MEMORANDUM

TO: Elise McCaleb
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FROM: Amanda Palumbo, Ph.D.
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Office of Environmental Health Hazard Assessment

DATE: May 21, 2020

SUBJECT: REVIEW OF HUMAN HEALTH RISK ASSESSMENT, 2750 EAST 20TH STREET, SIGNAL HILL, CALIFORNIA 90755, DATED MARCH 26, 2020
OEHHA # 830153-00

Scope of review

OEHHA was requested to review a risk assessment of residential and construction exposures to contaminated soil and contaminants in indoor air from vapor intrusion.

Document reviewed

OEHHA reviewed: *Human Health Risk Assessment*, 2750 East 20th Street, Signal Hill, California 90755 (Report), dated March 26, 2020, prepared by Mearns Consulting LLC (Mearns).

Limitations of the review

An accurate health assessment depends on adequate site characterization. The sampling plan must be adequate to capture all significant contamination and yield representative exposure concentrations. OEHHA defers to the project manager for information on site conditions that could affect exposure estimates and conclusions.

Site description and background

The site is a 0.28-acre property that historically was an oil field. The site has two abandoned oil wells, a single family residence serviced by a septic tank and leach line, and a garage. The site will be redeveloped with construction of three residential villas and surface level parking. No other detail was provided on the development plan in the Report.

The project manager provided additional information: The site in its current configuration is covered with concrete, buildings and concrete rubble with the exception of the 3-foot wide west side yard and 5-foot wide south back yard, and the locations of the borings and soil vapor probes. The site has a precipitous change in elevation along the southern edge, necessitating considerable earth moving in order to bring the site to grade for the planned redevelopment. Therefore, the residents and construction workers will not be exposed to soils at 1-foot below ground surface or shallower, but instead potential exposure will be to chemicals at 5-feet below ground or deeper. The future development of residential villas will have concrete poured over 90 percent of the site (Elise McCaleb, email on May 18, 2020).

Methane mitigation is required by city standards because of the on-site wells. The methane mitigation is designed to capture and vent methane to the atmosphere. It includes a sub-slab impervious membrane and sub-slab vents.

Chemicals of potential concern (COPCs)
COPCs in soil vapor are gasoline range organics, sec-butyl benzene, n-propylbenzene, and tetrachloroethene (PCE). COPCs in soils are petroleum hydrocarbons and inorganics.

Sampling for risk assessment
The sampling described below is the only site characterization data of which OEHHA is aware.

- Soil vapor samples were taken from four locations on February 26, 2020. The depth of the soil vapor samples were 5 and 10 feet below ground surface (bgs) in two locations and 5, 10, and 15 feet bgs in the other two locations.
- Soil samples were taken in the same four locations as the soil vapor samples on February 20, 2020. The depths of the soil samples were the same as the soil vapor samples, except one of the four locations lacked a 10-foot-deep sample.
- The soil samples did not include surface soils (for example the first six inches of soil, see Note 4, DTSC 2019c). Instead, the shallowest samples were at 5 feet bgs. Although, the conceptual site model in the report includes exposure of residents to surface soils, the project manager stated that residents and construction workers would not be exposed to surface soils (see *Site description and background*).

Soil vapor: Screening assessment

For screening sites for vapor intrusion, OEHHA used the maximum measured concentration in soil vapor from any of the three depths (5, 10 and 15 feet bgs), while Mearns performed separate analyses for shallow (5 and 10 feet bgs) and deep soil vapor (15 feet bgs) for residents. Mearns used the maximum from all depths for the trench workers.

Mearns used two attenuation factors: 1) the default future residential attenuation factor of 0.001 from DTSC guidance (DTSC 2011) and 2) the US EPA's recommended empirically-derived default attenuation factor of 0.03 (US EPA, 2015). OEHHA followed the more recent US EPA guidance and used the 0.03 attenuation factor.

OEHHA used the equations from DTSC's Vapor Intrusion guidance (DTSC 2011, Appendix C, page C-3) to calculate risk and hazard estimates from the indoor air concentrations. Values for exposure parameters were taken from DTSC's HERO Note 1 (DTSC 2019a) and toxicity values were from Note 10 (DTSC 2019d). For calculating cancer risks for residents, OEHHA recommends the use of the age sensitivity factor (ASF) to account for potential increased sensitivity to carcinogens during childhood. OEHHA recognizes that US EPA and DTSC apply the ASF only to carcinogens with a known mutagenic mode of action. However, OEHHA does not consider a lack of evidence of mutagenicity to be a solid justification for restricting application of the ASF to other carcinogens (OEHHA 2009).

For the trench scenario, Mearns used the Virginia Unified Risk Assessment Model. OEHHA used the same model, but did not use the default values for air-filled and water-filled porosity, since they are likely based on Virginia soils, which may be quite different from California soils. The Report states that silt and clay were encountered during the investigation, so OEHHA used the values for silty clay form DTSC's 2014 version of the Johnson and Ettinger model for air-filled and water-filled porosity (0.202 and 0.216, respectively), which will provide more conservative estimates.

OEHHA's results are in Table 1. For residents, the cancer risk was just above the *de minimis* risk level (1×10^{-6}), and the hazard index was above the typical threshold of 1. For the trench worker, the cancer risk was well below the *de minimis* risk level (1×10^{-6}) and the hazard index was below the typical threshold.

Table 1. OEHHA's Cancer Risk and Non-cancer Hazard Estimates for Contaminants in Soil Vapor

Chemical	Soil Vapor (µg/m^3)	Construction Cancer Risk	Construction Hazard Quotient	Trench Cancer Risk	Trench Hazard Quotient	Resident Cancer Risk	Resident Hazard Quotient
n-Propylbenzene	98	--	0.00	--	0.00	--	0.00
sec-Butylbenzene	295	--	0.00	--	0.00	--	0.02
Tetrachloroethene	12	1.3E-09	0.00	1.9E-09	0.00	2.2E-06	0.01
Gasoline Range Organics (aliphatic low: C5-C8)	101,000	--	0.10	--	0.43	--	4.84
Sums		**1.3E-09**	**0.11**	**1.9E-09**	**0.44**	**2.2E-06**	**4.88**

Note for Table: Double dash (--) indicates there is no toxicity criteria for cancer for that chemical, and the chemical is unlikely to be a known carcinogen.

Mearns calculated a much higher hazard quotient for the construction scenario than OEHHA. This is due to the use of a different petroleum fraction to represent gasoline range organics. Mearns used total petroleum hydrocarbons (TPH) aromatic low, while OEHHA used TPH *aliphatic* low, which has a lower toxicity. OEHHA did not use the aromatic fraction because the individual constituents of this fraction, such as benzene, ethyl benzene, toluene, xylenes, which have relatively high toxicity, were assessed individually and were all non-detect (as seen in the laboratory data sheets in the appendices of the Report).

On the other hand, Mearns' results for residential exposure were more similar to OEHHA's, because Mearns used a different approach than for construction. Mearns used the San Francisco Bay Regional Water Quality Control Board's Environmental Screening Level (ESL) for gasoline. The basis of the ESL is the aliphatic constituents and the ESL guidance recommends always measuring the aromatic constituents individually.

Soils: Screening assessment

The screening levels used by Mearns in Table 2 of the Report are from the Tier 1 ESLs. Tier 1 levels are the lowest of the levels established to protect human health, terrestrial habitat, leaching to groundwater, and other considerations. For some of the COPCs here, the Tier 1 ESLs are based on terrestrial habitat, and are lower than the levels that are protective of human health. Therefore, the some of the screening levels that are exceeded (e.g., for molybdenum and vanadium) do not necessarily indicate risk to residents or construction workers. The conceptual site model states there are no ecological receptors. On the other hand, the mercury screening level of 13 mg/kg (Table

2 of the Report) is higher than the value in Note 3 for residential soil exposure, which is 1.0 mg/kg.

OEHHA used the maximum concentration of each COPC detected at any depth and location to estimate risk and hazards. Since soil samples were taken from only four locations OEHHA did not combine the data to calculate a 95-percent upper confidence limit on the arithmetic mean (95% UCL) as Mearns did. Mearns used 7 data points to calculate the UCL (combining data from two depths), while guidance recommends a minimum of 8 t o10 data points for calculation of a UCL (US EPA 2015b). Because OEHHA did not use the 95 % UCL, OEHHA's estimates may be higher than Mearns'.

OEHHA used the equations from DTSC's Preliminary Endangerment Assessment Manual (DTSC 2015, Section 2.5) to calculate cumulative risk and hazard for chemicals in soil. Values for exposure parameters were taken from DTSC's HERO Note 1 (DTSC 2019a) and toxicity values were from Note 10 (DTSC 2019d). This was done for all metals detected, except lead.

Arsenic was not detected on site, but the detection limit was about 10 times higher than the screening level. In general, detection limits should not be above screening levels. However, the detection limit for Arsenic was below the level of the typical background level for Southern California, as Mearns concluded. So OEHHA calculated the total risk and hazard without arsenic.

The results are shown in Table 2. The cancer risks for residents and construction workers were under the *de minimis* level. The hazard index was slightly above the typical threshold of 1 for residents and construction workers. The constituents that were primarily contributing to the hazard were mercury and TPH for residents and nickel and cobalt for construction workers.

There were a couple significant differences in Mearns' and OEHHA's calculations. OEHHA's hazard index for mercury in soil was higher than Mearns'. It may be because OEHHA used a volatilization factor of 34,700 m^3/kg. Mearns did not report the volatilization factor used. For cadmium, OEHHA's hazard quotients are lower than Mearns'. Mearns used an incorrect toxicity factor (reference dose) for cadmium of 6.3×10^{-6} mg/kg/day compared to OEHHA, which used 1.0×10^{-3} mg/kg/day from DTSC's Note 10 (DTSC 2019d). This lower reference dose greatly increased the overall hazard index in Mearns' results.

Table 2. OEHHA's Cancer Risk and Non-cancer Hazard Estimates for Contaminants in Soils

Chemical	Soil Concentration (mg/kg)	Construction Cancer Risk	Construction Non-cancer Hazard	Residential Cancer Risk	Resident (Child) Non-cancer Hazard
barium	270	0.0E+0	0.13	0.0E+0	0.02
cadmium	1.9	2.6E-8	0.05	6.2E-9	0.02
chromium 3	21	0.0E+0	0.00	0.0E+0	0.00
cobalt	8.2	2.4E-7	0.40	5.7E-8	0.36
copper	97	0.0E+0	0.01	0.0E+0	0.03
mercury	1.25	0.0E+0	0.30	0.0E+0	1.25
molybdenum	13	0.0E+0	0.01	0.0E+0	0.03
nickel	31	2.6E-8	0.51	6.3E-9	0.04
silver	1.4	0.0E+0	0.00	0.0E+0	0.00
vanadium	31	0.0E+0	0.09	0.0E+0	0.08
zinc	240	0.0E+0	0.00	0.0E+0	0.01
total petroleum hydrocarbons	See Table 3	0.0E+0	0.25	0.0E+0	0.93
Sum		**2.9E-7**	**1.49**	**7.0E-8**	**1.85**

Table 3. Total Petroleum Hydrocarbons (TPH) in Soil: OEHHA's Estimates of Cancer Risk and Non-cancer Hazard*

TPH type	Fraction	Soil Concentration (mg/kg)	Construction Cancer Risk	Construction Non-cancer Hazard	Residential Cancer Risk	Resident (Child) Non-cancer Hazard
Aliphatic	C8	0	0.0E+00	0.00	0.0E+00	0.00
Aliphatic	C8-9	8.5	0.0E+00	0.00	0.0E+00	0.02
Aliphatic	C9-10	9.5	0.0E+00	0.03	0.0E+00	0.10
Aliphatic	C10-11	8	0.0E+00	0.02	0.0E+00	0.09
Aliphatic	C11-12	5.5	0.0E+00	0.01	0.0E+00	0.06
Aliphatic	C12-14	7	0.0E+00	0.02	0.0E+00	0.08
Aliphatic	c14-16	6	0.0E+00	0.02	0.0E+00	0.06
Aliphatic	c16-18	5.5	0.0E+00	0.01	0.0E+00	0.06
Aliphatic	C18-20	6	0.0E+00	0.00	0.0E+00	0.00
Aliphatic	C20-24	10.5	0.0E+00	0.00	0.0E+00	0.00
Aliphatic	C24-28	7	0.0E+00	0.00	0.0E+00	0.00
Aliphatic	C28-32	3.85	0.0E+00	0.00	0.0E+00	0.00
Aliphatic	C32+	2.15	0.0E+00	0.00	0.0E+00	0.00
Aromatic	C8	0	0.0E+00	0.00	0.0E+00	0.00
Aromatic	C8-9	8.5	0.0E+00	0.03	0.0E+00	0.09
Aromatic	C9-10	9.5	0.0E+00	0.03	0.0E+00	0.10
Aromatic	C10-11	8	0.0E+00	0.02	0.0E+00	0.08
Aromatic	C11-12	5.5	0.0E+00	0.02	0.0E+00	0.06
Aromatic	C12-14	7	0.0E+00	0.02	0.0E+00	0.07
Aromatic	C4-16	6	0.0E+00	0.02	0.0E+00	0.06
Aromatic	C16-18	5.5	0.0E+00	0.00	0.0E+00	0.00
Aromatic	C18-20	6	0.0E+00	0.00	0.0E+00	0.00
Aromatic	C20-24	10.5	0.0E+00	0.00	0.0E+00	0.00
Aromatic	C24-28	7	0.0E+00	0.00	0.0E+00	0.00
Aromatic	C28-32	3.85	0.0E+00	0.00	0.0E+00	0.00
Aromatic	C32+	2.15	0.0E+00	0.00	0.0E+00	0.00
	Sums		**0.0E+00**	**0.25**	**0.0E+00**	**0.93**

*The sum from Table 3 is included in Table 2.

Lead in soil

The maximum lead concentration on site was 88 mg/kg at 5 feet bgs. This concentration is just over the residential screening level of 80 mg/kg. It is not clear why Section 8.5 of the Report states that "DTSC's LeadSpread 8.0 Model results indicate that lead does not pose an unacceptable hazard to adults or children exposed to either the maximum detected concentration (88 mg/kg) or the 95UCL concentration (63.49 mg/kg)." It should be made clear that, the concentration of 88 mg/kg is over the DTSC screening level, which is based on a blood lead threshold of 1 ug/dL. However, the magnitude of the exceedance is small, and the site will be mostly paved (see *Site description and background*), so residential exposure to soil will be much lower than assumed by the residential screening levels.

The maximum concentration of lead in soil (88 mg/kg) was measured at 5 feet bgs. The 5 foot samples were the shallowest sample taken on the site. Location 3 has the maximum concentration of lead and other inorganics. Only four locations were sampled, and locations 2 and 3 have elevated levels of inorganics including lead and mercury compared to locations 1 and 4.

For the construction scenario there is no screening level for lead in soil, so OEHHA used the modified US EPA adult lead model in DTSC's Lead Risk Assessment Spreadsheet (LeadSpread 8) and modified the soil ingestion rate. A construction worker has a higher incidental ingestion rate of soil than an indoor commercial industrial worker (330 mg/day vs. 100 mg/day). OEHHA used half that ingestion rate in the model, as was done for the default commercial scenario (165 mg/day vs. 50 mg/day), since the model used mid-range ingestion rates rather than upper-end rates. The on-site concentration of 88 mg/kg resulted in a 90th percentile estimate of the increase in blood lead in the fetus of a pregnant adult construction worker of 0.90 µg/dL, i.e. just below the threshold of 1 µg/dL.

Mearns concluded that personal protective equipment worn by construction workers will protect them from elevated metals in soils. No information was provided to suggest that personal protective equipment would be required on-site, nor that personal protective equipment at construction sites is designed for this purpose.

Comparison of results

Table 4 and 5 show results from Mearns and OEHHA for comparison. OEHHA's cancer risk estimates are up to a factor of 3 higher because OEHHA used the ASF for residential cancer risk calculations. However, in general all cancer risk estimates from Mearns and OEHHA are low.

On the other hand, OEHHA's hazard indices are lower than Mearns'. For soils, Mearns used an incorrect reference dose for cadmium (described above in *Soils: Screening Assessment*). This lower value greatly increased the hazard index in Mearns' results.

For soil vapor, Mearns used TPH aromatic to represent gasoline range organics, while OEHHA used the TPH aliphatic fraction, which has lower toxicity (described above in *Soil vapor: Screening Assessment*). Although OEHHA's hazard indices are lower than Mearns', both Mearns' and OEHHA's residential hazard indices are above the typical acceptable threshold of 1.

Table 4. Soil Vapor Exposure: Comparison of results from Mearns and OEHHA

Approach	Construction Cancer Risk	Construction Hazard Quotient	Trench Cancer Risk	Trench Hazard Quotient	Resident Cancer Risk	Resident Hazard Quotient
Mearns (0.03 attenuation factor, deep)	NC	NC	2.6E-11	1.4	7.8E-7	5.1
OEHHA	1.3E-09	0.11	1.9E-09	0.44	2.2E-06	4.9

Notes for table: "NC" indicates not calculated.

Table 5. Soil Exposure: Comparison of results from Mearns and OEHHA

Approach	Construction Cancer Risk	Construction Non-cancer Hazard	Residential Cancer Risk	Resident (Child) Non-cancer Hazard
Mearns	2.9E-10	2.6	5.3E-9	5.4
OEHHA	2.9E-7	1.5	7.0E-8	1.9

Conclusions

- For soil vapor exposures, the cancer risk to residents only slightly exceeded the *de minimis* level (1×10^{-6}). The non-cancer hazard estimates were more significant particularly from the petroleum hydrocarbons. The hazard index for residents was 4.9, which is above the typical threshold of 1. The methane mitigation system, however, will likely decrease this risk, but OEHHA cannot estimate the degree to which the risk would be reduced. For construction and trench workers, soil vapor did not pose a significant risk or hazard.
- For soil exposures, the hazard index calculated for residents and for construction workers was slightly above the typically acceptable threshold of 1.
- There are a few points of uncertainly concerning soil exposures including the small number of samples taken on the site and lack of assessment of surface soils. OEHHA defers to the project manager on whether these points may be acceptable considering the development plan and potential future exposures.

Reviewed by

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