
Federal MCLs taken from http://water.epa.gov/drink/contaminants/upload/mcl-2.pdf.

- Naphthalene: No California or Federal value[2].

1,2-DCA and EDB both have lower MCLs than benzene (1 µg /L) and MTBE (13 µg /L [primary MCL] and 5 µg /L [secondary MCL]) and, as such, can be considered to be more toxic than these two proposed indicator chemicals. Falta (2004) notes:

> *"EDB has proven to be both mobile and persistent in groundwater, and contamination of ground water by EDB was documented in several states beginning in the early 1980s. The majority of this contamination is attributed to agricultural uses of EDB; however, ~90% of the EDB produced was used as a leaded gasoline additive and it was present in virtually all leaded gasoline sold in the United States. 1,2-DCA is commonly found as a groundwater contaminant, and it is both mobile and persistent. Past investigations and remediation efforts at sites contaminated by leaded gasoline have rarely addressed the potential for EDB or 1,2-DCA contamination. For this reason, there is a substantial likelihood that undetected EDB and 1,2-DCA plumes above the MCL may exist at many sites where leaded gasoline leaked or spilled."*

Comment 3.2: The Tech. Just.-GPL states that the peer-reviewed study by Shih *et al*. (2004) of plume lengths at 500 underground storage tank (UST) sites in the Los Angeles area is widely relied upon as representative of current knowledge of plume lengths at UST sites in California. Based on our review of Shih *et al*. (2004), it is recommended that tertiary butyl alcohol (TBA) be added to the listing of indicator chemicals in the Tech. Just-GPL. Shih *et al*. state because TBA has the greatest site maximum (geometric mean) concentration, "… its presence needs to be confirmed at LUFT sites so that specific cleanup strategies can be developed." The recommendation is further supported by the statement in Shih *et al*. (2004) that, with respect to plume length:

> *"The results demonstrate MTBE to pose the greatest problem, followed by TBA and benzene."*

Studies cited to support proposed policy

As noted above, the Tech. Just.-GPL states that the peer-reviewed study by Shih *et al*. (2004) is widely relied upon as representative of current knowledge of plume lengths at UST sites in California.

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[2] Florida has set an MCL for naphthalene at 100 µg/L (http://www.doh.state.fl.us/environment/community/health-advisory/HAL_list.pdf).

Comment 3.3: This study was published in the well-respected American Chemical Society (ACS) journal Environmental Science & Technology (ES&T). As noted above in Comment 3.1, it is recommended that Falta (2004) be considered when developing the final policy.

Criteria (i.e., metrics on which these scenarios are based and the stated values, including plume lengths, concentrations, distances to wells/surface water bodies) for defining "low threat groundwater scenarios"

The criteria for defining low threat groundwater scenarios include plume lengths, concentrations, distances to wells, distances to surface water bodies, and the presence or (absence) and mitigation of free product.

Comment 3.4: Regarding criteria for defining low threat groundwater scenarios, a detailed discussion is provided in Comment 3.12.

Basis of biodegradation rates

The draft policy does not refer to specific biodegradation rates. Biodegradation is recognized in the draft policy as an attenuation process that limits migration of indicator chemicals (*i.e.*, plume lengths).

Comment 3.5: See Comment 3.10 for comments regarding plume lengths.

Comment 3.6: It is recommended that the paragraph regarding silica gel cleanup be revised. The rationale for the recommendation is provided below and followed by a revised, recommended version of the paragraph associated with SGC.

The rationale for our recommended revision is as follows:

- EPA method 8015 is a non-specific method. The detector being used, a flame ionization detector (FID), cannot differentiate one hydrocarbon from another. The draft policy implies that this method can differentiate between polar and nonpolar hydrocarbons if SGC is used. This is not the case. The 8015 cannot differentiate between any compound whether it is cleaned up or not. The use of a Mass Spectrometer type method (such as EPA 8260 or 8270) will differentiate between different hydrocarbon types and should be used for this purpose.
- All compounds that contain carbon and hydrogen in their structures are hydrocarbons. The draft policy implies that polar hydrocarbons are not hydrocarbons at all, which is clearly not the case.
- Polar hydrocarbons have higher water solubilities than non-polar hydrocarbons of the same carbon number. The original statement implies that polar hydrocarbons are not dissolved hydrocarbons. This is not true.
- SGC will remove many dissolved phase hydrocarbons but they remove the polar hydrocarbons not the nonpolar compounds.

It is suggested that the SGC paragraph be rewritten as follows:

> *“For groundwater samples analyzed for TPHd for comparison to Water Quality Objectives (WQOs), a silica gel cleanup (SGC) should be included for the following reasons: it is well known that the TPHd analysis by EPA method 8015 is used to identify and quantitate different classes of hydrocarbon mixtures. Weathered TPHd can include polar as well as non-polar hydrocarbons. SGC cleanup is used in conjunction with the 8015 method to remove polar hydrocarbons from the mixture. The 8015 method is a non-selective method and cannot identify individual hydrocarbon compounds to determine whether they are polar or nopolar hydrocarbons. EPA method 8270 should be used for this purpose. In addition to the non-polar hydrocarbons present in TPHd in a water sample, various other polar hydrocarbons sources can be present (e.g. Zemo and Foote 2003). These polar hydrocarbons can be present in TPHd as the result of metabolites from biodegradation of petroleum (primarily organic alcohols and acids, with possibility of phenols, aldehydes and ketones). At sites with biodegrading petroleum hydrocarbons, the majority of the organics being measured in groundwater samples as “TPHd” without SGC can be polar hydrocarbons. The polar hydrocarbons will tend to have higher solubility (dissolved phase) in ground water samples and will dominate. WQOs for diesel range petroleum hydrocarbons for health risk or taste and odor concerns are based on the properties of dissolved non-polar hydrocarbons originally present in the refined fuel and not the polar hydrocarbons present due to oxidative biodegradation. For example, the health-based ESL for TPHd is based on the assumption that 100% of the TPH has a toxicity equivalent to the C11 to C22 aromatics, and the taste and odor value for TPHd is based on the dissolved phase of fresh diesel/kerosene (which would be primarily the C14 and smaller aromatics) (SFRWQCB 2008). The San Francisco Bay RWQCB recognized that reported TPHd concentrations may include polar compounds and issued a guidance memorandum recommending that SGC be routinely used so that “…decisions could be made based on analytical data that represents dissolved petroleum.” (SFRWQCB 1999). Only the nonpolar hydrocarbon component of TPHd should be compared to the TPHd WQOs, and thus SGC is necessary to separate the nonpolar hydrocarbons from the polar hydrocarbons in a groundwater sample prior to analysis. It has been well established that a*

> *properly performed SGC cleanup will not remove non-polar hydrocarbons from the sample. (e.g. Lundegard and Sweeney 2004). Further, the removal of polar hydrocarbons by SGC cleanup is always monitored by certified laboratories as part of routine laboratory quality assurance reporting. All approved EPA Gas Chromatography methods used for TPHd analyses utilize a hydrocarbon surrogate standard that is spiked into every sample prior to extraction and cleanup procedures (such as SGC). This surrogate standard concentration is measured during the analysis of TPHd with recoveries of these surrogates required to be maintained within acceptable ranges."*

Proposals regarding free product

Comment 3.7: The free product criteria/conditions for defining low threat groundwater scenarios requires further definition. An additional discussion of free product is provided in Comment 3.14.

Confirmation that the potential capture zone(s)/wellhead protection area(s) is/are not greater than the "Service Area of Public Water System"

The policy refers to "Service Area of Public Water System" and states that the draft policy is protective of water supply wells. Specifically, the draft policy states:

> *"This policy is protective of existing water supply wells. New water supply wells are unlikely to be installed in the shallow groundwater near former UST release sites. However, it is difficult to predict, on a statewide basis, where new wells will be installed, particularly in rural areas that are undergoing new development. This policy is limited to areas with available public drinking water supplies to reduce the likelihood that new wells in developing areas will be inadvertently impacted by residual petroleum in groundwater. Case closure outside of areas with a public water supply should be evaluated based upon this policy and a site specific evaluation of developing water supplies in the area."*

Comment 3.8: It is unclear whether "service area of public water system" is synonymous with "wellhead protection area" (WHPA). It is recommended that the policy provide a definition of "service area of public water system" and, if not synonymous with WHPA, it is recommended that "service area of public water system" be combined with the concept of "wellhead protection area" (WHPA) in the policy. This will minimize or eliminate the potential that the area considered in a case submitted for closure under the proposed policy is underestimated.

The federal Safe Drinking Water Act (SDWA), as amended in 1986 (USEPA, 1991), established a program for the States to delineate and manage Wellhead Protection Areas WHPAs for protection of groundwater supplies from contamination. Subsection 1428(e) of the Safe Drinking Water Act Amendments of 1986 identify a WHPA as: "the surface and subsurface area surrounding a well or well field, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or well field." According to the USEPA, the use of WHPAs has been implemented in several states, including all six New England states.[3] A preliminary websearch showed WHPA guidance is available on-line for Wisconsin[4], New Jersey[5], Minnesota[6], Massachusetts[7], Michigan[8], Indiana[9], Florida[10], Wyoming[11], New Hampshire[12], Kentucky[13], Washington[14], and likely other states. That is, depending on pumping rate(s), a well/wellfield may capture (pump) contaminated groundwater if the plume/plumes is/are sufficiently close to the pumping well/wellfield.

The manner in which "plume stability" and plume extent" are quantified

One of the criteria listed in the draft policy is that the plume be stable (*i.e.*, concentrations are stable or decreasing within the plume and the plume is not expanding or decreasing in size).

Comment 3.9: See Comment 3.11 and Comment 3.12 for comments regarding methodology to determine plume stability and plume extent. The criteria listed in the draft policy are also provided in Comment 3.13.

The manner in which the amount of time required for natural attenuation to attain water quality objectives is determined

The draft policy states that water quality objectives be attained within a "reasonable time frame".

Comment 3.10: See Comment 3.12 for comments regarding methodology to determine time required for natural attenuation to attain water quality objectives.

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[3] http://www.epa.gov/region1/eco/drinkwater/pc_wellhead_protection.html.
[4] http://dnr.wi.gov/org/water/dwg/gw/pubs/delineation.pdf and http://dnr.wi.gov/org/water/dwg/wellhead.htm.
[5] http://www.state.nj.us/dep/njgs/whpaguide.pdf.
[6] http://www.health.state.mn.us/divs/eh/water/swp/whp/index.htm.
[7] http://www.mass.gov/mgis/ziis.htm.
[8] http://www.michigan.gov/deq/0,1607,7-135-3313_3675_3695---,00.html.
[9] http://www.in.gov/idem/4289.htm.
[10] http://www.dep.state.fl.us/water/groundwater/wellhead.htm.
[11] http://www.wrds.uwyo.edu/wrds/deq/whp/whpsect2.html.
[12] http://des.nh.gov/organization/commissioner/pip/factsheets/dwgb/documents/dwgb-12-2.pdf.
[13] http://water.ky.gov/groundwater/Pages/WellheadProtection.aspx.
[14] http://www.doh.wa.gov/ehp/dw/Publications/331-106_2-28-06.pdf.

Basis of plume concentration value (e.g., MCL or other value) used to establish plume stability and extent.

Comment 3.11: It is recommended that the final guidance specify which concentration value is to be used to establish plume stability and extent. For example, in the case of MTBE, it is unclear if the plume extent is to be based on the secondary (more stringent) MCL of 5 µg/L or 1000 µg /L.

This section provides comments to excerpts from the Tech. Just.-GPL. The excerpts are shown in italics and are followed by our comments.

Excerpt 1

> *Resolution No. 92-49 does not require that the requisite level of water quality be met at the time of case closure; it specifies compliance with cleanup goals and objectives within a reasonable time frame.*
>
> *"Water quality control plans (Basin Plans) generally establish "background" water quality as a restorative endpoint. This policy recognizes the regulatory authority of the Basin Plans but underscores the flexibility contained in Resolution 92-49."*
>
> *"It is a fundamental tenet of this low-threat closure policy that if the closure criteria described in this policy are satisfied at a release site, water quality objectives will be attained through natural attenuation within a reasonable time, prior to the need for use of any affected groundwater. If groundwater with a designated beneficial use is affected by an unauthorized release, to satisfy the media-specific criteria for groundwater, the contaminant plume that exceeds water quality objectives must be stable or decreasing in areal extent, and meet all of the additional characteristics of one of the five classes of sites listed below. A plume that is "stable or decreasing" is a contaminant mass that has expanded to its maximum extent: the distance from the release where attenuation exceeds migration."*

Comment 3.12: It is recommended that the final policy define "reasonable time frame" or provide guidance as to how it is to be established.

Comment 3.13: It is recommended that the final policy provide guidance regarding the methodology: (a) for establishing whether a plume has "expanded to its maximum extent", (b) how one is to establish whether a contaminant plume is "stable or decreasing in areal extent" and (c) for establishing "where attenuation exceeds migration".

Excerpt 2
This excerpt presents the six groundwater plume cases considered by the draft policy. The first five cases involve sites where groundwater has been impacted. The last (sixth) case involves sites where groundwater has not been impacted.

> ***(1)*** *a. The contaminant plume that exceeds water quality objectives is less than 100 feet in length.*
>
> *b. There is no free product.*
>
> *c. The nearest existing water supply well and/or surface water body is greater than 250 feet from the defined plume boundary.*
>
> ***(2)*** *a. The contaminant plume that exceeds water quality objectives is less than 250 feet in length.*
>
> *b. The nearest existing water supply well and /or surface water body is greater than 1000 feet from the defined plume boundary.*
>
> *c. The dissolved concentration of benzene is less than 3000 μg/L and the dissolved concentration of MTBE is less than 1000 μg/L.*
>
> ***(3)*** *a. The contaminant plume that exceeds water quality objectives is less than 250 feet in length.*
>
> *b. Free product may be present below the site but does not extend off-site.*
>
> *c. The plume has been stable or decreasing for a minimum of five years.*
>
> *d. The nearest existing water supply well and/or surface water body is greater than 1000 feet from the defined plume boundary.*
>
> *e. The property owner is willing to accept a deed restriction if the regulatory agency requires a deed restriction as a condition of closure.*
>
> ***(4)*** *a. The contaminant plume that exceeds water quality objectives is less than 1000 feet in length.*
>
> *b. The nearest existing water supply well and/or surface water body is greater than 1000 feet from the defined plume boundary.*
>
> *c. The dissolved concentration of benzene is less than 1000 μg/L and the dissolved concentration of MTBE is less than 1000 μg/L.*

> ***(5)*** *a. An analysis of site specific conditions determines that the site under current and reasonably anticipated near-term future scenarios poses a low threat to human health and safety and to the environment and water quality objectives will be achieved within a reasonable time frame.*
>
> ***(6)*** *Sites with Releases That Have Not Affected Groundwater - Sites with soil that does not contain sufficient mobile constituents (leachate, vapors, or LNAPL) to cause groundwater to exceed the groundwater criteria in this policy shall be considered low-threat sites for the groundwater medium. Provided the general criteria and criteria for other media are also met, those sites are eligible for case closure. For older releases, the absence of current groundwater impact is often a good indication that residual concentrations present in the soil are not a source for groundwater pollution.*

Comment 3.14: Regarding Case 1: It is recommended that the phrase "there is no free product present" be removed and "General Criteria – Item d" should read "there is no free product present or free product has been removed to the extent practical".[15]

Comment 3.15: Regarding Case 2: A benzene plume at 1000 µg/L and 250 feet in length is highly unusual when considered in light of Shih *et al*. (2004) and, as such, should require additional characterization at a minimum and likely remediation. It is recommended that such a plume not be considered for closure as set forth in the final policy.

Comment 3.16: Regarding Case 4: A benzene plume at 1000 µg /L and 1000 feet in length is highly unusual when considered in light of Shih *et al*. (2004) and, as such, should require additional characterization at a minimum and likely, remediation. It is recommended that such a plume not be considered for closure as set forth in the final policy. Also, it is not clear whether free product is permissible in this case.

Comment 3.17: Regarding Case 5: Under current guidance, human health risk assessment guidance requires that future scenarios consider exposure 30 years and 25 years into the future for residential and commercial/industrial exposure scenarios, respectively. It is therefore recommended that the final policy define the time frame associated with "reasonably anticipated near-term future scenarios".

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[15] The "General Criteria" set forth in the draft policy are: *(a) The unauthorized release is located within the service area of a public water system; (b) The unauthorized release consists only of petroleum; (c) The unauthorized ("primary") release from the UST system has been stopped; (d) Free product has been removed to the maximum extent practicable; (e) A conceptual site model has been developed; (f) Secondary source removal has been addressed and (g) Soil or groundwater has been tested for MTBE and results reported in accordance with Health and Safety Code section 25296.15.*

Comment 3.18: The SWRCB has developed this draft policy in an attempt to inject reason into the manner in which sites are characterized, remediated, and closed. Case 5 and Case 6 capture the essence of what the draft policy is attempting to promulgate. However, the other four cases are unnecessary and presenting them confuses the characterization/remediation/closure process.

4.0 Technical Justification for Low Threat Closure Scenarios for Petroleum Vapor Intrusion Pathway (Tech. Just.-PVIP) (SWRCB Low-Threat UST Closure Policy Task Force, 2011d)

The draft policy for the petroleum vapor intrusion pathway addresses four contaminant source scenarios as follows:

- Scenario 1: Unweathered LNAPL on groundwater overlain by a minimum 30-foot-thick unsaturated soil “bioattenuation zone”[16] containing less than 100 milligrams per kilogram (mg/kg) of total petroleum hydrocarbons (TPH)[17];
- Scenario 2: Unweathered LNAPL in unsaturated zone soil at least 30 feet away from building foundation and containing less than 100 mg/kg TPH;
- Scenario 3: Dissolved phase benzene concentrations in groundwater overlain by a 5- or 10-foot thick unsaturated soil bioattenuation zone (depending on benzene and oxygen concentrations) containing less than 100 mg/kg of TPH; and
- Scenario 4: Direct measurement of soil gas concentrations at 5 feet below the building slab (for existing buildings) or below ground surface (for future buildings).

Petroleum release sites shall satisfy the criteria for petroleum vapor intrusion to indoor air and be considered low-threat for the vapor intrusion-to-indoor-air pathway if:

a. Site-specific conditions at the release site satisfy all of the characteristics and screening criteria of Scenarios 1 through 3 as applicable, *or* all of the characteristics and screening criteria of Scenario 4 as applicable; or

A site-specific risk assessment for the vapor intrusion pathway is conducted and demonstrates that human health is protected to the satisfaction of the regulatory agency.

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[16] The bioattenuation zone for this scenario refers to the vertical distance between the LNAPL source and the building foundation.

[17] TPH, as used in the draft vapor intrusion policy for all scenarios, represents the sum of TPH as gasoline (TPHg) and TPH as diesel (TPHd).

Selection of indicator chemicals (for model parameters and for risk characterization)

The indicator chemicals and media of concern selected for the vapor intrusion pathway are as follows:

- Scenario 1: TPH (combined TPHg and TPHd) and LNAPL on groundwater
- Scenario 2: TPH (combined TPHg and TPHd) and LNAPL in soil
- Scenario 3: Soil oxygen content (optional), TPH in soil, and benzene in groundwater
- Scenario 4: Soil oxygen content (optional), benzene and naphthalene in soil gas.

<u>Comment 4.1:</u> It is recommended that other carcinogenic constituents of gasoline releases and diesel releases be considered in a site-specific manner. For leaded gasoline releases, carcinogenic constituents may include 1,2-dichloroethane (1,2-DCA) and ethylene dibromide (EDB). Ethylbenzene should also be considered for both leaded and unleaded gasoline releases. For diesel releases, naphthalene should be considered for Scenarios 1 through 3, in addition to Scenario 4. Consideration of these additional carcinogenic constituents is consistent with the idea that high toxicity constituents should be used as indicator chemicals for the vapor intrusion pathway.

1,2-DCA and EDB both have lower MCLs than benzene (1 µg/L) and MTBE (13 µg/L [primary MCL] and 5 µg/L [secondary MCL]) and, as such, can be considered to be more toxic than these two proposed indicator chemicals. Falta (2004) notes:

> *"EDB has proven to be both mobile and persistent in groundwater, and contamination of ground water by EDB was documented in several states beginning in the early 1980s. The majority of this contamination is attributed to agricultural uses of EDB; however, ~90% of the EDB produced was used as a leaded gasoline additive and it was present in virtually all leaded gasoline sold in the United States. 1,2-DCA is commonly found as a groundwater contaminant, and it is both mobile and persistent. Past investigations and remediation efforts at sites contaminated by leaded gasoline have rarely addressed the potential for EDB or 1,2-DCA contamination. For this reason, there is a substantial likelihood that undetected EDB and 1,2-DCA plumes above the MCL may exist at many sites where leaded gasoline leaked or spilled."*

Consistency with current USEPA and CalEPA guidance

The indicator chemicals and media of concern selected for the vapor intrusion pathway are as follows:

- Scenario 1: TPH (combined TPHg and TPHd) and LNAPL on groundwater

- Scenario 2: TPH (combined TPHg and TPHd) and LNAPL in soil
- Scenario 3: Soil oxygen content (optional), TPH in soil, and benzene in groundwater
- Scenario 4: Soil oxygen content (optional), benzene and naphthalene in soil gas.

Comment 4.2: With the exception of Scenario 4, the media of concern are inconsistent with CalEPA guidance (CalEPA, 2005a), which states:

> *"Soil gas data should be used to evaluate vapor intrusion to indoor air. Soil gas data are recommended over other data, such as soil matrix and groundwater data, because soil gas data represent a direct measurement of the contaminant that will migrate into indoor air. In order to evaluate vapor intrusion, soil matrix and groundwater data must be converted to vapor concentrations using assumptions about the partitioning of the contaminant into the gas phase. While partitioning equations are readily available, using them increases the uncertainty in evaluating vapor intrusion. DTSC views this increased uncertainty as unacceptable in any indoor air evaluation. Hence, soil gas is the preferred contaminant data to use for calculating the risk from the vapor intrusion pathway. This preference for soil gas data to evaluate vapor intrusion is shared by USEPA (2002) and Johnson and Deize-Abreu (2003). In addition, it may be necessary to collect soil gas samples at two distinct time intervals to compensate for the effects of weather events, such as recent rainfall or barometric fluctuations. Ideally, for sites subject to vapor intrusion, permanent vadose monitoring points for sample collection should be installed to evaluate the long-term behavior of contaminated soil gas."*

Comment 4.3: With the exception of Scenario 4, the media of concern are inconsistent with CalEPA guidance (CalEPA, 2005b), which exclusively lists soil gas (and indoor air) risk-based concentrations for the vapor intrusion pathway for volatile organic compounds (VOCs) (*e.g.*, benzene). That is, this guidance does not list risk-based soil or groundwater concentrations for VOCs.

Comment 4.4: The draft policy is inconsistent with USEPA guidance (USEPA, 1989) and CalEPA guidance (CalEPA, 2005a) in that all detected compounds (*i.e.*, as opposed to only TPH and LNAPL in soil and groundwater, only benzene in groundwater, or only benzene and naphthalene in soil gas) should be considered when evaluating the risk associated with a given site.

Basis and use of "Rules of Thumb" (e.g., presence of LNAPL; weathered versus unweathered)

The draft policy sets forth "rules of thumb" regarding the presence and nature of LNAPL. Characterizing LNAPL is necessary for Scenarios 1 and 2.

Direct evidence for the presence of LNAPL as listed in the draft policy are:

- "sites with current or historical evidence of LNAPL in soil or LNAPL at the water table as evidenced in wells"

Indirect evidence for the presence of LNAPL as listed in the draft policy are:

- "chemicals of concern (COCs) approaching (> 0.2) effective solubilities (Bruce et al., 1991) in groundwater (*e.g.*, benzene > 3 mg/L; total benzene, toluene, ethylbenzene and xylenes (BTEX) > 20 mg/L; TPH diesel range organics (DRO) > 5 mg/L) and in soil (TPH gasoline range organics (GRO) > 100 - 200 mg/kg; TPH DRO > 10 - 50 mg/kg) (see ASTM, 2006, Alaska DEC, 2011)"
- "TPH vapor readings from a photo-ionization detector (PID) of > 1,000 ppm (recent gasoline release sites), > 100 ppm (recent diesel/historic gasoline release sites), and > 10 ppm (historic diesel sites) (Alaska DEC, 2011)."

To differentiate between weathered and unweathered LNAPL, the draft policy proposes:

- "For groundwater impacted by LNAPL or where groundwater is in proximity to LNAPL, effective solubility is a key indicator for whether the LNAPL is depleted of VOCs. For example, benzene's effective solubility is approximately 18 mg/L, if it constitutes 1% of gasoline. Therefore benzene concentrations < 1 mg/L are reasonable indicators that the LNAPL is weathered (depleted of VOCs)."
- For soil sources, TPH (GRO) < 100 mg/kg is a good indication that there is a small or low concentration (VOC) source.

<u>Comment 4.5:</u> The rules of thumb in the draft policy are consistent with generally accepted practices for identifying the presence and nature of LNAPL.

It should be noted that direct evidence requires the installation of monitoring wells properly screened across the water table to allow LNAPL (if present) to enter the well. Similarly, the first method listed as offering indirect evidence (the effective solubility approach) requires collection and analysis of groundwater samples for BTEX and TPH and/or analysis of soil samples for TPH. Differentiation between weathered and unweathered LNAPL also requires the collection and analysis of groundwater and/or soil samples.

Basis for the "Low-Threat Vapor Intrusion Screening Scenarios"

Aerobic biodegradation of fuel hydrocarbons is the primary factor on which the low threat scenarios are based. The draft policy relies on modeling studies and soil gas data collected at retail, distribution, and manufacturing sites across several states, including California, for evidence that aerobic biodegradation is the primary factor affecting the vapor intrusion pathway. Approximately 16% of the soil-gas data were collected directly below building foundations (*i.e.*, subslab).

Comment 4.6: The reviewer agrees with the idea that aerobic biodegradation can play a significant role in attenuating fuel hydrocarbon vapors under favorable conditions. However, it is recommended that soil gas samples collected from 5 feet and/or in close proximity to the subsurface source be used in conjunction with subslab or, in cases where no slab is present, near-surface (*e.g.*, at a depth of 1 or 2 feet) soil gas samples to establish that attenuation is indeed occurring at a given site. Leak tests and sample collection should be conducted consistent with CalEPA/LARWQCB guidance (CalEPA/LARWQCB, 2003) to ensure that high quality soil gas data are obtained. Use of site-specific soil gas data should significantly reduce uncertainty in comparison to reliance on modeling studies and non-site-specific data and is consistent with CalEPA guidance (CalEPA, 2005a).

Comment 4.7: The data requirements for the four scenarios set forth in the draft policy involve collection and analysis of soil data and/or groundwater data and/or soil gas data and characterization of LNAPL and, as such, appear to be less time- and cost-effective than simply collecting soil gas samples, as is being done under current CalEPA guidance. That is, the data requirements are inconsistent with the stated goal that the draft policy "… seeks to increase UST cleanup process efficiency".

Comment 4.8: The computer model must consider VOC concentrations that may prove toxic to microbes. This should be discussed in the guidance.

Comment 4.9: Assuming first order degradation, the rate constant assumed in the model gives a half-life of about 1 hour, which does seem high. This half-life must consider the presence of other fuel hydrocarbons (FHCs) that may be preferentially degraded over benzene. It is recommended that field-derived degradation rates be used in the model.

Comment 4.10: On page 15 of the draft policy, the reporting limit used to establish "full attenuation" must be specified.

Comment 4.11: Figure 5 on page 18 of the technical justification shows that the model is particularly sensitive to half-life (*e.g.*, a one order-of-magnitude change in rate constant yields a four order-of-magnitude change in attenuation factor). While this reviewer agrees with the idea biodegradation of fuel hydrocarbons (especially benzene) is significant and important to consider, the existence of a bioattenuation zone can be readily determined using 5 foot and subslab vapor probes. Such probes are relatively time- and cost-effective to install, sample, and analyze.

Comment 4.12: Page 21 of the Tech. Just.-PVIP speaks to a soil gas screening level for benzene of 5,000 µg/m^3. It is not clear how this value is related to those presented in Appendix 4 of the proposed LT-UST policy.

Role of subslab soil gas samples (and associated risk-based concentrations)

Comment 4.13: As stated previously, the reviewer agrees with the idea that aerobic biodegradation can play a significant role in attenuating fuel hydrocarbon vapors under favorable conditions. However, it is recommended that soil gas samples collected from 5 feet and/or in close proximity to the subsurface source be used in conjunction with subslab or, in cases where no slab is present, near-surface (*e.g.*, at a depth of 1 or 2 feet) soil gas samples to establish that attenuation is indeed occurring at a given site. Leak tests and sample collection should be conducted consistent with DTSC/LARWQCB guidance (DTSC/LARWCB, 2003) to ensure that high quality soil gas data are obtained. Use of site-specific soil gas data should significantly reduce uncertainty in comparison to reliance on modeling studies and non-site-specific data and is consistent with CalEPA guidance.

Exposure and toxicity inputs

Exposure and toxicity inputs are not presented in the draft policy and should be clearly identified. However, the draft policy indicates that the soil gas values for benzene and naphthalene in soil gas (Scenario 4) are based on the risk-based California Human Health Screening Levels (CHHSLs; CalEPA, 2005b). Specifically, in Appendix 4, it is stated that the values for benzene and naphthalene are the same as the CHHSLs for the case in which there is no bioattenuation zone and 1000-fold higher than the CHHSLs for the case in which there is a bioattenuation zone. The soil gas concentrations (in micrograms per cubic meter [µg/m^3]) listed in the draft policy are as follows:

Analyte	With Bioattenuation Zone		Without Bioattenuation Zone	
	Residential	**Commercial**	**Residential**	**Commercial**
Benzene	<85,000	<280,000	<85	<280
Naphthalene	<93,000	<310,000	<93	<310

Comment 4.14: The CHHSL values, as listed in CalEPA guidance (Table 2 of CalEPA, 2005b) are lower than those assumed in the proposed policy; the proposed policy needs to be internally consistent. If the values from Table 2 of CalEPA, 2005b are used, the above table would read as follows:

Analyte	With Bioattenuation Zone		Without Bioattenuation Zone	
	Residential	**Commercial**	**Residential**	**Commercial**
Benzene	<36,200	<122,000	<36.2	<122
Naphthalene	<31,900	<106,000	<31.9	<106

Basis of the numerical values presented in Appendices 1 through 4

Comment 4.15: As stated previously, the use of site-specific soil gas data should significantly reduce uncertainty in comparison to reliance on modeling studies and non-site-specific data and is consistent with CalEPA guidance.

Review of relevant references cited.

Comment 4.16: The modeling studies on which the draft policy is partially based have been presented in the well-respected American Chemical Society (ACS) journal Environmental Science & Technology (ES&T). However, the computer model should be available in the public domain such that results can be readily confirmed. This reviewer could not find the model on USEPA or CalEPA websites.

Comment 4.17: No URL or hyperlink is provided in the draft policy for the database. It is not clear that the database is available in the public domain.

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