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In reply, please refer to:
File:
178581IV

January 28, 2021

Transmitted via e-mail to: carol.mitsuyasu@idppgroup.org

Ms. Carol Mitsuyasu
lwilei District Participating Parties, LLC Project Coordinator
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Honolulu, HI 96816

Facility/Site: Honolulu Harbor Iwilei District Participating Parties, Site ID 2850

Subject: Re-Evaluation of Methane Matrix

Dear Ms. Mitsuyasu,

The Hawaii Department of Health (HDOH), Hazard Evaluation and Emergency Response (HEER) Office has in the course of the review process of the Environmental Hazard Management Plan (EHMP) for OU1B become aware that the IDPP Methane Matrix proposed in the OU1B EHMP (Attachment 1) is not adequately protective of human health and the environment as had previously been thought Especially not with respect to long-term management at IDPP/Honolulu Harbor sites.

The IDPP Methane Matrix was first proposed for OU1A in 2018 as part of the Refined Methane Evaluation Report and is a modified version of a similar matrix in the ASTM Standard for Methane (ASTM, 2016). At that time, HDOH trusted that the ASTM Methane Matrix was well founded based on thorough research and science. However, new information has become available that casts doubt on the reliability of the methane matrix in terms of human health protectiveness. In particular, HDOH has concerns regarding the 2 inches of water differential pressure threshold used in the matrices that had been deemed protective in the ASTM Standard for Methane in terms of fire/explosions hazards at a methane concentration above the lower explosive limit (LEL) of 5 %.

A more detailed evaluation of the IDPP Methane Matrix and ASTM Methane Standard, its cited sources and additional research by HDOH has revealed that the IDPP Methane Matrix can no longer be supported by HDOH as being protective of human health. Instead, HDOH urges IDPP to follow the methane guidance of the current HEER Office Technical Guidance Manual (TGM) (Section 9.4; Attachment A) and its matrix for all IDPP OUs and affected OU3 parcels encompassed by IDPP's OU2 area as per the Enforceable Agreement (EA) to ensure better protectiveness of site workers/users and construction crews from fire/explosion. The results of our re-evaluation of the methane matrices and reasons for rejecting the IDPP Methane Matrix are outlined below.

<u>Background</u>

Per the Site Assessment and Prioritization Report, the screening level for methane had been determined to be 0.5 percent (%) (10% LEL) or 5,000 ppmv. This levels has been carried through EHEs and Removal Action Report/RAAs/RAMs until the preparation of the Methane Decision Matrix prepared by Geosyntec for OU1A in 2011 that used the 0.5% screening level as well as a lower screening level of 0.1 % methane to account for data uncertainty and variability of site conditions as a safety margin. This decision matrix included, but was not limited to, methane monitoring, conduit seals and utility trench dams at a level of 0.1 to 0.5 % methane beneath structures, and additional vapor mitigation such as a vapor barrier and passive venting under the structure with the possibility to convert to an active venting system at 5 % methane with monitoring, sealing and utility trench dams within a 100 ft radius of a structure. This matrix was adopted by HDOH in 2014 and has since been incorporated into the HEER Office TGM Section 9.4 (Attachment A). The adopted 2014 HDOH Methane Mitigation Decision Matrix was then applied to the IDPP OU1A and OU1B methane investigation.

In 2016 the ASTM Standard E2993-16 “Standard Guide for Evaluating Potential Hazards as a Result of Methane in the Vadose Zone” (ASTM Methane Standard) was published. Based on this standard, IDPP then decided to revise the initial screening level of 0.5 % methane and developed the IDPP Methane Matrix (Attachment B). This matrix was then applied to OU1A, OU1B and OU1C in Refined Methane Evaluation Reports. This new Methane Matrix allows a concentration of methane above the LEL in soil vapor if the differential pressure measured during soil vapor collection was not in exceedances of 2 inches of water. At the time of initial review of the Refined Methane Evaluation Reports, HDOH did not have any further comments as HDOH believed the ASTM Methane Standard was based on sound science. However, based on the proposed use of the IDPP Methane Matrix as part of the Environmental Hazard Management Plan (EHMP) for long-term management after site close-out of OU1B, a detailed review of the applicability of the IDPP Methane Matrix was recently conducted. Below are details regarding HDOH’s review of this matrix.

<u>Sources</u>

The gold standard for distribution and reliability of scientific knowledge is the publication in an independent quality scientific/technical journal using the peer-review process and competent, independent reviewers. While the traditional peer-review process is far from perfect, it is the currently best available tool available to science. Competent, independent peer-reviewers are experts in their field and accountable to the scientific community.

Scientific facts are usually either demonstrated by providing data, data figures, or by providing references to reliable scientific publications in quality journals as outlined above.

Methane ASTM Standard

The ASTM Standard is not a technical or scientific journal, but a consensus industry standard, developed and reviewed by volunteers from industry, including manufacturers, consumers, as well as other interest groups such as government or academia. Any interested individual can participate on a technical committee through ASTM membership that can be purchased from ASTM; expertise is not required. Because the ASTM Standard does not meet the “gold standard” of an independent peer-reviewed, high quality scientific/technical publication, HDOH has concerns about the overall reliability and defensibility of the standard, and the standard needs to be carefully evaluated to reach the conclusion that it is protective of human health and the environment.

The ASTM Methane Standard has some good information that can be supported by basic scientific principles, e.g., movement/migration of methane or other gases along a pressure gradient, by diffusion, or advection; re-pressurization of vapors by rising groundwater level; potential accumulation of methane in the subsurface due to tight soils or surface capping by hardscapes; the effect of methane migration pathway change due to additional moisture (plugging, e.g., rain) in soil pores; reversals in soil gas flow direction as a result of diurnal and weather front related barometric pressure changes and associated pressure lag in the subsurface; or traveling of vapors along preferential pathways such as coarse gravel backfill around utility lines. However, all of these, and other parameters that influence methane migration, accumulation, and associated potential explosivity concerns are not reflected in the Methane Matrix of the ASTM Methane standard (or in the IDPP Methane Matrix).

Therefore, the matrix as used by itself is taken out of context and application of this matrix out of context can lead to fatalities and injuries. Further, it is simplified to the point that misapplication can lead to injury and fatalities. For example, the matrix proposes that soil gas concentrations between 5 and 30% methane (which is above the LEL) require no further action unless differential pressures exceed 500 Pa (2 inches of water), while indoor air concentrations above only 1.25% methane (which is below the LEL) require notifications of authorities and recommend owner/operator to evacuate the building.

The footnote to the table states in regard to the 500 Pa differential pressure requirement for action regarding soil gas concentrations that, for gravel or highly permeable matrices, a criterion less than 500Pa “may be appropriate” and that the pressure gradient refers to pressure gradients in the subsurface at a depth or interval of 1.5 m. Not incorporating these restrictions/specifications prominently into the main matrix is a minimization of hazards that could deceive the public/owners/operators into thinking there is no risk of fire/explosion/vapor intrusion when actually one exists (false negative decision error).

Overall, the ASTM Methane Matrix strictly applies to vapor intrusion into buildings; construction worker safety or risk posed by interaction of methane vapors with utilities is not included. This is despite the fact that utilities are normally located in the subsurface and under the building slab. By tying explosion concerns to vapor intrusion only, the standard omits an important part of explosivity concerns and necessary hazard management.

Notably, the Methane ASTM Standard does not mention in the section on Flammability of Methane that a minimum pressure is required for flammability to occur. It does state, however, that flammability can occur at 1 atm pressure in the presence of sufficient oxygen. This is in stark contrast to what is suggested by the methane matrix in the same standard. The standard also claims that methane within the void of a soil matrix is not flammable and cites a maximum safe experimental gap (MSEG) distance determined by tests for measuring flame propagation through cracks or gaps of 1.14 millimeters (mm) as a reason. 1.14 mm is not a very large gap, and a such sized gap can easily be exceeded in gravel beds surrounding utilities, voids, or underneath a building slab.

The ASTM Methane Standard ties the potential for significant rates of soil gas transport to relatively high differential pressure (e.g., > 500 Pa[2 inches of water]) and references the source of the 500 Pa differential pressure minimum threshold as two other references: Eklund, 2011 and Sepich, 2008; an explanation of how this minimum threshold differential pressure is derived is not provided in the ASTM Methane standard.

Eklund, 2011 Reference

The Article "Proposed Regulatory Framework for Evaluating the Methane Hazard due to Vapor Intrusion" is a Magazine Article in the EM Magazine, published by Air & Waste Management Association. Per Air & Waste Management Association Website, EM is a monthly magazine for environmental managers and explores a range of issues affecting the industry with timely, provocative articles and regular columns written by leaders in the field. The author guidelines describe that the review of the articles is an informal editorial review. Reviewers are encouraged to volunteer for reviews and authors are asked to provide names of potential expert reviewers. The wording of articles must be geared toward an audience of environmental professionals with a wide variety of backgrounds, not just specialists in a specific area. Under Section "References" it is stated that EM is not a peer-reviewed technical publication. Based on the description of the intent and publication guidelines HDOH is not confident that this publication is a reliable source; as it is not a peer-reviewed independent, high quality technical publication (in other words it does not meet the "gold standard" for scientific publications).

The magazine article's title makes it clear that the article targets risk by methane during vapor intrusion into a building and states that the typical soil matrix acts as a flame arrestor where methane cannot explode. It includes the caveat that this does not apply to large voids in soil, where "large" is not defined. It is also explained, that if a sufficient volume of gas enters into an enclosed space, or poorly ventilated area, where an ignition source is present, an explosion can occur. The author differentiates methane from other volatile organic compound (VOCs) in the sense that VOCs masses in general decrease with time, whereas methane gas production can start whenever conditions are conducive. HDOH can in general support these statements that are based on basic scientific principles and they are important to point out.

On the other hand, other statements in the article, are not supported by any references or data, which makes them unsupported claims with potentially dangerous consequences. For example, a table with emission fluxes of methane is provided and it is stated that a " a huge amount of literatures is available where the emission flux of methane has been measured for various types of soils or other sources" – yet no literature reference is provided, and it is unknown in what context the data presented in the table was collected and what methods were used during data collection. In the section about differential pressure it is stated that "a screening value of 2 in. H_2O has been proposed. Pressures below this screening value are considered to be negligible and pressures above this screening value require further consideration". It is not shown or explained how the 2 in of differential pressure threshold value is derived, but Sepich, 2008, the same conference presentation referenced in the ASTM Methane standard, is provided as a reference.

The 2 in. H_2O of differential pressure threshold that is also shown in a matrix in the article, is explained to be "a rule-of-thumb". It is further stated that "at methane concentrations of 40% and above, biogas likely is being generated at a sufficient high rate to completely replace other gases from the soil. Below this level, the gas production rate is likely too small to displace other gases from the soil pore spaces". Again, no evidence, explanation, or supporting literature or data is provided for this statement, so it excludes any potential for validation. 30% methane is used as another, but suggested conservative "rule-of-thumb". On the other hand, it is stated that if a large reservoir of methane exists in the soil gas near a building, it may pose a potential hazard, even if there is no on-going gas production or elevated differential pressure. It is neither explained what is meant by "large reservoir", nor is this woven into the matrix displayed in the article. The matrix is deceptively simple and does not reflect the ambiguity in the "rules-of-thumbs" of the values displayed in the matrix, nor that there is a risk despite the lack of elevated differential pressure or ongoing gas-production. However, the author explains towards the end of the article that the methane matrix has some important caveats.

1) The methane matrix "cannot completely replace the typical case-by-case evaluation that considers all available information (e.g., soil gas oxygen levels) and is intended for informative purposes to illustrate the general thought process proposed for use in VI evaluations".

2) The methane matrix assumes a slab-on-grade construction and that there is some form of ventilation.

3) The methane matrix is not applicable to small, unventilated spaces in the subsurface, such as utility vaults, which are more prone to VI issues.

However, this is offset again at the end of the article where the author states that "the decision matrix can be used to "screen out" sites with minimal potential hazard."

Sepich 2008 Reference

This "publication" is a conference paper from a presentation at a conference that does not rise to the status of an independent, high quality, peer-reviewed scientific journal article. Therefore, it is not considered as a "gold standard" of scientific publication.

Five of 18 references in the article are based on personal communications, two are from books, one is a conference article, five are from ordinances or guidance documents and a code of federal regulation, one is an ASTM standard, one is a inaccessible NY Times article, two are from a MTRANS model/report prepared by an engineering service company that could not be accessed or verified, and one is a power point presentation. The article does not provide any supporting data tables or data figures. Therefore, the scientific basis of this article is highly questionable.

There are several bold, but unsubstantiated, and potentially dangerous, rules (claims), in this article such as "In evaluating explosion hazard in building space, there is no inherently unsafe methane soil gas concentration".

The author proposes that soil gas action levels can be set 2-3 orders of magnitude higher than indoor air action levels without providing any site circumstances such as depth of the source to building, presence of oxygen in the subsurface or the presence or absence of preferential pathways, except that he excepts re-pressurization conditions.

These order of magnitude differences were derived from the Johnson & Ettinger Model which is based on diffusive transport and the MTRANS model developed from a site in San Diego. Specific circumstances of construction, geological conditions etc. were not described. The effects of methane ebullition from groundwater are also not discussed.

What was described in this article was that "observed pressures during the MTRANS study were not more than 2 inches of water, attributed to common barometric lag and minor source overpressure." Common background does not prove that 2 inches of water differential pressure is protective at methane concentration exceeding the LEL in all circumstances of methane vapor intrusion. It may have been applicable under the specific site-specific circumstances and building configurations, but no supporting data was provided to be able to evaluate the correctness, methods, and conditions of the study. Therefore, the data can only be described as anecdotal. Further, anecdotal description that explosions during vapor intrusions happened at some locations at high differential vapor pressure does not exclude the opposite, which is that explosions can happen at low differential vapor pressures.

IDPP Methane Matrix

The IDPP Methane Matrix is a modified version of the ASTM Methane Standard, that can lead to potentially harmful consequences.

The footnote to the matrix table in the ASTM Methane Standard stating that for gravel or highly permeable matrices, a criterion less than 500Pa "may be appropriate" and that the pressure gradient refers to pressure gradients in the subsurface at a depth interval of 1.5 m is completely omitted. This could deceive the public/owners/operators into thinking there is no hazard of fire/explosion when actually one exists (false negative decision error), which can lead to serious injury or fatalities.

The IDPP Methane Matrix goes one step further than the ASTM Methane Matrix and includes the need for conduit seals and utility trench dams *only* if more than 500 Pa of differential pressure is exceeded in the presence of methane concentrations above the LEL.

Discussion

The proposed 2 inches of water differential pressure threshold for vapor intrusion into buildings is in stark contrast with vapor intrusion testing results conducted by experts in building vapor intrusion testing (Geosyntec Consultants, Inc, 2021), who test for vapor intrusion at 10 to 50 Pa (<0.2 inches of water differential pressures) and detect vapors from vapor intrusion at these pressures in the buildings.

While it is not disputed that gas volume and differential pressures are factors during vapor intrusion, they do not necessarily control explosivity potential, especially not outside of (e.g. during construction) or underneath buildings where utilities are usually located, and vapor intrusion conditions are likely site and building specific given the many factors contributing to methane generation and flow.

The more cautious approach regarding explosivity potential is also reflected in the Los Angeles Methane Code (Ordinance No 175790, Attachment C). While the ordinance recognizes the 2 inches of water differential pressure as a threshold value, minimum sub-slab passive vapor mitigation systems such as perforated piping, gravel blankets, and passive vent risers in addition to impervious membranes are required for methane concentrations as low as 100 ppmv, independent of the differential pressure being above or below 2 inches of water differential pressure. The same is valid for de-watering systems, trench dams, and conduit and cable seal fittings. Differences in requirements based on differential pressures are only visible for active vapor mitigation systems such as mechanical ventilation and alarm and gas detection systems and that only for methane concentrations of less than 1,000 ppm (0.1 % methane). HDOH follows a similar, however less detailed, approach in the TGM.

The volume, concentration, and pressure differential can change in a dynamic environment and according to surface expression and the 2 inches of water differential pressure appears to be arbitrary set as a rule of thumb based on background barometric pressure variations and associated pressure differentials. Data collection needs to be interpreted in this context to account for potential future extrapolation of hazards.

For instance, Oertel et al. (2016) showed that many parameters, including, but not limited to, land cover, vegetation, temperature, nutrient availability and temperature and humidity all are key drivers of greenhouse gas emissions from soils with humidity being likely the single most important parameter for soil gas emission as a driver of microbial activities. This is supported by large emission fluxes of methane from wetlands. Experimental flooding experiments on meadow samples have also shown that methane rates are increased post flooding (King and Henry, 2019).

Continuous monitoring studies have shown that methane concentrations and fluxes can rapidly rise in response to sudden barometric pressure changes and associated pressure lag in the subsurface on the order of days, to hours or minutes (e.g., Xu, L. et al., 2014, Kram et al., 2013). Barometric pressure drops of 1 to 2 mbar (0.4-0.8 inches of H_2O pressure) were shown to result in methane concentration changes from 0 up to 100% methane.

Groundwater measurements at an active fuel terminal in Honolulu Harbor show rapid increases in methane concentrations within a few years- either as a response of discontinued product recovery, installation of a liner on the surface, rising sea-water level, or all of those factors combined (Attachment D), and there are known high methane vapor concentrations at the same fuel terminal.

If methane is accumulating in a stagnant atmosphere, the gas can stratify in relation to other gases according their relative specific gravities, and changes in water level can cause a reduction in hydrostatic pressure, allowing methane to come out of solution and transferring into the gas stage (DOE, 2001).

What Causes Explosions?

What causes explosions? And is a confined space or a certain pressure needed for explosions to occur? A very detailed study by Oran et al. (2020) was conducted to find out about the conditions for explosions to occur. They note that if mixtures are sufficiently reactive, detonations can occur even in the absence of confinement. One of the defining variables is the presence of turbulence. A small laminar flame can under the right circumstance develop into a turbulent flame which then can evolve into a detonation due to the presence of congestion, confinement, and shock waves. Even on small scales, shock waves can accelerate flames and lead to a transition of explosions and re-ignition.

Ignition experiments in a channel containing a flammable mixture show that a small flame sparked by ignition evolves into a flame that accelerates, creates higher temperatures and pressures, and becomes turbulent. Depending on the system geometry, the turbulent flame system can transition to a detonation via detonation waves through shock reflection or shock focusing that create overpressure -all within seconds. If the system is confined, the overpressure is higher because of reflection of detonation waves. However, even some degree of congestion or obstruction can lead to overpressures and detonation, but waves can dissipate faster, so the explosion might not quite be as violent, though not harmless. No congestion is necessary to sustain detonation propagation through a flammable mixture.

According to a detailed summary by Zabetakis et al. (1965), methane combustion does not need elevated pressure. These can form at atmospheric pressure in the presence of oxygen with the right oxygen/methane proportions and a spark. However, an increase in pressure (or temperature) usually extends the flammable mixture of combustible-oxidant system.

Summary and Conclusion

In summary HDOH rejects the IDPP 2018 Methane Matrix and deems it insufficiently protective, because of the following:

- The sources used for development of the IDPP Methane matrix are of questionable reliability and do not follow the “gold-standard” of a scientific publication. The ASTM Methane Standard and cited resources do not instill any confidence in HDOH that there is no threat to human health and the environment at levels of methane exceeding the LEL below the 2 inch water differential pressure threshold.

- The 10% LEL (0.5%) screening value for methane as initially determined in the Site Prioritization Report is still a good conservative screening level given the potential consequences of a fire/explosion when initial mitigation measures such as monitoring, conduit seals and utility trench dams should be implemented. This is in agreement with the TGM and is especially a valid preventative measure given the dynamic and anticipated changes in site conditions (e.g., sea level rise).

- Explosive risk and vapor intrusion risk are mixed in the IDPP Methane Matrix and need to be separated, explosions can occur at atmospheric pressure in the presence of a spark, and even in unconfined conditions, if enough turbulence is created. The LEL is the definition of lower explosive level at atmospheric pressures. This is not accounted for in the IDPP Methane Matrix.

- Methane (and other vapors) can accumulate under the slab (building or no building) in voids and can interact with utilities and cause explosion no matter what the pressure or main mode of vapor transport is. Voids larger than the MSEG of 1.14 mm necessary for flame propagation for methane can exist in the subsurface (natural or human made, e.g. utility corridors, sewers, storm drains).

- The IDPP and ASTM Methane Matrices are too simplified and taken out of context. Site-specific parameters and dynamics have to be considered. Barometric pressure changes (e.g., due to storms) can change methane concentrations drastically and vapor migration direction can change. Rains and rising water table can plug pores, lead to migrations changes and can lead to increased methane generation by anaerobic microbial activity. Oxidation of methane only occurs if sufficient oxygen is present, oxygen delivery is sustained, and oxidizing bacteria are present. Presence of hardscapes or other surface expressions that limit air intake can limit oxygen supply. Long-term aeration is currently not guaranteed in Honolulu Harbor.

- Vapor intrusion of gases into buildings have occurred at much less differential pressures than 2 inches differential water pressures. Building specifics must be considered.

- The 2 inches of water differential pressure is a rule-of-thumb and the derivation is questionable. The error margin on this value is unknown. It is therefore not considered a reliable threshold value, especially not at methane concentrations exceeding the LEL. A protective conservative threshold value (e.g. 10% LEL) should be used to account for the uncertainties. Relying on the 2 inch differential pressure threshold value as a safety measure for the protection of human health and the environment at methane concentrations exceeding the LEL is a serious concern to HDOH.

- The IDPP Methane Matrix is a modified version of the ASTM Methane Matrix and includes mitigation features that are unrelated to differential pressures dependencies and vapor intrusion into a building (e.g., conduit seals and utility trench dams).

- Nature’s pressures and differential pressures are difficult to control. Mitigation should focus on factors that can be controlled.

- The TGM for implementation for the State Contingency Plan should always be preferred to outside industry standards.

- The consequences of minimizing or underestimating risk are too large (false positive decision error= it was inferred that no risk exists when actually risk exists). These consequences can be serious injuries or fatalities.

If you have any questions regarding the above, feel free to contact me at 808-586-4653 or iris.vanderzander@doh.hawaii.gov.

Sincerely,

Iris van der Zander

Digitally signed by Iris van der Zander
Date: 2021.01.28 19:00:59 -10'00'

Iris van der Zander, Ph.D.
Remedial Project Manager
Hazard Evaluation and Emergency Response Office
Hawaii Department of Health

Attachments: A - TGM for the Implementation of the Hawaii State Contingency Plan, Subsection 9.4, Methane
B – 2018 IDPP Methane Matrix
C – 2004 Los Angeles Ordinance No. 175790
D – Methane Concentration Variations in Groundwater from Neighboring Fuel Terminal

References:

ASTM Standard (2016). ASTM Standard E2993-16 "Standard Guide for Evaluating Potential Hazards as a Result of Methane in the Vadose Zone" (ASTM Methane Standard)

DOE (2001). Technical Measures for the Investigation and Mitigation of Fugitive Methane Hazards in Areas of Coal Mining. U.S. Department of The Interior, Office of Surface Mining Reclamation and Enforcement, Appalachian Regional Coordinating Center, Pittsburg, PA, September 2001.

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Cc: Fenix Grange
Eric Jensen
Kathleen Ho

Attachment A - TGM for the Implementation of the Hawaii State Contingency Plan

9.4 METHANE

Figure 9.1 Methane Mitigation Decision Matrix

Distance to structure	Methane Concentration in Soil Gas			
	<1000 ppm (<0.1%, <2% LEL)	1000 - 5000 ppm (0.1% - 0.5% 2% LEL - 10% LEL)	5000 - 12,500 ppm (0.5% - 1.25% 10% LEL - 25% LEL)	> 12,500 ppm (> 1.25% > 25% LEL)
0 ft (beneath structure)	No Controls Recommended	Methane Monitoring Conduit Seals and Utility Trench Dams	Methane Monitoring Conduit Seals and Utility Trench Dams Vapor Mitigation	Methane Monitoring Conduit Seals and Utility Trench Dams Vapor Mitigation
0 - 100ft	No Controls Recommended	Methane Monitoring	Methane Monitoring Conduit Seals and Utility Trench Dams	Methane Monitoring Conduit Seals and Utility Trench Dams Vapor Mitigation
100 - 300ft	No Controls Recommended	No Controls Recommended	Methane Monitoring	Methane Monitoring Conduit Seals and Utility Trench Dams
>300ft	No Controls Recommended	No Controls Recommended	No Controls Recommended	Methane Monitoring

1. Decision matrix modeled after Geonsyntec 2011.
2. Actions listed in this decision matrix assume soil gas pressure is < 2 in-H2O. If soil gas pressure is greater than 2 in-H2O, then the need for enhanced mitigation measures should be evaluated.
3. This mitigation matrix does not preclude site-specific evaluation of engineering controls. Engineering control requirements can be reduced if additional indoor/sub-slab monitoring is conducted following construction of building or if site conditions are in the more conservative end of the listed criteria (i.e., lower end of methane concentration and upper end of distance criteria). If reduced controls are utilized, a mitigation decision matrix for soil gas and indoor air data should be developed.
4. Methane Monitoring can include testing of exterior soil gas, sub-slab, and/or indoor air. A specific monitoring program should be proposed prior to building construction.

Methane is a colorless, odorless and highly flammable gas generated by the anaerobic biodegradation of organic material, including petroleum. Methane can pose explosion and fire hazards under some conditions. In order for methane to create hazardous conditions, three conditions must be met: 1) A sufficient concentration of methane; 2) A sufficient concentration of oxygen and 3) An ignition source. Potential safety risks should be assessed by considering concentrations of methane and oxygen in soil gas, significance of advective (i.e., under pressure) transport, and potential for methane attenuation between the soil gas and structure or enclosed space.

Advective flow of methane under pressure from a source area is primarily a concern at landfills. This creates a high risk for significant, offsite migration and potential intrusion into the lower floors of buildings or subsurface utility corridors. Methane can be present at high concentrations in vadose-zone soil at petroleum-contaminated sites but is rarely under significant pressure and typically migrates by diffusion rather than advection. While significant offsite migration is less likely, diffusion into subsurface utility corridors could pose localized flash explosion or fire concerns if the methane mixes with oxygenated air and is encountered during subsurface construction or utility work. Accumulation of methane in poorly ventilated rooms of buildings with cracked floors, gaps around utility penetrations in the floor or other vapor entry routes could also pose potential hazards.

Figure 9-1 presents a summary of recommended monitoring and mitigation actions for site where high levels of methane are detected in soil vapors (Geosyntec 2011).

Final monitoring and mitigation actions for potential methane hazards will necessarily be site specific, and depend in part on the estimated area and volume of the source area, planned remedial actions to address the source, the presence and use of existing buildings and the planned use or redevelopment of the site. Coordination with HDOH and submittal of a site-specific workplan for review is recommended. Additional methane guidance can be found in the following document: Advisory on Methane Assessment and Common Remedies at Schools Sites (CalEPA 2005b).

Be aware that high levels of light-end (C5-C12), petroleum vapors can cause false, elevated readings of methane in vapor samples using a standard, landfill gas analyzer. The use of a carbon trap is recommended when evaluating for methane when using field instruments at sites where high levels of petroleum may be present in soil gas. A carbon trap will remove the majority of petroleum aliphatic and aromatic compounds from the soil gas and allow for a more accurate reading of methane.

Attachment B – 2018 IDPP Methane Matrix

FIGURE D–1

2018 IDPP OU1B METHANE MITIGATION DECISION MATRIX FOR PROPOSED NEW BUILDINGS[5]

TIER 1 Site Evaluation

Desk Top Review
Existing Site Data
Conceptual Site Model (CSM)

Need More Data? — NO → RANK SITE HAZARD; YES → Tier 2

TIER 2 Refined Site Evaluation

Additional Site Data (e.g.)
- Speciation (e.g. methane carbon dioxide, nitrogen, etc.)
- Pressure
- Additional Locations
- Temporal Variability
- Emissions & Flux

Update CSM

Need More Data? — NO → RANK SITE HAZARD; YES → Tier 3

TIER 3 Special Case Evaluation

Further Investigation Needed
- Biogas Generation
- Preferential Pathways
- Existing Data Not Recent (past 2 to 5 Years) and/or Not Within Proposed Building Footprint

Migration Modeling

Customized Approach — NO → RANK SITE HAZARD; YES → Alternative Customized Mitigation Measures

RANK SITE HAZARD

PRESCRIPTIVE MITIGATION MEASURES[1]

This table provides minimum requirements. If desired, more robust systems can be selected.

Methane Pressure (inches of water) / Distance to Methane Detections	Methane Concentration in Soil Gas: > 1.25% to 5% (> 12,500 parts per million by volume [ppm-v] to 50,000 ppm-v)	> 5% to 30% (> 50,000 ppm-v to 300,000 ppm-v)	> 30% (> 300,000 ppm-v)
Less than 2 — Detections within a proposed new building footprint	No Controls	Consider Need for Periodic Monitoring[6]	Engineering Controls • Vapor Barrier System • Conduit Seals and Utility Trench Dams; Performance Monitoring[3]
Less than 2 — Detections outside of proposed new building footprint up to 200 feet away[2]	No Controls	No Controls	Engineering Controls[2] • Conduit Seals and Utility Trench Dams; Performance Monitoring[3]
Greater than 2 — Detections within a proposed new building footprint	No Controls	Engineering Controls • Vapor Barrier System • Conduit Seals and Utility Trench Dams; Performance Monitoring[3]	Engineering Controls • Vapor Barrier System • Conduit Seals and Utility Trench Dams; Performance Monitoring[3]
Greater than 2 — Detections outside of proposed new building footprint up to 200 feet away[2]	No Controls	Engineering Controls[2] • Conduit Seals and Utility Trench Dams; Performance Monitoring[3]	Engineering Controls[2] • Conduit Seals and Utility Trench Dams; Performance Monitoring[3]
Greater than 2 — Detections more than 200 feet away from proposed new building footprint	No Controls	No Controls	Consider Need for Periodic Monitoring[6]

ALTERNATIVE CUSTOMIZED MITIGATION MEASURES[4]

Site-specific methane mitigation controls and/or methane source remediation or removal should be established by qualified professionals with experience in such controls.

Notes:

1: Isolated detections of methane that may require engineering controls could alternatively be addressed by soil or soil gas remediation.
2: If methane is present outside of the building footprint but within 200 ft, mitigation decisions should be based on the closest available data point(s) to the building footprint.
3: Performance monitoring – Methods of monitoring the effectiveness of methane controls after building construction, if applicable, would be addressed in the Environmental Hazard Management Plan (EHMP) and/or Long-Term Monitoring Plan (LTMP).
4: Customized approach is applied when prescriptive approach is ***either*** deemed unecessary/unfeasible ***or*** a more robust system than the prescriptive approach is desired.
5: The decision matrix presented above was prepared for undeveloped sites in the Pier 32 area where IDPP has completed additional methane investigation through 2016. This decision matrix would be applied at the OU1B site instead of the April 2014 HDOH Methane Mitigation Decision Matrix, presented as Figure 9.1 in Section 9.4 of the HDOH Technical Guidance Manual.
6: Periodic monitoring – Methods of monitoring potential concerns with methane migration, if applicable, would be addressed in the EHMP and/or LTMP.

Items EXCLUDED from this IDPP matrix include:
- Mitigation requirements for existing buildings; refer to ASTM E2993-16 for additional guidance. https://www.astm.org/Standards/E2993.htm.
- Vapor issues associated with Volatile Organic Compounds (VOCs) or other non-IDPP constituents of concern.
- Construction related to the installation and/or repair of utility corridors/trenches.

Revised 12/19/18

Attachment C – 2004 Los Angeles Ordinance No. 175790

TABLE 71. MINIMUM METHANE MITIGATION REQUIREMENTS.

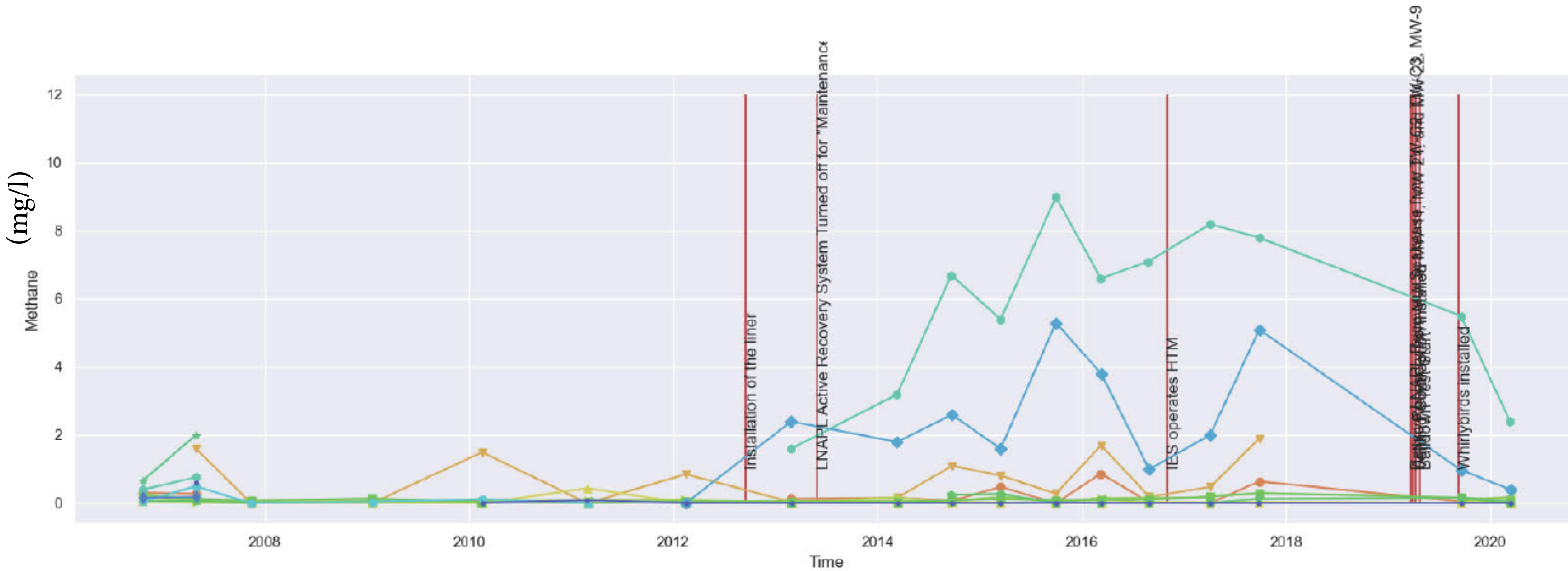
Site Design Level			LEVEL I		LEVEL II		LEVEL III		LEVEL IV		LEVEL V
Design Methane Concentration (ppmv)			0-100		101-1,000		1,001-5,000		5,001-12,500		>12,500
Design Methane Pressure (inches of water pressure)			#2	>2	#2	>2	#2	>2	#2	>2	All Pressures
PASSIVE SYSTEM	De-watering System [1]		X	X	X	X	X	X	X	X	X
PASSIVE SYSTEM	Sub-Slab Vent System	Perforated Horizontal Pipes	X	X	X	X	X	X	X	X	X
PASSIVE SYSTEM	Sub-Slab Vent System	Gravel Blanket Thickness Under Impervious Membrane	2"	2"	2"	3"	2"	3"	2"	4"	4"
PASSIVE SYSTEM	Sub-Slab Vent System	Gravel Thickness Surrounding Perforated Horizontal Pipes	2"	2"	2"	3"	2"	3"	2"	4"	4"
PASSIVE SYSTEM	Sub-Slab Vent System	Vent Risers	X	X	X	X	X	X	X	X	X
PASSIVE SYSTEM	Impervious Membrane		X	X	X	X	X	X	X	X	X
ACTIVE SYSTEM	Sub-Slab System	Pressure Sensors Below Impervious Membrane								X	X
ACTIVE SYSTEM	Sub-Slab System	Mechanical Extraction System [2]								X	X
ACTIVE SYSTEM	Lowest Occupied Space System	Gas Detection System [3]		X		X	X	X	X	X	X
ACTIVE SYSTEM	Lowest Occupied Space System	Mechanical Ventilation [3, 4, 5]		X		X	X	X	X	X	X
ACTIVE SYSTEM	Lowest Occupied Space System	Alarm System		X		X	X	X	X	X	X
ACTIVE SYSTEM	Control Panel			X		X	X	X	X	X	X
MISC. SYSTEM	Trench Dam		X	X	X	X	X	X	X	X	X
MISC. SYSTEM	Conduit or Cable Seal Fitting		X	X	X	X	X	X	X	X	X
MISC. SYSTEM	Additional Vent Risers [6]										X

X = Indicates a Required Mitigation Component

1. See Section 91.7104.3.7 for exception.
2. The Mechanical Extraction System shall be capable of providing an equivalent of a complete change of air every 20 minutes of the total volume of the Gravel Blanket.
3. See Section 91.7104.3.1 for Narrow Buildings.

Attachment D – Methane Concentration Variations in Groundwater from Neighboring Fuel Terminal

Methane Concentration Variations in Groundwater from Neighboring Fuel Terminal in Honolulu Harbor



Lines represent Methane concentrations in groundwater from different wells.