

Via E-mail

June 14, 2021

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David Simons, Vice Chair
Sue Harrison, Commissioner
John Howe, Commissioner
Ken Olevson, Commissioner
Ken Rheume, Commissioner
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**Re: Comments Regarding Proposed Commercial Street Hotels Project at
247 and 295 Commercial Street (File # 21-0628) – June 14, 2021
Planning Commission Meeting, Agenda Item No. 2**

Dear Chair Howard, Vice-Chair Simons, Commissioners Harrison, Howe,
Olevson, Rheume and Weiss, and Ms. Hom:

I am writing on behalf of the Laborers International Union of North America, Local Union 270 and its members living in the City of Sunnyvale ("LIUNA"), regarding the Commercial Street Hotels Project ("Project"). The Project proposes to construct two new six-story hotel buildings totaling 274 hotel rooms, an underground parking garage, and related site improvements on a 1.5 acre site located at 247 and 295 Commercial Street (APNs: 205-34-006 and 205-34-013) by applicant DOA Developments in the City of Sunnyvale ("City").

LIUNA is concerned that the City is proposing to approve the Project without environmental review under the California Environmental Quality Act ("CEQA"), Public Resources Code section 21000, *et seq.*, based on the assertion that the Project is eligible for a Class 32 In-fill Exemption.

Certified Industrial Hygienist, Francis "Bud" Offermann, PE, CIH has conducted a review of the Project and the documents provided to the Planning Commission and prepared expert comments on the Project's indoor air emissions and associated health risks. Mr. Offermann concludes it is likely that the Project will expose future employees of the Project to significant impacts related to indoor air quality, and in particular, emissions of the cancer-causing chemical formaldehyde. Mr. Offermann is a leading

expert on indoor air quality and has published extensively on the topic. Mr. Offermann's expert comments and curriculum vitae are attached as Exhibit A.

Environmental consulting firm Soil/Water/Air Protection Enterprise ("SWAPE") has reviewed the Project and its location on a site listed on the Cortese list. SWAPE's expert comments, as well as the curriculum vitae of SWAPE's consultants are attached hereto as Exhibit B.

Ecologist Shawn Smallwood, Ph.D. also reviewed the Project and Project documents. Dr. Smallwood concludes that the Project site does have value as habitat for endangered, rare or threatened species. Additionally, Dr. Smallwood concludes that the Project may pose significant impacts to biological resources due to collisions with the Project's windows. Dr. Smallwood's expert comments and curriculum vitae are attached as Exhibit C.

LIUNA's review of the Project, with the assistance of these experts, has found that the Project will have significant effects relating to air quality, the Project site is included on the Cortese list and the site has value as habitat for endangered, rare or threatened species, all of which preclude the City's use of the Class 32 In-fill development exemption for the Project. LIUNA respectfully requests that the Commission not approve the Project and instead direct staff to prepare a mitigated negative declaration ("MND") or an environmental impact report ("EIR") for the Project prior to approval in compliance with CEQA.

I. PROJECT DESCRIPTION

The applicant, DOA Developments, is requesting that the Planning Commission review and approve a Use Permit for two new six-story hotel buildings totaling 274 hotel rooms, an underground parking garage with 219 spaces with a parking adjustment to allow valet parking and mechanical parking, and installation of related site improvements, as well as a Tentative Map to allow a lot merger and subdivision for condominium purposes. The Project site is located at 247 and 295 Commercial Street (APNs: 205-34-006 and 205-34-013). The City is proposing to approve the Project using a Class 32 Categorical Exemption under CEQA.

II. LEGAL STANDARD

CEQA mandates that "the long-term protection of the environment . . . shall be the guiding criterion in public decisions" throughout California. PRC § 21001(d). A "project" is "the whole of an action" directly undertaken, supported, or authorized by a public agency "which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment." PRC § 21065; CEQA Guidelines, 14 CCR § 15378(a). For this reason, CEQA is concerned with an action's ultimate "impact on the environment." *Bozung v. LAFCO* (1975) 13 Cal.3d 263,

283. CEQA requires environmental factors to be considered at the “earliest possible stage . . . before [the project] gains irreversible momentum,” *Id.* 13 Cal.3d at 277, “at a point in the planning process where genuine flexibility remains.” *Sundstrom v. Mendocino County* (1988) 202 Cal.App.3d 296, 307.

To achieve its objectives of environmental protection, CEQA has a three-tiered structure. 14 CCR § 15002(k); *Committee to Save the Hollywoodland Specific Plan v. City of Los Angeles* (2008) 161 Cal.App.4th 1168, 1185-86 (“*Hollywoodland*”). First, if a project falls into an exempt category, or it can be seen with certainty that the activity in question will not have a significant effect on the environment, no further agency evaluation is required. *Id.* Second, if there is a possibility the project will have a significant effect on the environment, the agency must perform an initial threshold study. *Id.*; 14 CCR § 15063(a). If the study indicates that there is no substantial evidence that the project or any of its aspects may cause a significant effect on the environment the agency may issue a negative declaration. *Id.*, 14 CCR §§ 15063(b)(2), 15070. Finally, if the project will have a significant effect on the environment, an environmental impact report (“EIR”) is required. *Id.* Here, since the City proposes to exempt the Project from CEQA entirely, we are at the first step of the CEQA process.

A. CEQA Exemptions.

CEQA identifies certain classes of projects which are exempt from the provisions of CEQA. These are called categorical exemptions. 14 CCR §§ 15300, 15354. “Exemptions to CEQA are narrowly construed and “[e]xemption categories are not to be expanded beyond the reasonable scope of their statutory language.” *Mountain Lion Foundation v. Fish & Game Com.* (1997) 16 Cal.4th 105, 125.

The determination as to the appropriate scope of a categorical exemption is a question of law subject to independent, *i.e.* de novo, review. *San Lorenzo Valley Community Advocates for Responsible Education v. San Lorenzo Valley Unified School Dist.*, (2006) 139 Cal.App.4th 1356, 1375 (“[Q]uestions of interpretation or application of the requirements of CEQA are matters of law. (Citations.) Thus, for example, interpreting the scope of a CEQA exemption presents ‘a question of law, subject to de novo review by this court.’ (Citations).”)

The City asserts the Project is categorically exempt from the requirements of CEQA as an “in-fill” project (Class 32). In order to utilize a Class 32 In-Fill Exemption, the City must have substantial evidence that, among other findings, “[t]he project site has no value as habitat for endangered, rare or threatened species” or where “[a]pproval of the project would not result in any significant effects relating to traffic, noise, air quality, or water quality.” 14 CCR §§ 15332(c), (d). These factual determinations required to be made in order for the City to invoke the Class 32 In-Fill Exemption must be supported by substantial evidence in the record. *Banker's Hill*,

Hillcrest, Park W. Cmty. Pres. Grp. v. City of San Diego (2006) 139 Cal.App.4th 249, 267-69.

Substantial evidence evident in the record and provided by LIUNA's experts demonstrates that the City cannot make the findings that are prerequisite to utilizing a Class 32 In-Fill Exemption. As a result, the City should prepare an MND or EIR to analyze the Project's impacts on air quality, health risks to construction workers and future employees, and sensitive wildlife, and the MND or draft EIR should be circulated for public review and comment in accordance with CEQA.

III. ANALYSIS

A. The Project Site's Presence on the Cortese List Precludes Use of a Categorical Exemption.

The Project may not be exempted from CEQA review because it is on the State of California's Cortese List of highly contaminated sites. This exception to the use of any categorical exemption is unequivocal:

"[a] categorical exemption shall not be used for a project located on a site which is **included on any list** compiled pursuant to Section 65962.5 of the Government Code [Cortese List]."

14 CCR §15300.2(e) (emphasis added). The CEQA itself provides:

No project located on a site which is included on any list compiled pursuant to Section 65962.5 of the Government Code [Cortese List] shall be exempted from this division pursuant to subdivision (a)[categorical exemptions]."

PRC § 21084(c)). "The provisions in Government Code Section 65962.5 are commonly referred to as the 'Cortese List'" The GeoTracker list is one of the lists in the Cortese List. <https://calepa.ca.gov/SiteCleanup/CorteseList/>. The Project site is included on the Cortese list.

https://geotracker.waterboards.ca.gov/profile_report?global_id=T10000007798. See SWAPE Comments, Exhibit B.

As a result, the Class 32 In-Fill exemption is not available for the Project.

There is no caveat included in this exception for sites that have purportedly been closed or cleaned up. If the site is on the Cortese list, a Class 32 exemption is not available. Nevertheless, it also is worth noting that any past efforts to remediate the site only had industrial uses in mind – not a hotel with an underground parking garage. And, as Attachment 4 to the staff report notes, high levels of metals, VOC soil vapors and likely contaminated groundwater remain present at the site, underscoring the wisdom of

the Cortese list exception to CEQA's categorical exemptions. Staff Report, Att. 4, p. 12. It is imperative that the City properly evaluate through an MND or EIR the potential impacts that may result from the Project's disturbance of the existing toxic contaminants at the site and the health risks that would result to construction workers and future employees of the hotel.

B. The Project Will Have Significant Air Quality Impacts, Precluding Reliance on the Categorical Exemption.

In addition to the toxic threats posed by the Project's disturbance of contaminated soils and groundwater at the site, the Project also will introduce toxic air contaminants to air inside the Project that poses significant risks to future employees of the hotel. Formaldehyde is a known human carcinogen and listed by the State of California as a Toxic Air Contaminant ("TAC"). The Bay Area Air Quality Management District ("BAAQMD") has established a significance threshold of health risks for carcinogenic TACs of 10 in a million. See Rincon Consultants, Air Quality Study, p. 12 (June 2021). The City's proposed exemption fails to acknowledge the significant indoor air emissions that will result from the Project.

Mr. Offermann explains that many composite wood products typically used indoors contain formaldehyde-based glues which off-gas formaldehyde over a very long time period. Ex. A, pp. 2-3. He explains, "The primary source of formaldehyde indoors is composite wood products manufactured with urea-formaldehyde resins, such as plywood, medium density fiberboard, and particle board. These materials are commonly used in building construction for flooring, cabinetry, baseboards, window shades, interior doors, and window and door trims." *Id.*

Mr. Offermann calculates that future employees of the Project will be exposed to a cancer risk from formaldehyde of approximately 17.7 per million, assuming all materials are compliant with the California Air Resources Board's formaldehyde airborne toxics control measure. *Id.* at 4. This exceeds BAAQMD's CEQA significance thresholds for airborne cancer risk of 10 per million. *Id.* Mr. Offermann stresses that his calculations account for the fact that wood products for the project would be compliant with the most recent CARB standards. *Id.* at 4-5.

Mr. Offermann concludes that these significant environmental impacts must be analyzed, and mitigation measures should be imposed to reduce employees' formaldehyde exposure. *Id.* He prescribes a methodology for calculating the Project's formaldehyde emissions in order to do a more project-specific health risk assessment. *Id.* at 5-11. Mr. Offermann also suggests several feasible mitigation measures, such as requiring the use of composite wood products manufactured with CARB approved no-added formaldehyde (NAF) resins, which are readily available. *Id.* at 11-13.

When a Project exceeds a duly adopted CEQA significance threshold, as here,

this alone establishes substantial evidence that the project will have a significant adverse environmental impact. Indeed, in many instances, such air quality thresholds are the only criteria reviewed and treated as dispositive in evaluating the significance of a project's air quality impacts. See, e.g. *Schenck v. County of Sonoma* (2011) 198 Cal.App.4th 949, 960 (County applies Air District's "published CEQA quantitative criteria" and "threshold level of cumulative significance"); see also *Communities for a Better Env't. v. California Res. Agency* (2002) 103 Cal.App.4th 98, 110-11 ("A 'threshold of significance' for a given environmental effect is simply that level at which the lead agency finds the effects of the project to be significant").

The carcinogenic formaldehyde emissions identified by Mr. Offermann are not an existing environmental condition. Those emissions to the air will be from the Project. People, and in particular the hotel employees, will be using the Project once it is built and begins emitting formaldehyde. Once built, the Project will begin to emit formaldehyde at levels that pose significant direct and cumulative health risks. Mr. Offermann's expert analysis demonstrates that the City cannot make the requisite finding needed to rely on the Class 32 exemption that "the project would not result in any significant effects relating to ... air quality...." 14 CCR § 15332(d).

C. The Project Site Has Value as Habitat for Endangered, Rare or Threatened Species.

The existing Project site is composed of two industrial buildings, totaling approximately 9,720 square feet, with several trees dispersed on the site. Despite the initial appearance of the site, Dr. Smallwood notes that it does provide habitat that is important to many species, including rare, threatened or endangered species. Ex. C, p. 2.

Habitat is defined by a species' use of the environment and the gaseous atmosphere is a medium of life that is an essential aspect of habitat for species of flora and fauna. *Id.* Many species of flora and fauna morphologically adapted to living in that part of the atmosphere referred to as the aerosphere. See *id.* Birds' and bats' wings are specifically adapted to particular uses of the atmosphere: short powerful wings for speed, long slender wings for glide, and broad wings for maneuverability, for example. *Id.* Additionally, the atmosphere is such an important element of habitat to wildlife that some birds sleep while in flight, and bats and owls hunt in it, even at night. *Id.* "The aerosphere is an essential element of habitat for a vast number of wildlife species." *Id.*

At least one million birds pass through the South Bay annually and at least 40 special-status species of birds are known to the Project area. *Id.* at 3. Of those 40 special status bird species, at least 20 are species of special concern ("SSC"), endangered, or threatened. Threatened and endangered species include Swainson's hawks, Least Bell's vireos, Willow flycatchers, and tricolored blackbirds. *Id.* at 5-6. The California Department of Fish and Wildlife explains that wildlife designated as species of

special concern are addressed under CEQA when evaluating impacts to rare species. <https://wildlife.ca.gov/Conservation/SSC#394871319-how-are-sscs-addressed-under-the-california-environmental-quality-act>. Dr. Smallwood identifies 12 species of special concern near the Project site including species that have been documented to collide with windows such as Grasshopper sparrows, Summer tanagers, Yellow-breasted chats, Yellow warblers, San Francisco common yellowthroats, and Purple martins. *Id.* at 5-6. The analogous category of wildlife on the federal level is the US Fish & Wildlife Service's designation of Bird Species of Conservation Concern ("BCC"). These rare BCC species present in and around the Project site which have been documented in window collisions include Peregrine falcons, Costa's hummingbirds, Allen's hummingbirds, and Oak titmouses. *Id.* The Project site is not only located within the Pacific Flyway but is also located nearby to numerous parks and green spaces that birds use the aerosphere to travel between. The existing buildings at the Project site appear to be both single stories, whereas the proposed Project's two buildings will be six stories with an additional roof level. The Project site's aerosphere therefore provides valuable habitat for endangered, rare or threatened species, which will be removed by the development of the Project.

Dr. Smallwood also highlighted his work that has focused on impacts to wildlife caused by insertions of human structures into the aerosphere, most of which are inserted without a thought of their potential impacts to volant wildlife – animals that fly. *Id.* at 2. Some of these impacts include habitat loss, energy costs of having to navigate around the structure, increased predation risk from predators using the structures as hunting perches or foraging screens, and collision mortality. *Id.* Specifically, birds are vulnerable to the transparency of buildings' windows, to the reflectance of vegetation and other birds in many windows, to the false perception of cavity space of some windows, and to confusion caused by interior lighting issues from windows at night. *Id.* at 3. Window collisions are the second or third largest source of human-caused bird mortality, and a high rate of bird-window collisions has been measured in the Bay Area. *Id.* Of the 22 SSC, BCC or listed species identified by Dr. Smallwood as known to the Project area, 7 of these species have been documented as window collision fatalities and are therefore susceptible to new structural glass installations. *Id.*

Dr. Smallwood indicates that the Project, as proposed, will result in significant impacts to birds colliding with the Project's clear glass windows. *Id.* at 7. Specifically, Dr. Smallwood predicts "108 bird deaths per year" due to the Project. *Id.* The Project's plans show ample use of windows on portions of the buildings' facades. Based on the Project's Site and Architectural Plans, Dr. Smallwood estimates that the Project would use at least 1,477 square meters of glass of the buildings' facades. *Id.* Despite emerging scientific literature about window collisions as one of the largest sources of avian mortality worldwide, the City fails to assess this impact.

Dr. Smallwood also notes that the depictions of the Project's facades are not entirely consistent with the standards identified in the City's own Bird-Safe Guidelines.

Id. at 4. Under Option 2 of the City's Bird Safe Building Design Guidelines, the first standard is to "[a]void large expanse of glass near open areas, especially when tall landscaping is immediately adjacent to the glass walls." City of Sunnyvale, Bird Safe Building Design Guidelines, p. BS 1. However, the Project site and the Project plans depict large glass windows that would reflect tall vegetation in adjacent landscaping. Ex. C, p. 4. The fifth standard is to "[r]educe glass at top of a building, especially when incorporating a green roof into the design." City of Sunnyvale, Bird Safe Building Design Guidelines, p. BS 1. However, the Project's top floor contains windows on all sides of the buildings, in the same amount as the lower floors, despite both buildings containing green roofs. Additionally, when reviewing the effectiveness of the City's Bird Safe Design Guidelines, the report to City Council specifically highlighted that special attention should be paid to projects that include a green roof since it is an area that "tend[s] to be more likely environments for birds and provide the greatest threats to birds near buildings with a lot of glass," as well as "[c]areful building design when a green roof is included to ensure there is no reflective glass facades since the birds will be attracted to the green roof." City of Sunnyvale File # 16-0706. There is no evidence in the Project's Site and Architectural Plans that this has been done.

The Project's site's aerosphere provides value as habitat for endangered, rare or threatened species, precluding the City from exempting the Project pursuant to the CEQA In-fill exemption. The City should instead prepare either an MND or EIR to analyze and mitigate the Project's potentially significant impacts to birds.

IV. The Project's Cumulative Impacts on Wildlife Preclude the Use of the Class 32 In-Fill Exemption.

The Class 32 exemption also cannot be used when a project will have cumulative impacts: "Cumulative Impact. All exemptions for these classes are inapplicable when the cumulative impact of successive projects of the same type in the same place, over time is significant." 14 CCR § 15300.2(b). The expert comments discussed above point out the Project's significant contributions to ongoing cumulative impacts of similar types of tall buildings on sensitive bird species. For these reasons as well, the Class 32 exemption is inapplicable to the Project.

V. Conclusion

LIUNA respectfully requests that the City withdraw the CEQA Exemption and prepare either an MND or EIR to analyze and mitigate the Project's adverse environmental impacts. Thank you for considering these comments.

Sincerely,



Michael R. Lozeau

EXHIBIT A



INDOOR ENVIRONMENTAL ENGINEERING



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Date: June 10, 2021

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From: Francis J. Offermann PE CIH

Subject: Indoor Air Quality: Commercial Street Hotels, Sunnyvale, CA.
(IEE File Reference: P-4430)

Pages: 18

Indoor Air Quality Impacts

Indoor air quality (IAQ) directly impacts the comfort and health of building occupants, and the achievement of acceptable IAQ in newly constructed and renovated buildings is a well-recognized design objective. For example, IAQ is addressed by major high-performance building rating systems and building codes (California Building Standards Commission, 2014; USGBC, 2014). Indoor air quality in homes is particularly important because occupants, on average, spend approximately ninety percent of their time indoors with the majority of this time spent at home (EPA, 2011). Some segments of the population that are most susceptible to the effects of poor IAQ, such as the very young and the elderly, occupy their homes almost continuously. Additionally, an increasing number of adults are working from home at least some of the time during the workweek. Indoor air quality also is a serious concern for workers in hotels, offices and other business establishments.

The concentrations of many air pollutants often are elevated in homes and other buildings relative to outdoor air because many of the materials and products used indoors contain

and release a variety of pollutants to air (Hodgson et al., 2002; Offermann and Hodgson, 2011). With respect to indoor air contaminants for which inhalation is the primary route of exposure, the critical design and construction parameters are the provision of adequate ventilation and the reduction of indoor sources of the contaminants.

Indoor Formaldehyde Concentrations Impact. In the California New Home Study (CNHS) of 108 new homes in California (Offermann, 2009), 25 air contaminants were measured, and formaldehyde was identified as the indoor air contaminant with the highest cancer risk as determined by the California Proposition 65 Safe Harbor Levels (OEHHA, 2017a), No Significant Risk Levels (NSRL) for carcinogens. The NSRL is the daily intake level calculated to result in one excess case of cancer in an exposed population of 100,000 (i.e., ten in one million cancer risk) and for formaldehyde is 40 µg/day. The NSRL concentration of formaldehyde that represents a daily dose of 40 µg is 2 µg/m³, assuming a continuous 24-hour exposure, a total daily inhaled air volume of 20 m³, and 100% absorption by the respiratory system. All of the CNHS homes exceeded this NSRL concentration of 2 µg/m³. The median indoor formaldehyde concentration was 36 µg/m³, and ranged from 4.8 to 136 µg/m³, which corresponds to a median exceedance of the 2 µg/m³ NSRL concentration of 18 and a range of 2.3 to 68.

Therefore, the cancer risk of a resident living in a California home with the median indoor formaldehyde concentration of 36 µg/m³, is 180 per million as a result of formaldehyde alone. The CEQA significance threshold for airborne cancer risk is 10 per million, as established by the South Coast Air Quality Management District (BAAQMD, 2017).

Besides being a human carcinogen, formaldehyde is also a potent eye and respiratory irritant. In the CNHS, many homes exceeded the non-cancer reference exposure levels (RELs) prescribed by California Office of Environmental Health Hazard Assessment (OEHHA, 2017b). The percentage of homes exceeding the RELs ranged from 98% for the Chronic REL of 9 µg/m³ to 28% for the Acute REL of 55 µg/m³.

The primary source of formaldehyde indoors is composite wood products manufactured with urea-formaldehyde resins, such as plywood, medium density fiberboard, and

particleboard. These materials are commonly used in building construction for flooring, cabinetry, baseboards, window shades, interior doors, and window and door trims.

In January 2009, the California Air Resources Board (CARB) adopted an airborne toxics control measure (ATCM) to reduce formaldehyde emissions from composite wood products, including hardwood plywood, particleboard, medium density fiberboard, and also furniture and other finished products made with these wood products (California Air Resources Board 2009). While this formaldehyde ATCM has resulted in reduced emissions from composite wood products sold in California, they do not preclude that homes built with composite wood products meeting the CARB ATCM will have indoor formaldehyde concentrations below cancer and non-cancer exposure guidelines.

A follow up study to the California New Home Study (CNHS) was conducted in 2016-2018 (Singer et. al., 2019), and found that the median indoor formaldehyde in new homes built after 2009 with CARB Phase 2 Formaldehyde ATCM materials had lower indoor formaldehyde concentrations, with a median indoor concentrations of $22.4 \mu\text{g}/\text{m}^3$ (18.2 ppb) as compared to a median of $36 \mu\text{g}/\text{m}^3$ found in the 2007 CNHS. Unlike in the CNHS study where formaldehyde concentrations were measured with pumped DNPH samplers, the formaldehyde concentrations in the HENGH study were measured with passive samplers, which were estimated to under-measure the true indoor formaldehyde concentrations by approximately 7.5%. Applying this correction to the HENGH indoor formaldehyde concentrations results in a median indoor concentration of $24.1 \mu\text{g}/\text{m}^3$, which is 33% lower than the $36 \mu\text{g}/\text{m}^3$ found in the 2007 CNHS.

Thus, while new homes built after the 2009 CARB formaldehyde ATCM have a 33% lower median indoor formaldehyde concentration and cancer risk, the median lifetime cancer risk is still 120 per million for homes built with CARB compliant composite wood products. This median lifetime cancer risk is more than 12 times the OEHHHA 10 in a million cancer risk threshold (OEHHHA, 2017a).

With respect to the Commercial Street Hotels Project, the buildings consist of two hotel buildings.

The employees of the hotels are expected to experience significant indoor exposures (e.g., 40 hours per week, 50 weeks per year). These exposures for employees are anticipated to result in significant cancer risks resulting from exposures to formaldehyde released by the building materials and furnishing commonly found in offices, warehouses, residences and hotels.

Because these hotel spaces will be constructed with CARB Phase 2 Formaldehyde ATCM materials, and be ventilated with the minimum code required amount of outdoor air, the indoor formaldehyde concentrations are likely similar to those concentrations observed in residences built with CARB Phase 2 Formaldehyde ATCM materials, which is a median of $24.1 \mu\text{g}/\text{m}^3$ (Singer et. al., 2020)

Assuming that the hotel employees work 8 hours per day and inhale 20 m^3 of air per day, the formaldehyde dose per work-day at the offices is $161 \mu\text{g}/\text{day}$.

Assuming that these employees work 5 days per week and 50 weeks per year for 45 years (start at age 20 and retire at age 65) the average 70-year lifetime formaldehyde daily dose is $70.9 \mu\text{g}/\text{day}$.

This is 1.77 times the NSRL (OEHHA, 2017a) of $40 \mu\text{g}/\text{day}$ and represents a cancer risk of 17.7 per million, which exceeds the CEQA cancer risk of 10 per million. This impact should be analyzed in an environmental impact report (“EIR”), and the agency should impose all feasible mitigation measures to reduce this impact. Several feasible mitigation measures are discussed below and these and other measures should be analyzed in an EIR.

Appendix A, Indoor Formaldehyde Concentrations and the CARB Formaldehyde ATCM, provides analyses that show utilization of CARB Phase 2 Formaldehyde ATCM materials will not ensure acceptable cancer risks with respect to formaldehyde emissions from composite wood products.

Even composite wood products manufactured with CARB certified ultra low emitting formaldehyde (ULEF) resins do not insure that the indoor air will have concentrations of formaldehyde that meet the OEHHA cancer risks that substantially exceed 10 per million. The permissible emission rates for ULEF composite wood products are only 11-15% lower than the CARB Phase 2 emission rates. Only use of composite wood products made with no-added formaldehyde resins (NAF), such as resins made from soy, polyvinyl acetate, or methylene diisocyanate can insure that the OEHHA cancer risk of 10 per million is met.

The following describes a method that should be used, prior to construction in the environmental review under CEQA, for determining whether the indoor concentrations resulting from the formaldehyde emissions of specific building materials/furnishings selected exceed cancer and non-cancer guidelines. Such a design analyses can be used to identify those materials/furnishings prior to the completion of the City's CEQA review and project approval, that have formaldehyde emission rates that contribute to indoor concentrations that exceed cancer and non-cancer guidelines, so that alternative lower emitting materials/furnishings may be selected and/or higher minimum outdoor air ventilation rates can be increased to achieve acceptable indoor concentrations and incorporated as mitigation measures for this project.

Pre-Construction Building Material/Furnishing Formaldehyde Emissions Assessment

This formaldehyde emissions assessment should be used in the environmental review under CEQA to assess the indoor formaldehyde concentrations from the proposed loading of building materials/furnishings, the area-specific formaldehyde emission rate data for building materials/furnishings, and the design minimum outdoor air ventilation rates. This assessment allows the applicant (and the City) to determine, before the conclusion of the environmental review process and the building materials/furnishings are specified, purchased, and installed, if the total chemical emissions will exceed cancer and non-cancer guidelines, and if so, allow for changes in the selection of specific material/furnishings and/or the design minimum outdoor air ventilations rates such that cancer and non-cancer guidelines are not exceeded.

1.) Define Indoor Air Quality Zones. Divide the building into separate indoor air quality zones, (IAQ Zones). IAQ Zones are defined as areas of well-mixed air. Thus, each ventilation system with recirculating air is considered a single zone, and each room or group of rooms where air is not recirculated (e.g. 100% outdoor air) is considered a separate zone. For IAQ Zones with the same construction material/furnishings and design minimum outdoor air ventilation rates. (e.g. hotel rooms, apartments, condominiums, etc.) the formaldehyde emission rates need only be assessed for a single IAQ Zone of that type.

2.) Calculate Material/Furnishing Loading. For each IAQ Zone, determine the building material and furnishing loadings (e.g., m^2 of material/ m^2 floor area, units of furnishings/ m^2 floor area) from an inventory of all potential indoor formaldehyde sources, including flooring, ceiling tiles, furnishings, finishes, insulation, sealants, adhesives, and any products constructed with composite wood products containing urea-formaldehyde resins (e.g., plywood, medium density fiberboard, particleboard).

3.) Calculate the Formaldehyde Emission Rate. For each building material, calculate the formaldehyde emission rate ($\mu\text{g}/\text{h}$) from the product of the area-specific formaldehyde emission rate ($\mu\text{g}/\text{m}^2\text{-h}$) and the area (m^2) of material in the IAQ Zone, and from each furnishing (e.g. chairs, desks, etc.) from the unit-specific formaldehyde emission rate ($\mu\text{g}/\text{unit-h}$) and the number of units in the IAQ Zone.

NOTE: As a result of the high-performance building rating systems and building codes (California Building Standards Commission, 2014; USGBC, 2014), most manufacturers of building materials furnishings sold in the United States conduct chemical emission rate tests using the California Department of Health “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions for Indoor Sources Using Environmental Chambers,” (CDPH, 2017), or other equivalent chemical emission rate testing methods. Most manufacturers of building furnishings sold in the United States conduct chemical emission rate tests using ANSI/BIFMA M7.1 Standard Test Method for Determining VOC Emissions (BIFMA, 2018), or other equivalent chemical emission rate testing methods.

CDPH, BIFMA, and other chemical emission rate testing programs, typically certify that a material or furnishing does not create indoor chemical concentrations in excess of the maximum concentrations permitted by their certification. For instance, the CDPH emission rate testing requires that the measured emission rates when input into an office, school, or residential model do not exceed one-half of the OEHHA Chronic Exposure Guidelines (OEHHA, 2017b) for the 35 specific VOCs, including formaldehyde, listed in Table 4-1 of the CDPH test method (CDPH, 2017). These certifications themselves do not provide the actual area-specific formaldehyde emission rate (i.e., $\mu\text{g}/\text{m}^2\text{-h}$) of the product, but rather provide data that the formaldehyde emission rates do not exceed the maximum rate allowed for the certification. Thus, for example, the data for a certification of a specific type of flooring may be used to calculate that the area-specific emission rate of formaldehyde is less than $31 \mu\text{g}/\text{m}^2\text{-h}$, but not the actual measured specific emission rate, which may be 3, 18, or $30 \mu\text{g}/\text{m}^2\text{-h}$. These area-specific emission rates determined from the product certifications of CDPH, BIFA, and other certification programs can be used as an initial estimate of the formaldehyde emission rate.

If the actual area-specific emission rates of a building material or furnishing is needed (i.e. the initial emission rates estimates from the product certifications are higher than desired), then that data can be acquired by requesting from the manufacturer the complete chemical emission rate test report. For instance if the complete CDPH emission test report is requested for a CDHP certified product, that report will provide the actual area-specific emission rates for not only the 35 specific VOCs, including formaldehyde, listed in Table 4-1 of the CDPH test method (CDPH, 2017), but also all of the cancer and reproductive/developmental chemicals listed in the California Proposition 65 Safe Harbor Levels (OEHHA, 2017a), all of the toxic air contaminants (TACs) in the California Air Resources Board Toxic Air Contamination List (CARB, 2011), and the 10 chemicals with the greatest emission rates.

Alternatively, a sample of the building material or furnishing can be submitted to a chemical emission rate testing laboratory, such as Berkeley Analytical Laboratory (<https://berkeleyanalytical.com>), to measure the formaldehyde emission rate.

4.) Calculate the Total Formaldehyde Emission Rate. For each IAQ Zone, calculate the total formaldehyde emission rate (i.e. µg/h) from the individual formaldehyde emission rates from each of the building material/furnishings as determined in Step 3.

5.) Calculate the Indoor Formaldehyde Concentration. For each IAQ Zone, calculate the indoor formaldehyde concentration (µg/m³) from Equation 1 by dividing the total formaldehyde emission rates (i.e. µg/h) as determined in Step 4, by the design minimum outdoor air ventilation rate (m³/h) for the IAQ Zone.

$$C_{in} = \frac{E_{total}}{Q_{oa}} \text{ (Equation 1)}$$

where:

C_{in} = indoor formaldehyde concentration (µg/m³)

E_{total} = total formaldehyde emission rate (µg/h) into the IAQ Zone.

Q_{oa} = design minimum outdoor air ventilation rate to the IAQ Zone (m³/h)

The above Equation 1 is based upon mass balance theory, and is referenced in Section 3.10.2 “Calculation of Estimated Building Concentrations” of the California Department of Health “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions for Indoor Sources Using Environmental Chambers”, (CDPH, 2017).

6.) Calculate the Indoor Exposure Cancer and Non-Cancer Health Risks. For each IAQ Zone, calculate the cancer and non-cancer health risks from the indoor formaldehyde concentrations determined in Step 5 and as described in the OEHHA Air Toxics Hot Spots Program Risk Assessment Guidelines; Guidance Manual for Preparation of Health Risk Assessments (OEHHA, 2015).

7.) Mitigate Indoor Formaldehyde Exposures of exceeding the CEQA Cancer and/or Non-Cancer Health Risks. In each IAQ Zone, provide mitigation for any formaldehyde exposure risk as determined in Step 6, that exceeds the CEQA cancer risk of 10 per million or the CEQA non-cancer Hazard Quotient of 1.0.

Provide the source and/or ventilation mitigation required in all IAQ Zones to reduce the

health risks of the chemical exposures below the CEQA cancer and non-cancer health risks.

Source mitigation for formaldehyde may include:

- 1.) reducing the amount materials and/or furnishings that emit formaldehyde
- 2.) substituting a different material with a lower area-specific emission rate of formaldehyde

Ventilation mitigation for formaldehyde emitted from building materials and/or furnishings may include:

- 1.) increasing the design minimum outdoor air ventilation rate to the IAQ Zone.

NOTE: Mitigating the formaldehyde emissions through use of less material/furnishings, or use of lower emitting materials/furnishings, is the preferred mitigation option, as mitigation with increased outdoor air ventilation increases initial and operating costs associated with the heating/cooling systems.

Further, we are not asking that the builder “speculate” on what and how much composite materials be used, but rather at the design stage to select composite wood materials based on the formaldehyde emission rates that manufacturers routinely conduct using the California Department of Health “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions for Indoor Sources Using Environmental Chambers,” (CDPH, 2017), and use the procedure described earlier above (i.e. Pre-Construction Building Material/Furnishing Formaldehyde Emissions Assessment) to insure that the materials selected achieve acceptable cancer risks from material off gassing of formaldehyde.

Outdoor Air Ventilation Impact. Another important finding of the CNHS, was that the outdoor air ventilation rates in the homes were very low. Outdoor air ventilation is a very important factor influencing the indoor concentrations of air contaminants, as it is the primary removal mechanism of all indoor air generated contaminants. Lower outdoor air exchange rates cause indoor generated air contaminants to accumulate to higher indoor air

concentrations. Many homeowners rarely open their windows or doors for ventilation as a result of their concerns for security/safety, noise, dust, and odor concerns (Price, 2007). In the CNHS field study, 32% of the homes did not use their windows during the 24-hour Test Day, and 15% of the homes did not use their windows during the entire preceding week. Most of the homes with no window usage were homes in the winter field session. Thus, a substantial percentage of homeowners never open their windows, especially in the winter season. The median 24-hour measurement was 0.26 air changes per hour (ach), with a range of 0.09 ach to 5.3 ach. A total of 67% of the homes had outdoor air exchange rates below the minimum California Building Code (2001) requirement of 0.35 ach. Thus, the relatively tight envelope construction, combined with the fact that many people never open their windows for ventilation, results in homes with low outdoor air exchange rates and higher indoor air contaminant concentrations.

According to the Planning Resubmittal – Commercial Street Hotels, 247/295 Commercial Street, Sunnyvale, CA (Lowney Arch, 2021), the Project is close to roads with moderate to high traffic (e.g., Commercial Street, N. Wolfe Street, E. Arques Avenue, Central Expressway, etc.), and thus high outdoor noise levels are anticipated. An acoustic study should be conducted to assess the magnitude of the outdoor noise levels and prepare a mitigation plan such that the indoor noise levels do not exceed local regulations.

As a result of the anticipated high outdoor noise levels, the current project will require a mechanical supply of outdoor air ventilation to allow for a habitable interior environment with closed windows and doors. Such a ventilation system would allow windows and doors to be kept closed at the occupant's discretion to control exterior noise within building interiors.

PM_{2.5} Outdoor Concentrations Impact. An additional impact of the nearby motor vehicle traffic associated with this project, are the outdoor concentrations of PM_{2.5}. According to the Planning Resubmittal – Commercial Street Hotels, 247/295 Commercial Street, Sunnyvale, CA (Lowney Arch, 2021), the Project is located in the San Francisco Bay Area Basin, which is a State and Federal non-attainment area for PM_{2.5}.

An air quality analyses should to be conducted to determine the concentrations of PM_{2.5} in the outdoor and indoor air that people inhale each day. This air quality analyses needs to consider the cumulative impacts of the project related emissions, existing and projected future emissions from local PM_{2.5} sources (e.g. stationary sources, motor vehicles, and airport traffic) upon the outdoor air concentrations at the Project site. If the outdoor concentrations are determined to exceed the California and National annual average PM_{2.5} exceedence concentration of 12 µg/m³, or the National 24-hour average exceedence concentration of 35 µg/m³, then the buildings need to have a mechanical supply of outdoor air that has air filtration with sufficient removal efficiency, such that the indoor concentrations of outdoor PM_{2.5} particles is less than the California and National PM_{2.5} annual and 24-hour standards.

It is my experience that based on the projected high traffic noise levels, the annual average concentration of PM_{2.5} will exceed the California and National PM_{2.5} annual and 24-hour standards and warrant installation of high efficiency air filters (i.e. MERV 13 or higher) in all mechanically supplied outdoor air ventilation systems.

Indoor Air Quality Impact Mitigation Measures

The following are recommended mitigation measures to minimize the impacts upon indoor quality:

Indoor Formaldehyde Concentrations Mitigation. Use only composite wood materials (e.g. hardwood plywood, medium density fiberboard, particleboard) for all interior finish systems that are made with CARB approved no-added formaldehyde (NAF) resins (CARB, 2009). CARB Phase 2 certified composite wood products, or ultra-low emitting formaldehyde (ULEF) resins, do not insure indoor formaldehyde concentrations that are below the CEQA cancer risk of 10 per million. Only composite wood products manufactured with CARB approved no-added formaldehyde (NAF) resins, such as resins made from soy, polyvinyl acetate, or methylene diisocyanate can insure that the OEHHHA cancer risk of 10 per million is met.

Alternatively, conduct the previously described Pre-Construction Building Material/Furnishing Chemical Emissions Assessment, to determine that the combination of formaldehyde emissions from building materials and furnishings do not create indoor formaldehyde concentrations that exceed the CEQA cancer and non-cancer health risks.

It is important to note that we are not asking that the builder “speculate” on what and how much composite materials be used, but rather at the design stage to select composite wood materials based on the formaldehyde emission rates that manufacturers routinely conduct using the California Department of Health “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions for Indoor Sources Using Environmental Chambers”, (CDPH, 2017), and use the procedure described above (i.e. Pre-Construction Building Material/Furnishing Formaldehyde Emissions Assessment) to insure that the materials selected achieve acceptable cancer risks from material off gassing of formaldehyde.

Outdoor Air Ventilation Mitigation. Provide each habitable room with a continuous mechanical supply of outdoor air that meets or exceeds the California 2016 Building Energy Efficiency Standards (California Energy Commission, 2015) requirements of the greater of 15 cfm/occupant or 0.15 cfm/ft² of floor area. Following installation of the system conduct testing and balancing to insure that required amount of outdoor air is entering each habitable room and provide a written report documenting the outdoor airflow rates. Do not use exhaust only mechanical outdoor air systems, use only balanced outdoor air supply and exhaust systems or outdoor air supply only systems. Provide a manual for the occupants or maintenance personnel, that describes the purpose of the mechanical outdoor air system and the operation and maintenance requirements of the system.

PM_{2.5} Outdoor Air Concentration Mitigation. Install air filtration with sufficient PM_{2.5} removal efficiency (e.g. MERV 13 or higher) to filter the outdoor air entering the mechanical outdoor air supply systems, such that the indoor concentrations of outdoor PM_{2.5} particles are less than the California and National PM_{2.5} annual and 24-hour standards. Install the air filters in the system such that they are accessible for replacement

by the occupants or maintenance personnel. Include in the mechanical outdoor air ventilation system manual instructions on how to replace the air filters and the estimated frequency of replacement.

References

Bay Area Air Quality Management District (BAAQMD). 2017. California Environmental Quality Act Air Quality Guidelines. Bay Area Air Quality Management District, San Francisco, CA. http://www.baaqmd.gov/~media/files/planning-and-research/ceqa/ceqa_guidelines_may2017-pdf.pdf?la=en

BIFA. 2018. BIFMA Product Safety and Performance Standards and Guidelines. www.bifma.org/page/standardsoverview

California Air Resources Board. 2009. Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products. California Environmental Protection Agency, Sacramento, CA. <https://www.arb.ca.gov/regact/2007/compwood07/fro-final.pdf>

California Air Resources Board. 2011. Toxic Air Contaminant Identification List. California Environmental Protection Agency, Sacramento, CA. <https://www.arb.ca.gov/toxics/id/taclist.htm>

California Building Code. 2001. California Code of Regulations, Title 24, Part 2 Volume 1, Appendix Chapter 12, Interior Environment, Division 1, Ventilation, Section 1207: 2001 California Building Code, California Building Standards Commission. Sacramento, CA.

California Building Standards Commission (2014). 2013 California Green Building Standards Code. California Code of Regulations, Title 24, Part 11. California Building Standards Commission, Sacramento, CA <http://www.bsc.ca.gov/Home/CALGreen.aspx>.

California Energy Commission, PIER Program. CEC-500-2007-033. Final Report, ARB Contract 03-326. Available at: www.arb.ca.gov/research/apr/past/03-326.pdf.

California Energy Commission, 2015. 2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings, California Code of Regulations, Title 24, Part 6. <http://www.energy.ca.gov/2015publications/CEC-400-2015-037/CEC-400-2015-037-CMF.pdf>

CDPH. 2017. Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions for Indoor Sources Using Environmental Chambers, Version 1.1. California Department of Public Health, Richmond, CA. <https://www.cdph.ca.gov/Programs/CCDCPHP/DEODC/EHLB/IAQ/Pages/VOC.aspx>.

EPA. 2011. Exposure Factors Handbook: 2011 Edition, Chapter 16 – Activity Factors. Report EPA/600/R-09/052F, September 2011. U.S. Environmental Protection Agency, Washington, D.C.

Hodgson, A. T., D. Beal, J.E.R. McIlvaine. 2002. Sources of formaldehyde, other aldehydes and terpenes in a new manufactured house. Indoor Air 12: 235–242.

Lowney Arch. 2021. Planning Resubmittal – Commercial Street Hotels, 247/295 Commercial Street, Sunnyvale, CA.

OEHHA (Office of Environmental Health Hazard Assessment). 2015. Air Toxics Hot Spots Program Risk Assessment Guidelines; Guidance Manual for Preparation of Health Risk Assessments.

OEHHA (Office of Environmental Health Hazard Assessment). 2017a. Proposition 65 Safe Harbor Levels. No Significant Risk Levels for Carcinogens and Maximum Allowable Dose Levels for Chemicals Causing Reproductive Toxicity. Available at: <http://www.oehha.ca.gov/prop65/pdf/safeharbor081513.pdf>

OEHHA - Office of Environmental Health Hazard Assessment. 2017b. All OEHHA Acute, 8-hour and Chronic Reference Exposure Levels. Available at: <http://oehha.ca.gov/air/allrels.html>

Offermann, F. J. 2009. Ventilation and Indoor Air Quality in New Homes. California Air Resources Board and California Energy Commission, PIER Energy-Related Environmental Research Program. Collaborative Report. CEC-500-2009-085. <https://www.arb.ca.gov/research/apr/past/04-310.pdf>

Offermann, F. J. and A. T. Hodgson. 2011. Emission Rates of Volatile Organic Compounds in New Homes. Proceedings Indoor Air 2011 (12th International Conference on Indoor Air Quality and Climate 2011), June 5-10, 2011, Austin, TX.

Singer, B.C, Chan, W.R, Kim, Y., Offermann, F.J., and Walker I.S. 2020. Indoor Air Quality in California Homes with Code-Required Mechanical Ventilation. Indoor Air, Vol 30, Issue 5, 885-899.

USGBC. 2014. LEED BD+C Homes v4. U.S. Green Building Council, Washington, D.C. <http://www.usgbc.org/credits/homes/v4>

APPENDIX A

INDOOR FORMALDEHYDE CONCENTRATIONS AND THE CARB FORMALDEHYDE ATCM

With respect to formaldehyde emissions from composite wood products, the CARB ATCM regulations of formaldehyde emissions from composite wood products, do not assure healthful indoor air quality. The following is the stated purpose of the CARB ATCM regulation - *The purpose of this airborne toxic control measure is to “reduce formaldehyde emissions from composite wood products, and finished goods that contain composite wood products, that are sold, offered for sale, supplied, used, or manufactured for sale in California”*. In other words, the CARB ATCM regulations do not “assure healthful indoor air quality”, but rather “reduce formaldehyde emissions from composite wood products”.

Just how much protection do the CARB ATCM regulations provide building occupants from the formaldehyde emissions generated by composite wood products? Definitely some, but certainly the regulations do not “*assure healthful indoor air quality*” when CARB Phase 2 products are utilized. As shown in the Chan 2019 study of new California homes, the median indoor formaldehyde concentration was of 22.4 $\mu\text{g}/\text{m}^3$ (18.2 ppb), which corresponds to a cancer risk of 112 per million for occupants with continuous exposure, which is more than 11 times the CEQA cancer risk of 10 per million.

Another way of looking at how much protection the CARB ATCM regulations provide building occupants from the formaldehyde emissions generated by composite wood products is to calculate the maximum number of square feet of composite wood product that can be in a residence without exceeding the CEQA cancer risk of 10 per million for occupants with continuous occupancy.

For this calculation I utilized the floor area (2,272 ft^2), the ceiling height (8.5 ft), and the number of bedrooms (4) as defined in Appendix B (New Single-Family Residence Scenario) of the Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions for Indoor Sources Using Environmental Chambers, Version 1.1, 2017, California

Department of Public Health, Richmond, CA. <https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHLB/IAQ/Pages/VOC.aspx>.

For the outdoor air ventilation rate I used the 2019 Title 24 code required mechanical ventilation rate (ASHRAE 62.2) of 106 cfm (180 m³/h) calculated for this model residence. For the composite wood formaldehyde emission rates I used the CARB ATCM Phase 2 rates.

The calculated maximum number of square feet of composite wood product that can be in a residence, without exceeding the CEQA cancer risk of 10 per million for occupants with continuous occupancy are as follows for the different types of regulated composite wood products.

Medium Density Fiberboard (MDF) – 15 ft² (0.7% of the floor area), or
Particle Board – 30 ft² (1.3% of the floor area), or
Hardwood Plywood – 54 ft² (2.4% of the floor area), or
Thin MDF – 46 ft² (2.0 % of the floor area).

For offices and hotels the calculated maximum amount of composite wood product (% of floor area) that can be used without exceeding the CEQA cancer risk of 10 per million for occupants, assuming 8 hours/day occupancy, and the California Mechanical Code minimum outdoor air ventilation rates are as follows for the different types of regulated composite wood products.

Medium Density Fiberboard (MDF) – 3.6 % (offices) and 4.6% (hotel rooms), or
Particle Board – 7.2 % (offices) and 9.4% (hotel rooms), or
Hardwood Plywood – 13 % (offices) and 17% (hotel rooms), or
Thin MDF – 11 % (offices) and 14 % (hotel rooms)

Clearly the CARB ATCM does not regulate the formaldehyde emissions from composite wood products such that the potentially large areas of these products, such as for flooring, baseboards, interior doors, window and door trims, and kitchen and bathroom cabinetry,

could be used without causing indoor formaldehyde concentrations that result in CEQA cancer risks that substantially exceed 10 per million for occupants with continuous occupancy.

Even composite wood products manufactured with CARB certified ultra low emitting formaldehyde (ULEF) resins do not insure that the indoor air will have concentrations of formaldehyde that meet the OEHHA cancer risks that substantially exceed 10 per million. The permissible emission rates for ULEF composite wood products are only 11-15% lower than the CARB Phase 2 emission rates. Only use of composite wood products made with no-added formaldehyde resins (NAF), such as resins made from soy, polyvinyl acetate, or methylene diisocyanate can insure that the OEHHA cancer risk of 10 per million is met.

If CARB Phase 2 compliant or ULEF composite wood products are utilized in construction, then the resulting indoor formaldehyde concentrations should be determined in the design phase using the specific amounts of each type of composite wood product, the specific formaldehyde emission rates, and the volume and outdoor air ventilation rates of the indoor spaces, and all feasible mitigation measures employed to reduce this impact (e.g. use less formaldehyde containing composite wood products and/or incorporate mechanical systems capable of higher outdoor air ventilation rates). See the procedure described earlier (i.e., Pre-Construction Building Material/Furnishing Formaldehyde Emissions Assessment) to insure that the materials selected achieve acceptable cancer risks from material off gassing of formaldehyde.

Alternatively, and perhaps a simpler approach, is to use only composite wood products (e.g. hardwood plywood, medium density fiberboard, particleboard) for all interior finish systems that are made with CARB approved no-added formaldehyde (NAF) resins.

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Education

M.S. Mechanical Engineering (1985)
Stanford University, Stanford, CA.

Graduate Studies in Air Pollution Monitoring and Control (1980)
University of California, Berkeley, CA.

B.S. in Mechanical Engineering (1976)
Rensselaer Polytechnic Institute, Troy, N.Y.

Professional Experience

President: Indoor Environmental Engineering, San Francisco, CA. December, 1981 - present.

Direct team of environmental scientists, chemists, and mechanical engineers in conducting State and Federal research regarding indoor air quality instrumentation development, building air quality field studies, ventilation and air cleaning performance measurements, and chemical emission rate testing.

Provide design side input to architects regarding selection of building materials and ventilation system components to ensure a high quality indoor environment.

Direct Indoor Air Quality Consulting Team for the winning design proposal for the new State of Washington Ecology Department building.

Develop a full-scale ventilation test facility for measuring the performance of air diffusers; ASHRAE 129, Air Change Effectiveness, and ASHRAE 113, Air Diffusion Performance Index.

Develop a chemical emission rate testing laboratory for measuring the chemical emissions from building materials, furnishings, and equipment.

Principle Investigator of the California New Homes Study (2005-2007). Measured ventilation and indoor air quality in 108 new single family detached homes in northern and southern California.

Develop and teach IAQ professional development workshops to building owners, managers, hygienists, and engineers.

Air Pollution Engineer: Earth Metrics Inc., Burlingame, CA, October, 1985 to March, 1987.

Responsible for development of an air pollution laboratory including installation a forced choice olfactometer, tracer gas electron capture chromatograph, and associated calibration facilities. Field team leader for studies of fugitive odor emissions from sewage treatment plants, entrainment of fume hood exhausts into computer chip fabrication rooms, and indoor air quality investigations.

Staff Scientist: Building Ventilation and Indoor Air Quality Program, Energy and Environment Division, Lawrence Berkeley Laboratory, Berkeley, CA. January, 1980 to August, 1984.

Deputy project leader for the Control Techniques group; responsible for laboratory and field studies aimed at evaluating the performance of indoor air pollutant control strategies (i.e. ventilation, filtration, precipitation, absorption, adsorption, and source control).

Coordinated field and laboratory studies of air-to-air heat exchangers including evaluation of thermal performance, ventilation efficiency, cross-stream contaminant transfer, and the effects of freezing/defrosting.

Developed an *in situ* test protocol for evaluating the performance of air cleaning systems and introduced the concept of effective cleaning rate (ECR) also known as the Clean Air Delivery Rate (CADR).

Coordinated laboratory studies of portable and ducted air cleaning systems and their effect on indoor concentrations of respirable particles and radon progeny.

Co-designed an automated instrument system for measuring residential ventilation rates and radon concentrations.

Designed hardware and software for a multi-channel automated data acquisition system used to evaluate the performance of air-to-air heat transfer equipment.

Assistant Chief Engineer: Alta Bates Hospital, Berkeley, CA, October, 1979 to January, 1980.

Responsible for energy management projects involving installation of power factor correction capacitors on large inductive electrical devices and installation of steam meters on physical plant steam lines. Member of Local 39, International Union of Operating Engineers.

Manufacturing Engineer: American Precision Industries, Buffalo, NY, October, 1977 to October, 1979.

Responsible for reorganizing the manufacturing procedures regarding production of shell and tube heat exchangers. Designed customized automatic assembly, welding, and testing equipment. Designed a large paint spray booth. Prepared economic studies justifying new equipment purchases. Safety Director.

Project Engineer: Arcata Graphics, Buffalo, N.Y. June, 1976 to October, 1977.

Responsible for the design and installation of a bulk ink storage and distribution system and high speed automatic counting and marking equipment. Also coordinated material handling studies which led to the purchase and installation of new equipment.

PROFESSIONAL ORGANIZATION MEMBERSHIP

American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

- Chairman of SPC-145P, Standards Project Committee - Test Method for Assessing the Performance of Gas Phase Air Cleaning Equipment (1991-1992)
- Member SPC-129P, Standards Project Committee - Test Method for Ventilation Effectiveness (1986-97)
 - Member of Drafting Committee
- Member Environmental Health Committee (1992-1994, 1997-2001, 2007-2010)
 - Chairman of EHC Research Subcommittee
 - Member of Man Made Mineral Fiber Position Paper Subcommittee
 - Member of the IAQ Position Paper Committee
 - Member of the Legionella Position Paper Committee
 - Member of the Limiting Indoor Mold and Dampness in Buildings Position Paper Committee
- Member SSPC-62, Standing Standards Project Committee - Ventilation for Acceptable Indoor Air Quality (1992 to 2000)
 - Chairman of Source Control and Air Cleaning Subcommittee
- Chairman of TC-4.10, Indoor Environmental Modeling (1988-92)
 - Member of Research Subcommittee
- Chairman of TC-2.3, Gaseous Air Contaminants and Control Equipment (1989-92)
 - Member of Research Subcommittee

American Society for Testing and Materials (ASTM)

- D-22 Sampling and Analysis of Atmospheres
 - Member of Indoor Air Quality Subcommittee
- E-06 Performance of Building Constructions

American Board of Industrial Hygiene (ABIH)

American Conference of Governmental Industrial Hygienists (ACGIH)

- Bioaerosols Committee (2007-2013)

American Industrial Hygiene Association (AIHA)

Cal-OSHA Indoor Air Quality Advisory Committee

International Society of Indoor Air Quality and Climate (ISIAQ)

- Co-Chairman of Task Force on HVAC Hygiene

U. S. Green Building Council (USGBC)

- Member of the IEQ Technical Advisory Group (2007-2009)
- Member of the IAQ Performance Testing Work Group (2010-2012)

Western Construction Consultants (WESTCON)

PROFESSIONAL CREDENTIALS

Licensed Professional Engineer - Mechanical Engineering

Certified Industrial Hygienist - American Board of Industrial Hygienists

SCIENTIFIC MEETINGS AND SYMPOSIA

Biological Contamination, Diagnosis, and Mitigation, Indoor Air'90, Toronto, Canada, August, 1990.

Models for Predicting Air Quality, Indoor Air'90, Toronto, Canada, August, 1990.

Microbes in Building Materials and Systems, Indoor Air '93, Helsinki, Finland, July, 1993.

Microorganisms in Indoor Air Assessment and Evaluation of Health Effects and Probable Causes, Walnut Creek, CA, February 27, 1997.

Controlling Microbial Moisture Problems in Buildings, Walnut Creek, CA, February 27, 1997.

Scientific Advisory Committee, Roomvent 98, 6th International Conference on Air Distribution in Rooms, KTH, Stockholm, Sweden, June 14-17, 1998.

Moisture and Mould, Indoor Air '99, Edinburgh, Scotland, August, 1999.

Ventilation Modeling and Simulation, Indoor Air '99, Edinburgh, Scotland, August, 1999.

Microbial Growth in Materials, Healthy Buildings 2000, Espoo, Finland, August, 2000.

Co-Chair, Bioaerosols X- Exposures in Residences, Indoor Air 2002, Monterey, CA, July 2002.

Healthy Indoor Environments, Anaheim, CA, April 2003.

Chair, Environmental Tobacco Smoke in Multi-Family Homes, Indoor Air 2008, Copenhagen, Denmark, July 2008.

Co-Chair, ISIAQ Task Force Workshop; HVAC Hygiene, Indoor Air 2002, Monterey, CA, July 2002.

Chair, ETS in Multi-Family Housing: Exposures, Controls, and Legalities Forum, Healthy Buildings 2009, Syracuse, CA, September 14, 2009.

Chair, Energy Conservation and IAQ in Residences Workshop, Indoor Air 2011, Austin, TX, June 6, 2011.

Chair, Electronic Cigarettes: Chemical Emissions and Exposures Colloquium, Indoor Air 2016, Ghent, Belgium, July 4, 2016.

SPECIAL CONSULTATION

Provide consultation to the American Home Appliance Manufacturers on the development of a standard for testing portable air cleaners, AHAM Standard AC-1.

Served as an expert witness and special consultant for the U.S. Federal Trade Commission regarding the performance claims found in advertisements of portable air cleaners and residential furnace filters.

Conducted a forensic investigation for a San Mateo, CA pro se defendant, regarding an alleged homicide where the victim was kidnapped in a steamer trunk. Determined the air exchange rate in the steamer trunk and how long the person could survive.

Conducted *in situ* measurement of human exposure to toluene fumes released during nailpolish application for a plaintiffs attorney pursuing a California Proposition 65 product labeling case. June, 1993.

Conducted a forensic *in situ* investigation for the Butte County, CA Sheriff's Department of the emissions of a portable heater used in the bedroom of two twin one year old girls who suffered simultaneous crib death.

Consult with OSHA on the 1995 proposed new regulation regarding indoor air quality and environmental tobacco smoke.

Consult with EPA on the proposed Building Alliance program and with OSHA on the proposed new OSHA IAQ regulation.

Johnson Controls Audit/Certification Expert Review; Milwaukee, WI. May 28-29, 1997.

Winner of the nationally published 1999 Request for Proposals by the State of Washington to conduct a comprehensive indoor air quality investigation of the Washington State Department of Ecology building in Lacey, WA.

Selected by the State of California Attorney General's Office in August, 2000 to conduct a comprehensive indoor air quality investigation of the Tulare County Court House.

Lawrence Berkeley Laboratory IAQ Experts Workshop: "Cause and Prevention of Sick Building Problems in Offices: The Experience of Indoor Environmental Quality Investigators", Berkeley, California, May 26-27, 2004.

Provide consultation and chemical emission rate testing to the State of California Attorney General's Office in 2013-2015 regarding the chemical emissions from e-cigarettes.

PEER-REVIEWED PUBLICATIONS :

F.J.Offermann, C.D.Hollowell, and G.D.Roseme, "Low-Infiltration Housing in Rochester, New York: A Study of Air Exchange Rates and Indoor Air Quality," *Environment International*, 8, pp. 435-445, 1982.

W.W.Nazaroff, F.J.Offermann, and A.W.Robb, "Automated System for Measuring Air Exchange Rate and Radon Concentration in Houses," *Health Physics*, 45, pp. 525-537, 1983.

F.J.Offermann, W.J.Fisk, D.T.Grimsrud, B.Pedersen, and K.L.Revzan, "Ventilation Efficiencies of Wall- or Window-Mounted Residential Air-to-Air Heat Exchangers," *ASHRAE Annual Transactions*, 89-2B, pp 507-527, 1983.

W.J.Fisk, K.M.Archer, R.E Chant, D. Hekmat, F.J.Offermann, and B.Pedersen, "Onset of Freezing in Residential Air-to-Air Heat Exchangers," *ASHRAE Annual Transactions*, 91-1B, 1984.

W.J.Fisk, K.M.Archer, R.E Chant, D. Hekmat, F.J.Offermann, and B.Pedersen, "Performance of Residential Air-to-Air Heat Exchangers During Operation with Freezing and Periodic Defrosts," *ASHRAE Annual Transactions*, 91-1B, 1984.

F.J.Offermann, R.G.Sextro, W.J.Fisk, D.T.Grimsrud, W.W.Nazaroff, A.V.Nero, and K.L.Revzan, "Control of Respirable Particles with Portable Air Cleaners," *Atmospheric Environment*, Vol. 19, pp.1761-1771, 1985.

R.G.Sextro, F.J.Offermann, W.W.Nazaroff, A.V.Nero, K.L.Revzan, and J.Yater, "Evaluation of Indoor Control Devices and Their Effects on Radon Progeny Concentrations," *Atmospheric Environment*, *12*, pp. 429-438, 1986.

W.J. Fisk, R.K.Spencer, F.J.Offermann, R.K.Spencer, B.Pedersen, R.Sextro, "Indoor Air Quality Control Techniques," *Noyes Data Corporation*, Park Ridge, New Jersey, (1987).

F.J.Offermann, "Ventilation Effectiveness and ADPI Measurements of a Forced Air Heating System," *ASHRAE Transactions* , Volume 94, Part 1, pp 694-704, 1988.

F.J.Offermann and D. Int-Hout "Ventilation Effectiveness Measurements of Three Supply/Return Air Configurations," *Environment International* , Volume 15, pp 585-592 1989.

F.J. Offermann, S.A. Loiselle, M.C. Quinlan, and M.S. Rogers, "A Study of Diesel Fume Entrainment in an Office Building," *IAQ '89*, The Human Equation: Health and Comfort, pp 179-183, ASHRAE, Atlanta, GA, 1989.

R.G.Sextro and F.J.Offermann, "Reduction of Residential Indoor Particle and Radon Progeny Concentrations with Ducted Air Cleaning Systems," submitted to *Indoor Air*, 1990.

S.A.Loiselle, A.T.Hodgson, and F.J.Offermann, "Development of An Indoor Air Sampler for Polycyclic Aromatic Compounds", *Indoor Air* , Vol 2, pp 191-210, 1991.

F.J.Offermann, S.A.Loiselle, A.T.Hodgson, L.A. Gundel, and J.M. Daisey, "A Pilot Study to Measure Indoor Concentrations and Emission Rates of Polycyclic Aromatic Compounds", *Indoor Air* , Vol 4, pp 497-512, 1991.

F.J. Offermann, S. A. Loiselle, R.G. Sextro, "Performance Comparisons of Six Different Air Cleaners Installed in a Residential Forced Air Ventilation System," *IAQ'91*, Healthy Buildings, pp 342-350, ASHRAE, Atlanta, GA (1991).

F.J. Offermann, J. Daisey, A. Hodgson, L. Gundell, and S. Loiselle, "Indoor Concentrations and Emission Rates of Polycyclic Aromatic Compounds", *Indoor Air*, Vol 4, pp 497-512 (1992).

F.J. Offermann, S. A. Loiselle, R.G. Sextro, "Performance of Air Cleaners Installed in a Residential Forced Air System," *ASHRAE Journal*, pp 51-57, July, 1992.

F.J. Offermann and S. A. Loiselle, "Performance of an Air-Cleaning System in an Archival Book Storage Facility," *IAQ'92*, ASHRAE, Atlanta, GA, 1992.

S.B. Hayward, K.S. Liu, L.E. Alevantis, K. Shah, S. Loiselle, F.J. Offermann, Y.L. Chang, L. Webber, "Effectiveness of Ventilation and Other Controls in Reducing Exposure to ETS in Office Buildings," *Indoor Air '93*, Helsinki, Finland, July 4-8, 1993.

F.J. Offermann, S. A. Loiselle, G. Ander, H. Lau, "Indoor Contaminant Emission Rates Before and After a Building Bake-out," *IAQ'93*, Operating and Maintaining Buildings for Health, Comfort, and Productivity, pp 157-163, ASHRAE, Atlanta, GA, 1993.

L.E. Alevantis, Hayward, S.B., Shah, S.B., Loiselle, S., and Offermann, F.J. "Tracer Gas Techniques for Determination of the Effectiveness of Pollutant Removal From Local Sources," *IAQ '93*, Operating and Maintaining Buildings for Health, Comfort, and Productivity, pp 119-129, ASHRAE, Atlanta, GA, 1993.

L.E. Alevantis, Liu, L.E., Hayward, S.B., Offermann, F.J., Shah, S.B., Leiserson, K. Tsao, E., and Huang, Y., "Effectiveness of Ventilation in 23 Designated Smoking Areas in California Buildings," *IAQ '94*, Engineering Indoor Environments, pp 167-181, ASHRAE, Atlanta, GA, 1994.

L.E. Alevantis, Offermann, F.J., Loiselle, S., and Macher, J.M., "Pressure and Ventilation Requirements of Hospital Isolation Rooms for Tuberculosis (TB) Patients: Existing Guidelines in the United States and a Method for Measuring Room Leakage", Ventilation and Indoor air quality in Hospitals, M. Maroni, editor, Kluwer Academic publishers, Netherlands, 1996.

F.J. Offermann, M. A. Waz, A.T. Hodgson, and H.M. Ammann, "Chemical Emissions from a Hospital Operating Room Air Filter," *IAQ'96*, Paths to Better Building Environments, pp 95-99, ASHRAE, Atlanta, GA, 1996.

F.J. Offermann, "Professional Malpractice and the Sick Building Investigator," *IAQ'96*, Paths to Better Building Environments, pp 132-136, ASHRAE, Atlanta, GA, 1996.

F.J. Offermann, "Standard Method of Measuring Air Change Effectiveness," *Indoor Air*, Vol 1, pp.206-211, 1999.

F. J. Offermann, A. T. Hodgson, and J. P. Robertson, "Contaminant Emission Rates from PVC Backed Carpet Tiles on Damp Concrete", Healthy Buildings 2000, Espoo, Finland, August 2000.

K.S. Liu, L.E. Alevantis, and F.J. Offermann, "A Survey of Environmental Tobacco Smoke Controls in California Office Buildings", *Indoor Air*, Vol 11, pp. 26-34, 2001.

F.J. Offermann, R. Colfer, P. Radzinski, and J. Robertson, "Exposure to Environmental Tobacco Smoke in an Automobile", Indoor Air 2002, Monterey, California, July 2002.

F. J. Offermann, J.P. Robertson, and T. Webster, "The Impact of Tracer Gas Mixing on Airflow Rate Measurements in Large Commercial Fan Systems", Indoor Air 2002, Monterey, California, July 2002.

M. J. Mendell, T. Brennan, L. Hathon, J.D. Odom, F.J. Offermann, B.H. Turk, K.M. Wallingford, R.C. Diamond, W.J. Fisk, "Causes and prevention of Symptom Complaints

in Office Buildings: Distilling the Experience of Indoor Environmental Investigators”, submitted to Indoor Air 2005, Beijing, China, September 4-9, 2005.

F.J. Offermann, “Ventilation and IAQ in New Homes With and Without Mechanical Outdoor Air Systems”, Healthy Buildings 2009, Syracuse, CA, September 14, 2009.

F.J. Offermann, “ASHRAE 62.2 Intermittent Residential Ventilation: What’s It Good For, Intermittently Poor IAQ”, IAQVEC 2010, Syracuse, CA, April 21, 2010.

F.J. Offermann and A.T. Hodgson, “Emission Rates of Volatile Organic Compounds in New Homes”, Indoor Air 2011, Austin, TX, June, 2011.

P. Jenkins, R. Johnson, T. Phillips, and F. Offermann, “Chemical Concentrations in New California Homes and Garages”, Indoor Air 2011, Austin, TX, June, 2011.

W. J. Mills, B. J. Grigg, F. J. Offermann, B. E. Gustin, and N. E. Spingarm, “Toluene and Methyl Ethyl Ketone Exposure from a Commercially Available Contact Adhesive”, Journal of Occupational and Environmental Hygiene, 9:D95-D102 May, 2012.

F. J. Offermann, R. Maddalena, J. C. Offermann, B. C. Singer, and H. Wilhelm, “The Impact of Ventilation on the Emission Rates of Volatile Organic Compounds in Residences”, HB 2012, Brisbane, AU, July, 2012.

F. J. Offermann, A. T. Hodgson, P. L. Jenkins, R. D. Johnson, and T. J. Phillips, “Attached Garages as a Source of Volatile Organic Compounds in New Homes”, HB 2012, Brisbane, CA, July, 2012.

R. Maddalena, N. Li, F. Offermann, and B. Singer, “Maximizing Information from Residential Measurements of Volatile Organic Compounds”, HB 2012, Brisbane, AU, July, 2012.

W. Chen, A. Persily, A. Hodgson, F. Offermann, D. Poppendieck, and K. Kumagai, “Area-Specific Airflow Rates for Evaluating the Impacts of VOC emissions in U.S. Single-Family Homes”, Building and Environment, Vol. 71, 204-211, February, 2014.

F. J. Offermann, A. Eagan A. C. Offermann, and L. J. Radonovich, “Infectious Disease Aerosol Exposures With and Without Surge Control Ventilation System Modifications”, Indoor Air 2014, Hong Kong, July, 2014.

F. J. Offermann, “Chemical Emissions from E-Cigarettes: Direct and Indirect Passive Exposures”, Building and Environment, Vol. 93, Part 1, 101-105, November, 2015.

F. J. Offermann, “Formaldehyde Emission Rates From Lumber Liquidators Laminate Flooring Manufactured in China”, Indoor Air 2016, Belgium, Ghent, July, 2016.

F. J. Offermann, “Formaldehyde and Acetaldehyde Emission Rates for E-Cigarettes”, Indoor Air 2016, Belgium, Ghent, July, 2016.

OTHER REPORTS:

W.J.Fisk, P.G.Cleary, and F.J.Offermann, "Energy Saving Ventilation with Residential Heat Exchangers," a Lawrence Berkeley Laboratory brochure distributed by the Bonneville Power Administration, 1981.

F.J.Offermann, J.R.Girman, and C.D.Hollowell, "Midway House Tightening Project: A Study of Indoor Air Quality," Lawrence Berkeley Laboratory, Berkeley, CA, Report LBL-12777, 1981.

F.J.Offermann, J.B.Dickinson, W.J.Fisk, D.T.Grimsrud, C.D.Hollowell, D.L.Krinkle, and G.D.Roseme, "Residential Air-Leakage and Indoor Air Quality in Rochester, New York," Lawrence Berkeley Laboratory, Berkeley, CA, Report LBL-13100, 1982.

F.J.Offermann, W.J.Fisk, B.Pedersen, and K.L.Revzan, Residential Air-to-Air Heat Exchangers: A Study of the Ventilation Efficiencies of Wall- or Window- Mounted Units," Lawrence Berkeley Laboratory, Berkeley, CA, Report LBL-14358, 1982.

F.J.Offermann, W.J.Fisk, W.W.Nazaroff, and R.G.Sextro, "A Review of Portable Air Cleaners for Controlling Indoor Concentrations of Particulates and Radon Progeny," An interim report for the Bonneville Power Administration, 1983.

W.J.Fisk, K.M.Archer, R.E.Chant, D.Hekmat, F.J.Offermann, and B.S. Pedersen, "Freezing in Residential Air-to-Air Heat Exchangers: An Experimental Study," Lawrence Berkeley Laboratory, Berkeley, CA, Report LBL-16783, 1983.

R.G.Sextro, W.W.Nazaroff, F.J.Offermann, and K.L.Revzan, "Measurements of Indoor Aerosol Properties and Their Effect on Radon Progeny," Proceedings of the American Association of Aerosol Research Annual Meeting, April, 1983.

F.J.Offermann, R.G.Sextro, W.J.Fisk, W.W. Nazaroff, A.V.Nero, K.L.Revzan, and J.Yater, "Control of Respirable Particles and Radon Progeny with Portable Air Cleaners," Lawrence Berkeley Laboratory, Berkeley, CA, Report LBL-16659, 1984.

W.J.Fisk, R.K.Spencer, D.T.Grimsrud, F.J.Offermann, B.Pedersen, and R.G.Sextro, "Indoor Air Quality Control Techniques: A Critical Review," Lawrence Berkeley Laboratory, Berkeley, CA, Report LBL-16493, 1984.

F.J.Offermann, J.R.Girman, and R.G.Sextro, "Controlling Indoor Air Pollution from Tobacco Smoke: Models and Measurements," Indoor Air, Proceedings of the 3rd International Conference on Indoor Air Quality and Climate, Vol 1, pp 257-264, Swedish Council for Building Research, Stockholm (1984), Lawrence Berkeley Laboratory, Berkeley, CA, Report LBL-17603, 1984.

R.Otto, J.Girman, F.Offermann, and R.Sextro, "A New Method for the Collection and Comparison of Respirable Particles in the Indoor Environment," Lawrence Berkeley Laboratory, Berkeley, CA, Special Director Fund's Study, 1984.

A.T.Hodgson and F.J.Offermann, "Examination of a Sick Office Building," Lawrence Berkeley Laboratory, Berkeley, CA, an informal field study, 1984.

R.G.Sextro, F.J.Offermann, W.W.Nazaroff, and A.V.Nero, "Effects of Aerosol Concentrations on Radon Progeny," *Aerosols, Science, & Technology, and Industrial Applications of Airborne Particles*, editors B.Y.H.Liu, D.Y.H.Pui, and H.J.Fissan, p525, Elsevier, 1984.

K.Sexton, S.Hayward, F.Offermann, R.Sextro, and L.Weber, "Characterization of Particulate and Organic Emissions from Major Indoor Sources, Proceedings of the Third International Conference on Indoor Air Quality and Climate, Stockholm, Sweden, August 20-24, 1984.

F.J.Offermann, "Tracer Gas Measurements of Laboratory Fume Entrainment at a Semiconductor Manufacturing Plant," an Indoor Environmental Engineering R&D Report, 1986.

F.J.Offermann, "Tracer Gas Measurements of Ventilation Rates in a Large Office Building," an Indoor Environmental Engineering R&D Report, 1986.

F.J.Offermann, "Measurements of Volatile Organic Compounds in a New Large Office Building with Adhesive Fastened Carpeting," an Indoor Environmental Engineering R&D Report, 1986.

F.J.Offermann, "Designing and Operating Healthy Buildings", an Indoor Environmental Engineering R&D Report, 1986.

F.J.Offermann, "Measurements and Mitigation of Indoor Spray-Applied Pesticides", an Indoor Environmental Engineering R&D Report, 1988.

F.J.Offermann and S. Loiselle, "Measurements and Mitigation of Indoor Mold Contamination in a Residence", an Indoor Environmental Engineering R&D Report, 1989.

F.J.Offermann and S. Loiselle, "Performance Measurements of an Air Cleaning System in a Large Archival Library Storage Facility", an Indoor Environmental Engineering R&D Report, 1989.

F.J. Offermann, J.M. Daisey, L.A. Gundel, and A.T. Hodgson, S. A. Loiselle, "Sampling, Analysis, and Data Validation of Indoor Concentrations of Polycyclic Aromatic Hydrocarbons", Final Report, Contract No. A732-106, California Air Resources Board, March, 1990.

L.A. Gundel, J.M. Daisey, and F.J. Offermann, "A Sampling and Analytical Method for Gas Phase Polycyclic Aromatic Hydrocarbons", Proceedings of the 5th International Conference on Indoor Air Quality and Climate, Indoor Air '90, July 29-August 1990.

A.T. Hodgson, J.M. Daisey, and F.J. Offermann "Development of an Indoor Sampling and Analytical Method for Particulate Polycyclic Aromatic Hydrocarbons", Proceedings of the 5th International Conference on Indoor Air Quality and Climate, Indoor Air '90, July 29-August, 1990.

F.J. Offermann, J.O. Sateri, "Tracer Gas Measurements in Large Multi-Room Buildings", Indoor Air '93, Helsinki, Finland, July 4-8, 1993.

F.J. Offermann, M. T. O'Flaherty, and M. A. Waz "Validation of ASHRAE 129 - Standard Method of Measuring Air Change Effectiveness", Final Report of ASHRAE Research Project 891, December 8, 1997.

S.E. Guffey, F.J. Offermann et. al., "Proceedings of the Workshop on Ventilation Engineering Controls for Environmental Tobacco smoke in the Hospitality Industry", U.S. Department of Labor Occupational Safety and Health Administration and ACGIH, 1998.

F.J. Offermann, R.J. Fiskum, D. Kosar, and D. Mudaari, "A Practical Guide to Ventilation Practices & Systems for Existing Buildings", *Heating/Piping/Air Conditioning Engineering* supplement to April/May 1999 issue.

F.J. Offermann, P. Pasanen, "Workshop 18: Criteria for Cleaning of Air Handling Systems", Healthy Buildings 2000, Espoo, Finland, August 2000.

F.J. Offermann, Session Summaries: Building Investigations, and Design & Construction, Healthy Buildings 2000, Espoo, Finland, August 2000.

F.J. Offermann, "The IAQ Top 10", Engineered Systems, November, 2008.

L. Kincaid and F.J. Offermann, "Unintended Consequences: Formaldehyde Exposures in Green Homes, AIHA Synergist, February, 2010.

F.J. Offermann, "IAQ in Air Tight Homes", ASHRAE Journal, November, 2010.

F.J. Offermann, "The Hazards of E-Cigarettes", ASHRAE Journal, June, 2014.

PRESENTATIONS :

"Low-Infiltration Housing in Rochester, New York: A Study of Air Exchange Rates and Indoor Air Quality," Presented at the International Symposium on Indoor Air Pollution, Health and Energy Conservation, Amherst, MA, October 13-16, 1981.

"Ventilation Efficiencies of Wall- or Window-Mounted Residential Air-to-Air Heat Exchangers," Presented at the American Society of Heating, Refrigeration, and Air Conditioning Engineers Summer Meeting, Washington, DC, June, 1983.

"Controlling Indoor Air Pollution from Tobacco Smoke: Models and Measurements," Presented at the Third International Conference on Indoor Air Quality and Climate, Stockholm, Sweden, August 20-24, 1984.

"Indoor Air Pollution: An Emerging Environmental Problem", Presented to the Association of Environmental Professionals, Bar Area/Coastal Region 1, Berkeley, CA, May 29, 1986.

"Ventilation Measurement Techniques," Presented at the Workshop on Sampling and Analytical Techniques, Georgia Institute of Technology, Atlanta, Georgia, September 26, 1986 and September 25, 1987.

"Buildings That Make You Sick: Indoor Air Pollution", Presented to the Sacramento Association of Professional Energy Managers, Sacramento, CA, November 18, 1986.

"Ventilation Effectiveness and Indoor Air Quality", Presented to the American Society of Heating, Refrigeration, and Air Conditioning Engineers Northern Nevada Chapter, Reno, NV, February 18, 1987, Golden Gate Chapter, San Francisco, CA, October 1, 1987, and the San Jose Chapter, San Jose, CA, June 9, 1987.

"Tracer Gas Techniques for Studying Ventilation," Presented at the Indoor Air Quality Symposium, Georgia Tech Research Institute, Atlanta, GA, September 22-24, 1987.

"Indoor Air Quality Control: What Works, What Doesn't," Presented to the Sacramento Association of Professional Energy Managers, Sacramento, CA, November 17, 1987.

"Ventilation Effectiveness and ADPI Measurements of a Forced Air Heating System," Presented at the American Society of Heating, Refrigeration, and Air Conditioning Engineers Winter Meeting, Dallas, Texas, January 31, 1988.

"Indoor Air Quality, Ventilation, and Energy in Commercial Buildings", Presented at the Building Owners & Managers Association of Sacramento, Sacramento, CA, July 21, 1988.

"Controlling Indoor Air Quality: The New ASHRAE Ventilation Standards and How to Evaluate Indoor Air Quality", Presented at a conference "Improving Energy Efficiency and Indoor Air Quality in Commercial Buildings," National Energy Management Institute, Reno, Nevada, November 4, 1988.

"A Study of Diesel Fume Entrainment Into an Office Building," Presented at Indoor Air '89: The Human Equation: Health and Comfort, American Society of Heating, Refrigeration, and Air Conditioning Engineers, San Diego, CA, April 17-20, 1989.

"Indoor Air Quality in Commercial Office Buildings," Presented at the Renewable Energy Technologies Symposium and International Exposition, Santa Clara, CA June 20, 1989.

"Building Ventilation and Indoor Air Quality", Presented to the San Joaquin Chapter of the American Society of Heating, Refrigeration, and Air Conditioning Engineers, September 7, 1989.

"How to Meet New Ventilation Standards: Indoor Air Quality and Energy Efficiency," a workshop presented by the Association of Energy Engineers; Chicago, IL, March 20-21, 1989; Atlanta, GA, May 25-26, 1989; San Francisco, CA, October 19-20, 1989; Orlando, FL, December 11-12, 1989; Houston, TX, January 29-30, 1990; Washington D.C., February 26-27, 1990; Anchorage, Alaska, March 23, 1990; Las Vegas, NV, April 23-24, 1990; Atlantic City, NJ, September 27-28, 1991; Anaheim, CA, November 19-20, 1991; Orlando, FL, February 28 - March 1, 1991; Washington, DC, March 20-21, 1991; Chicago, IL, May 16-17, 1991; Lake Tahoe, NV, August 15-16, 1991; Atlantic City, NJ, November 18-19, 1991; San Jose, CA, March 23-24, 1992.

"Indoor Air Quality," a seminar presented by the Anchorage, Alaska Chapter of the American Society of Heating, Refrigeration, and Air Conditioning Engineers, March 23, 1990.

"Ventilation and Indoor Air Quality", Presented at the 1990 HVAC & Building Systems Congress, Santa Clara, CA, March 29, 1990.

"Ventilation Standards for Office Buildings", Presented to the South Bay Property Managers Association, Santa Clara, May 9, 1990.

"Indoor Air Quality", Presented at the Responsive Energy Technologies Symposium & International Exposition (RETSIE), Santa Clara, CA, June 20, 1990.

"Indoor Air Quality - Management and Control Strategies", Presented at the Association of Energy Engineers, San Francisco Bay Area Chapter Meeting, Berkeley, CA, September 25, 1990.

"Diagnosing Indoor Air Contaminant and Odor Problems", Presented at the ASHRAE Annual Meeting, New York City, NY, January 23, 1991.

"Diagnosing and Treating the Sick Building Syndrome", Presented at the Energy 2001, Oklahoma, OK, March 19, 1991.

"Diagnosing and Mitigating Indoor Air Quality Problems" a workshop presented by the Association of Energy Engineers, Chicago, IL, October 29-30, 1990; New York, NY, January 24-25, 1991; Anaheim, April 25-26, 1991; Boston, MA, June 10-11, 1991; Atlanta, GA, October 24-25, 1991; Chicago, IL, October 3-4, 1991; Las Vegas, NV, December 16-17, 1991; Anaheim, CA, January 30-31, 1992; Atlanta, GA, March 5-6, 1992; Washington, DC, May 7-8, 1992; Chicago, IL, August 19-20, 1992; Las Vegas,

NV, October 1-2, 1992; New York City, NY, October 26-27, 1992, Las Vegas, NV, March 18-19, 1993; Lake Tahoe, CA, July 14-15, 1994; Las Vegas, NV, April 3-4, 1995; Lake Tahoe, CA, July 11-12, 1996; Miami, FL, December 9-10, 1996.

"Sick Building Syndrome and the Ventilation Engineer", Presented to the San Jose Engineers Club, May, 21, 1991.

"Duct Cleaning: Who Needs It ? How Is It Done ? What Are The Costs ?" What Are the Risks ?, Moderator of Forum at the ASHRAE Annual Meeting, Indianapolis ID, June 23, 1991.

"Operating Healthy Buildings", Association of Plant Engineers, Oakland, CA, November 14, 1991.

"Duct Cleaning Perspectives", Moderator of Seminar at the ASHRAE Semi-Annual Meeting, Indianapolis, IN, June 24, 1991.

"Duct Cleaning: The Role of the Environmental Hygienist," ASHRAE Annual Meeting, Anaheim, CA, January 29, 1992.

"Emerging IAQ Issues", Fifth National Conference on Indoor Air Pollution, University of Tulsa, Tulsa, OK, April 13-14, 1992.

"International Symposium on Room Air Convection and Ventilation Effectiveness", Member of Scientific Advisory Board, University of Tokyo, July 22-24, 1992.

"Guidelines for Contaminant Control During Construction and Renovation Projects in Office Buildings," Seminar paper at the ASHRAE Annual Meeting, Chicago, IL, January 26, 1993.

"Outside Air Economizers: IAQ Friend or Foe", Moderator of Forum at the ASHRAE Annual Meeting, Chicago, IL, January 26, 1993.

"Orientation to Indoor Air Quality," an EPA two and one half day comprehensive indoor air quality introductory workshop for public officials and building property managers; Sacramento, September 28-30, 1992; San Francisco, February 23-24, 1993; Los Angeles, March 16-18, 1993; Burbank, June 23, 1993; Hawaii, August 24-25, 1993; Las Vegas, August 30, 1993; San Diego, September 13-14, 1993; Phoenix, October 18-19, 1993; Reno, November 14-16, 1995; Fullerton, December 3-4, 1996; Fresno, May 13-14, 1997.

"Building Air Quality: A Guide for Building Owners and Facility Managers," an EPA one half day indoor air quality introductory workshop for building owners and facility managers. Presented throughout Region IX 1993-1995.

"Techniques for Airborne Disease Control", EPRI Healthcare Initiative Symposium; San Francisco, CA; June 7, 1994.

“Diagnosing and Mitigating Indoor Air Quality Problems”, CIHC Conference; San Francisco, September 29, 1994.

”Indoor Air Quality: Tools for Schools,” an EPA one day air quality management workshop for school officials, teachers, and maintenance personnel; San Francisco, October 18-20, 1994; Cerritos, December 5, 1996; Fresno, February 26, 1997; San Jose, March 27, 1997; Riverside, March 5, 1997; San Diego, March 6, 1997; Fullerton, November 13, 1997; Santa Rosa, February 1998; Cerritos, February 26, 1998; Santa Rosa, March 2, 1998.

ASHRAE 62 Standard “Ventilation for Acceptable IAQ”, ASCR Convention; San Francisco, CA, March 16, 1995.

“New Developments in Indoor Air Quality: Protocol for Diagnosing IAQ Problems”, AIHA-NC; March 25, 1995.

"Experimental Validation of ASHRAE SPC 129, Standard Method of Measuring Air Change Effectiveness", 16th AIVC Conference, Palm Springs, USA, September 19-22, 1995.

“Diagnostic Protocols for Building IAQ Assessment”, American Society of Safety Engineers Seminar: ‘Indoor Air Quality – The Next Door’; San Jose Chapter, September 27, 1995; Oakland Chapter, 9, 1997.

“Diagnostic Protocols for Building IAQ Assessment”, Local 39; Oakland, CA, October 3, 1995.

“Diagnostic Protocols for Solving IAQ Problems”, CSU-PPD Conference; October 24, 1995.

“Demonstrating Compliance with ASHRAE 62-1989 Ventilation Requirements”, AIHA; October 25, 1995.

“IAQ Diagnostics: Hands on Assessment of Building Ventilation and Pollutant Transport”, EPA Region IX; Phoenix, AZ, March 12, 1996; San Francisco, CA, April 9, 1996; Burbank, CA, April 12, 1996.

“Experimental Validation of ASHRAE 129P: Standard Method of Measuring Air Change Effectiveness”, Room Vent ‘96 / International Symposium on Room Air Convection and Ventilation Effectiveness”; Yokohama, Japan, July 16-19, 1996.

“IAQ Diagnostic Methodologies and RFP Development”, CCEHSA 1996 Annual Conference, Humboldt State University, Arcata, CA, August 2, 1996.

“The Practical Side of Indoor Air Quality Assessments”, California Industrial Hygiene Conference ‘96, San Diego, CA, September 2, 1996.

“ASHRAE Standard 62: Improving Indoor Environments”, Pacific Gas and Electric Energy Center, San Francisco, CA, October 29, 1996.

“Operating and Maintaining Healthy Buildings”, April 3-4, 1996, San Jose, CA; July 30, 1997, Monterey, CA.

“IAQ Primer”, Local 39, April 16, 1997; Amdahl Corporation, June 9, 1997; State Compensation Insurance Fund’s Safety & Health Services Department, November 21, 1996.

“Tracer Gas Techniques for Measuring Building Air Flow Rates”, ASHRAE, Philadelphia, PA, January 26, 1997.

“How to Diagnose and Mitigate Indoor Air Quality Problems”; Women in Waste; March 19, 1997.

“Environmental Engineer: What Is It?”, Monte Vista High School Career Day; April 10, 1997.

“Indoor Environment Controls: What’s Hot and What’s Not”, Shaklee Corporation; San Francisco, CA, July 15, 1997.

“Measurement of Ventilation System Performance Parameters in the US EPA BASE Study”, Healthy Buildings/IAQ’97, Washington, DC, September 29, 1997.

“Operations and Maintenance for Healthy and Comfortable Indoor Environments”, PASMA; October 7, 1997.

“Designing for Healthy and Comfortable Indoor Environments”, Construction Specification Institute, Santa Rosa, CA, November 6, 1997.

“Ventilation System Design for Good IAQ”, University of Tulsa 10th Annual Conference, San Francisco, CA, February 25, 1998.

“The Building Shell”, Tools For Building Green Conference and Trade Show, Alameda County Waste Management Authority and Recycling Board, Oakland, CA, February 28, 1998.

“Identifying Fungal Contamination Problems In Buildings”, The City of Oakland Municipal Employees, Oakland, CA, March 26, 1998.

“Managing Indoor Air Quality in Schools: Staying Out of Trouble”, CASBO, Sacramento, CA, April 20, 1998.

“Indoor Air Quality”, CSOOC Spring Conference, Visalia, CA, April 30, 1998.

“Particulate and Gas Phase Air Filtration”, ACGIH/OSHA, Ft. Mitchell, KY, June 1998.

“Building Air Quality Facts and Myths”, The City of Oakland / Alameda County Safety Seminar, Oakland, CA, June 12, 1998.

“Building Engineering and Moisture”, Building Contamination Workshop, University of California Berkeley, Continuing Education in Engineering and Environmental Management, San Francisco, CA, October 21-22, 1999.

“Identifying and Mitigating Mold Contamination in Buildings”, Western Construction Consultants Association, Oakland, CA, March 15, 2000; AIG Construction Defect Seminar, Walnut Creek, CA, May 2, 2001; City of Oakland Public Works Agency, Oakland, CA, July 24, 2001; Executive Council of Homeowners, Alamo, CA, August 3, 2001.

“Using the EPA BASE Study for IAQ Investigation / Communication”, Joint Professional Symposium 2000, American Industrial Hygiene Association, Orange County & Southern California Sections, Long Beach, October 19, 2000.

“Ventilation,” Indoor Air Quality: Risk Reduction in the 21st Century Symposium, sponsored by the California Environmental Protection Agency/Air Resources Board, Sacramento, CA, May 3-4, 2000.

“Workshop 18: Criteria for Cleaning of Air Handling Systems”, Healthy Buildings 2000, Espoo, Finland, August 2000.

“Closing Session Summary: ‘Building Investigations’ and ‘Building Design & Construction’”, Healthy Buildings 2000, Espoo, Finland, August 2000.

“Managing Building Air Quality and Energy Efficiency, Meeting the Standard of Care”, BOMA, MidAtlantic Environmental Hygiene Resource Center, Seattle, WA, May 23rd, 2000; San Antonio, TX, September 26-27, 2000.

“Diagnostics & Mitigation in Sick Buildings: When Good Buildings Go Bad,” University of California Berkeley, September 18, 2001.

“Mold Contamination: Recognition and What To Do and Not Do”, Redwood Empire Remodelers Association; Santa Rosa, CA, April 16, 2002.

“Investigative Tools of the IAQ Trade”, Healthy Indoor Environments 2002; Austin, TX; April 22, 2002.

“Finding Hidden Mold: Case Studies in IAQ Investigations”, AIHA Northern California Professionals Symposium; Oakland, CA, May 8, 2002.

“Assessing and Mitigating Fungal Contamination in Buildings”, Cal/OSHA Training; Oakland, CA, February 14, 2003 and West Covina, CA, February 20-21, 2003.

“Use of External Containments During Fungal Mitigation”, Invited Speaker, ACGIH Mold Remediation Symposium, Orlando, FL, November 3-5, 2003.

Building Operator Certification (BOC), 106-IAQ Training Workshops, Northwest Energy Efficiency Council; Stockton, CA, December 3, 2003; San Francisco, CA, December 9, 2003; Irvine, CA, January 13, 2004; San Diego, January 14, 2004; Irwindale, CA, January 27, 2004; Downey, CA, January 28, 2004; Santa Monica, CA, March 16, 2004; Ontario, CA, March 17, 2004; Ontario, CA, November 9, 2004, San Diego, CA, November 10, 2004; San Francisco, CA, November 17, 2004; San Jose, CA, November 18, 2004; Sacramento, CA, March 15, 2005.

“Mold Remediation: The National QUEST for Uniformity Symposium”, Invited Speaker, Orlando, Florida, November 3-5, 2003.

“Mold and Moisture Control”, Indoor Air Quality workshop for The Collaborative for High Performance Schools (CHPS), San Francisco, December 11, 2003.

“Advanced Perspectives In Mold Prevention & Control Symposium”, Invited Speaker, Las Vegas, Nevada, November 7-9, 2004.

“Building Sciences: Understanding and Controlling Moisture in Buildings”, American Industrial Hygiene Association, San Francisco, CA, February 14-16, 2005.

“Indoor Air Quality Diagnostics and Healthy Building Design”, University of California Berkeley, Berkeley, CA, March 2, 2005.

“Improving IAQ = Reduced Tenant Complaints”, Northern California Facilities Exposition, Santa Clara, CA, September 27, 2007.

“Defining Safe Building Air”, Criteria for Safe Air and Water in Buildings, ASHRAE Winter Meeting, Chicago, IL, January 27, 2008.

“Update on USGBC LEED and Air Filtration”, Invited Speaker, NAFA 2008 Convention, San Francisco, CA, September 19, 2008.

“Ventilation and Indoor air Quality in New California Homes”, National Center of Healthy Housing, October 20, 2008.

“Indoor Air Quality in New Homes”, California Energy and Air Quality Conference, October 29, 2008.

“Mechanical Outdoor air Ventilation Systems and IAQ in New Homes”, ACI Home Performance Conference, Kansas City, MO, April 29, 2009.

“Ventilation and IAQ in New Homes with and without Mechanical Outdoor Air Systems”, Healthy Buildings 2009, Syracuse, CA, September 14, 2009.

“Ten Ways to Improve Your Air Quality”, Northern California Facilities Exposition, Santa Clara, CA, September 30, 2009.

“New Developments in Ventilation and Indoor Air Quality in Residential Buildings”, Westcon meeting, Alameda, CA, March 17, 2010.

“Intermittent Residential Mechanical Outdoor Air Ventilation Systems and IAQ”, ASHRAE SSPC 62.2 Meeting, Austin, TX, April 19, 2010.

“Measured IAQ in Homes”, ACI Home Performance Conference, Austin, TX, April 21, 2010.

“Respiration: IEQ and Ventilation”, AIHce 2010, How IH Can LEED in Green buildings, Denver, CO, May 23, 2010.

“IAQ Considerations for Net Zero Energy Buildings (NZEB)”, Northern California Facilities Exposition, Santa Clara, CA, September 22, 2010.

“Energy Conservation and Health in Buildings”, Berkeley High School Green Career Week, Berkeley, CA, April 12, 2011.

“What Pollutants are Really There ?”, ACI Home Performance Conference, San Francisco, CA, March 30, 2011.

“Energy Conservation and Health in Residences Workshop”, Indoor Air 2011, Austin, TX, June 6, 2011.

“Assessing IAQ and Improving Health in Residences”, US EPA Weatherization Plus Health, September 7, 2011.

“Ventilation: What a Long Strange Trip It’s Been”, Westcon, May 21, 2014.

“Chemical Emissions from E-Cigarettes: Direct and Indirect Passive Exposures”, Indoor Air 2014, Hong Kong, July, 2014.

“Infectious Disease Aerosol Exposures With and Without Surge Control Ventilation System Modifications”, Indoor Air 2014, Hong Kong, July, 2014.

“Chemical Emissions from E-Cigarettes”, IMF Health and Welfare Fair, Washington, DC, February 18, 2015.

“Chemical Emissions and Health Hazards Associated with E-Cigarettes”, Roswell Park Cancer Institute, Buffalo, NY, August 15, 2014.

“Formaldehyde Indoor Concentrations, Material Emission Rates, and the CARB ATCM”, Harris Martin’s Lumber Liquidators Flooring Litigation Conference, WQ Minneapolis Hotel, May 27, 2015.

“Chemical Emissions from E-Cigarettes: Direct and Indirect Passive Exposure”, FDA Public Workshop: Electronic Cigarettes and the Public Health, Hyattsville, MD June 2, 2015.

“Creating Healthy Homes, Schools, and Workplaces”, Chautauqua Institution, Athenaeum Hotel, August 24, 2015.

“Diagnosing IAQ Problems and Designing Healthy Buildings”, University of California Berkeley, Berkeley, CA, October 6, 2015.

“Diagnosing Ventilation and IAQ Problems in Commercial Buildings”, BEST Center Annual Institute, Lawrence Berkeley National Laboratory, January 6, 2016.

“A Review of Studies of Ventilation and Indoor Air Quality in New Homes and Impacts of Environmental Factors on Formaldehyde Emission Rates From Composite Wood Products”, AIHce2016, May, 21-26, 2016.

“Admissibility of Scientific Testimony”, Science in the Court, Proposition 65 Clearinghouse Annual Conference, Oakland, CA, September 15, 2016.

“Indoor Air Quality and Ventilation”, ASHRAE Redwood Empire, Napa, CA, December 1, 2016.

EXHIBIT B



Technical Consultation, Data Analysis and
Litigation Support for the Environment

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June 14, 2021

Michael R. Lozeau
Lozeau Drury LLP
1939 Harrison Street, Suite 150
Oakland, CA 94612

Subject: Comments on the Commercial Street Hotels Project

Dear Mr. Lozeau,

We have reviewed the January 2021 Planning Resubmittal ("Site Plan"), as well as the Class 32 Checklist ("Checklist"), for the Commercial Street Hotels ("Project") located in the City of Sunnyvale ("City"). The Project proposes to demolish two existing buildings, totaling 9,720-SF, and construct two separate hotels, including a total of 274 hotel rooms and 220 parking spaces, on the 65,512-SF site.

Our review concludes that the City fails to adequately evaluate the Project's hazards and hazardous materials impact. As a result of our findings, the proposed Project does not qualify for a Class 32 Exemption under the California Environmental Quality Act ("CEQA") and 14 Cal. Code of Regs. 1500 et seq. ("CEQA Guidelines"). We recommend that the City prepare an environmental impact report ("EIR") as required under the Commerce Municipal Code ("CMC" or "Code").

Hazards and Hazardous Materials

The Project includes the property at 295 Commercial Street, which is the location of a closed auto dismantler, listed on the California State Water Resources Control Board Geotracker website.¹ Because the 295 Commercial Street address is listed on Geotracker, it is a Hazardous Waste and Substances Sites (Cortese) List site. However, the Cortese listing is not identified in the Site Plan or Checklist.

The listing of a site on the Cortese List must be disclosed in CEQA documentation per Government Code § 65962.5 which states:

¹ https://geotracker.waterboards.ca.gov/profile_report?global_id=T10000007798

“Before a lead agency accepts as complete an application for any development project which will be used by any person, the applicant shall consult the lists sent to the appropriate city or county and shall submit a signed statement to the local agency indicating whether the project and any alternatives are located on a site that is included on any of the lists compiled pursuant to this section and shall specify any list.”²

The site at 295 Commercial Street was placed on the Cortese list because it is the location of a former auto dismantler, Dayton Auto Dismantlers.³ It was closed in 1996 with petroleum hydrocarbon contamination left in place in soil. The closure letter stated that closure applied to current land use, i.e., commercial/industrial land use.⁴ The Project proposes to construct hotels which is a change in land use.

Furthermore, according to the Checklist:

“Exceptions to a categorical exemption apply in the following circumstances, effectively nullifying a CEQA categorical exemption:

- (e) Hazardous Waste Sites. A categorical exemption shall not be used for a project located on a site which is included on any list compiled pursuant to Section 65962.5 of the Government Code” (p. 3).

As the Project site is a Hazardous Waste and Substances Sites (Cortese) List site, the Project does not qualify for a Class 32 categorical exemption pursuant to CEQA Guidelines § 15332. An EIR should be prepared to disclose the Project site’s status as a Cortese List site.

Disclaimer

SWAPE has received limited discovery regarding this project. Additional information may become available in the future; thus, we retain the right to revise or amend this report when additional information becomes available. Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable environmental consultants practicing in this or similar localities at the time of service. No other warranty, expressed or implied, is made as to the scope of work, work methodologies and protocols, site conditions, analytical testing results, and findings presented. This report reflects efforts which were limited to information that was reasonably accessible at the time of the work, and may contain informational gaps, inconsistencies, or otherwise be incomplete due to the unavailability or uncertainty of information obtained or provided by third parties.

Sincerely,

² “Government Code – Gov.” California State Legislature, *available at*:

https://leginfo.ca.gov/faces/codes_displaySection.xhtml?lawCode=GOV§ionNum=65962.5.

³ https://geotracker.waterboards.ca.gov/profile_report?global_id=T10000007798

⁴ https://documents.geotracker.waterboards.ca.gov/regulators/deliverable_documents/4654240489/racomm.pdf



Matt Hagemann, P.G., C.Hg.



Paul E. Rosenfeld, Ph.D.



Paul Rosenfeld, Ph.D.

Chemical Fate and Transport & Air Dispersion Modeling

Principal Environmental Chemist

Risk Assessment & Remediation Specialist

Education:

Ph.D. Soil Chemistry, University of Washington, 1999. Dissertation on VOC filtration.
M.S. Environmental Science, U.C. Berkeley, 1995. Thesis on organic waste economics.
B.A. Environmental Studies, U.C. Santa Barbara, 1991. Thesis on wastewater treatment.

Professional Experience:

Dr. Rosenfeld is the Co-Founder and Principal Environmental Chemist at Soil Water Air Protection Enterprise (SWAPE). His focus is the fate and transport of environmental contaminants, risk assessment, and ecological restoration. Dr. Rosenfeld has evaluated and modeled emissions from unconventional oil drilling, oil spills, boilers, incinerators and other industrial and agricultural sources relating to nuisance and personal injury. His project experience ranges from monitoring and modeling of pollution sources as they relate to human and ecological health. Dr. Rosenfeld has investigated and designed remediation programs and risk assessments for contaminated sites containing petroleum, chlorinated solvents, pesticides, radioactive waste, PCBs, PAHs, dioxins, furans, volatile organics, semi-volatile organics, perchlorate, heavy metals, asbestos, PFOA, unusual polymers, MtBE, fuel oxygenates and odor. Dr. Rosenfeld has evaluated greenhouse gas emissions using various modeling programs recommended by California Air Quality Management Districts.

Professional History:

Soil Water Air Protection Enterprise (SWAPE); 2003 to present; Principal and Founding Partner
UCLA School of Public Health; 2007 to 2011; Lecturer (Assistant Researcher)
UCLA School of Public Health; 2003 to 2006; Adjunct Professor
UCLA Environmental Science and Engineering Program; 2002-2004; Doctoral Intern Coordinator
UCLA Institute of the Environment, 2001-2002; Research Associate
Komex H₂O Science, 2001 to 2003; Senior Remediation Scientist
National Groundwater Association, 2002-2004; Lecturer
San Diego State University, 1999-2001; Adjunct Professor
Anteon Corp., San Diego, 2000-2001; Remediation Project Manager
Ogden (now Amec), San Diego, 2000-2000; Remediation Project Manager
Bechtel, San Diego, California, 1999 – 2000; Risk Assessor
King County, Seattle, 1996 – 1999; Scientist
James River Corp., Washington, 1995-96; Scientist
Big Creek Lumber, Davenport, California, 1995; Scientist
Plumas Corp., California and USFS, Tahoe 1993-1995; Scientist
Peace Corps and World Wildlife Fund, St. Kitts, West Indies, 1991-1993; Scientist
Bureau of Land Management, Kremmling Colorado 1990; Scientist

Publications:

Chen, J. A., Zapata, A R., Sutherland, A. J., Molmen, D. R., Chow, B. S., Wu, L. E., **Rosenfeld, P. E.**, Hesse, R. C., (2012) Sulfur Dioxide and Volatile Organic Compound Exposure To A Community In Texas City Texas Evaluated Using Aermოდ and Empirical Data. *American Journal of Environmental Science*, 8(6), 622-632.

Rosenfeld, P.E. & Feng, L. (2011). *The Risks of Hazardous Waste*. Amsterdam: Elsevier Publishing.

Cheremisinoff, N.P., & **Rosenfeld, P.E.** (2011). *Handbook of Pollution Prevention and Cleaner Production: Best Practices in the Agrochemical Industry*, Amsterdam: Elsevier Publishing.

Gonzalez, J., Feng, L., Sutherland, A., Waller, C., Sok, H., Hesse, R., **Rosenfeld, P.** (2010). PCBs and Dioxins/Furans in Attic Dust Collected Near Former PCB Production and Secondary Copper Facilities in Sauget, IL. *Procedia Environmental Sciences*. 113–125.

Feng, L., Wu, C., Tam, L., Sutherland, A.J., Clark, J.J., **Rosenfeld, P.E.** (2010). Dioxin and Furan Blood Lipid and Attic Dust Concentrations in Populations Living Near Four Wood Treatment Facilities in the United States. *Journal of Environmental Health*. 73(6), 34-46.

Cheremisinoff, N.P., & **Rosenfeld, P.E.** (2010). *Handbook of Pollution Prevention and Cleaner Production: Best Practices in the Wood and Paper Industries*. Amsterdam: Elsevier Publishing.

Cheremisinoff, N.P., & **Rosenfeld, P.E.** (2009). *Handbook of Pollution Prevention and Cleaner Production: Best Practices in the Petroleum Industry*. Amsterdam: Elsevier Publishing.

Wu, C., Tam, L., Clark, J., **Rosenfeld, P.** (2009). Dioxin and furan blood lipid concentrations in populations living near four wood treatment facilities in the United States. *WIT Transactions on Ecology and the Environment, Air Pollution*, 123 (17), 319-327.

Tam L. K., Wu C. D., Clark J. J. and **Rosenfeld, P.E.** (2008). A Statistical Analysis Of Attic Dust And Blood Lipid Concentrations Of Tetrachloro-p-Dibenzodioxin (TCDD) Toxicity Equivalency Quotients (TEQ) In Two Populations Near Wood Treatment Facilities. *Organohalogen Compounds*, 70, 002252-002255.

Tam L. K., Wu C. D., Clark J. J. and **Rosenfeld, P.E.** (2008). Methods For Collect Samples For Assessing Dioxins And Other Environmental Contaminants In Attic Dust: A Review. *Organohalogen Compounds*, 70, 000527-000530.

Hensley, A.R. A. Scott, J. J. J. Clark, **Rosenfeld, P.E.** (2007). Attic Dust and Human Blood Samples Collected near a Former Wood Treatment Facility. *Environmental Research*. 105, 194-197.

Rosenfeld, P.E., J. J. J. Clark, A. R. Hensley, M. Suffet. (2007). The Use of an Odor Wheel Classification for Evaluation of Human Health Risk Criteria for Compost Facilities. *Water Science & Technology* 55(5), 345-357.

Rosenfeld, P. E., M. Suffet. (2007). The Anatomy Of Odour Wheels For Odours Of Drinking Water, Wastewater, Compost And The Urban Environment. *Water Science & Technology* 55(5), 335-344.

Sullivan, P. J. Clark, J.J.J., Agardy, F. J., **Rosenfeld, P.E.** (2007). *Toxic Legacy, Synthetic Toxins in the Food, Water, and Air in American Cities*. Boston Massachusetts: Elsevier Publishing,

Rosenfeld P.E., and Suffet, I.H. (Mel) (2007). Anatomy of an Odor Wheel. *Water Science and Technology*.

Rosenfeld, P.E., Clark, J.J.J., Hensley A.R., Suffet, I.H. (Mel) (2007). The use of an odor wheel classification for evaluation of human health risk criteria for compost facilities. *Water Science And Technology*.

- Rosenfeld, P.E.,** and Suffet I.H. (2004). Control of Compost Odor Using High Carbon Wood Ash. *Water Science and Technology*. 49(9),171-178.
- Rosenfeld P. E.,** J.J. Clark, I.H. (Mel) Suffet (2004). The Value of An Odor-Quality-Wheel Classification Scheme For The Urban Environment. *Water Environment Federation's Technical Exhibition and Conference (WEFTEC) 2004*. New Orleans, October 2-6, 2004.
- Rosenfeld, P.E.,** and Suffet, I.H. (2004). Understanding Odorants Associated With Compost, Biomass Facilities, and the Land Application of Biosolids. *Water Science and Technology*. 49(9), 193-199.
- Rosenfeld, P.E.,** and Suffet I.H. (2004). Control of Compost Odor Using High Carbon Wood Ash, *Water Science and Technology*, 49(9), 171-178.
- Rosenfeld, P. E.,** Grey, M. A., Sellew, P. (2004). Measurement of Biosolids Odor and Odorant Emissions from Windrows, Static Pile and Biofilter. *Water Environment Research*. 76(4), 310-315.
- Rosenfeld, P.E.,** Grey, M and Suffet, M. (2002). Compost Demonstration Project, Sacramento California Using High-Carbon Wood Ash to Control Odor at a Green Materials Composting Facility. *Integrated Waste Management Board Public Affairs Office*, Publications Clearinghouse (MS-6), Sacramento, CA Publication #442-02-008.
- Rosenfeld, P.E.,** and C.L. Henry. (2001). Characterization of odor emissions from three different biosolids. *Water Soil and Air Pollution*. 127(1-4), 173-191.
- Rosenfeld, P.E.,** and Henry C. L., (2000). Wood ash control of odor emissions from biosolids application. *Journal of Environmental Quality*. 29, 1662-1668.
- Rosenfeld, P.E.,** C.L. Henry and D. Bennett. (2001). Wastewater dewatering polymer affect on biosolids odor emissions and microbial activity. *Water Environment Research*. 73(4), 363-367.
- Rosenfeld, P.E.,** and C.L. Henry. (2001). Activated Carbon and Wood Ash Sorption of Wastewater, Compost, and Biosolids Odorants. *Water Environment Research*, 73, 388-393.
- Rosenfeld, P.E.,** and Henry C. L., (2001). High carbon wood ash effect on biosolids microbial activity and odor. *Water Environment Research*. 131(1-4), 247-262.
- Chollack, T. and **P. Rosenfeld.** (1998). Compost Amendment Handbook For Landscaping. Prepared for and distributed by the City of Redmond, Washington State.
- Rosenfeld, P. E.** (1992). The Mount Liamuiga Crater Trail. *Heritage Magazine of St. Kitts*, 3(2).
- Rosenfeld, P. E.** (1993). High School Biogas Project to Prevent Deforestation On St. Kitts. *Biomass Users Network*, 7(1).
- Rosenfeld, P. E.** (1998). Characterization, Quantification, and Control of Odor Emissions From Biosolids Application To Forest Soil. Doctoral Thesis. University of Washington College of Forest Resources.
- Rosenfeld, P. E.** (1994). Potential Utilization of Small Diameter Trees on Sierra County Public Land. Masters thesis reprinted by the Sierra County Economic Council. Sierra County, California.
- Rosenfeld, P. E.** (1991). How to Build a Small Rural Anaerobic Digester & Uses Of Biogas In The First And Third World. Bachelors Thesis. University of California.

Presentations:

Rosenfeld, P.E., Sutherland, A; Hesse, R.; Zapata, A. (October 3-6, 2013). Air dispersion modeling of volatile organic emissions from multiple natural gas wells in Decatur, TX. *44th Western Regional Meeting, American Chemical Society*. Lecture conducted from Santa Clara, CA.

Sok, H.L.; Waller, C.C.; Feng, L.; Gonzalez, J.; Sutherland, A.J.; Wisdom-Stack, T.; Sahai, R.K.; Hesse, R.C.; **Rosenfeld, P.E.** (June 20-23, 2010). Atrazine: A Persistent Pesticide in Urban Drinking Water. *Urban Environmental Pollution*. Lecture conducted from Boston, MA.

Feng, L.; Gonzalez, J.; Sok, H.L.; Sutherland, A.J.; Waller, C.C.; Wisdom-Stack, T.; Sahai, R.K.; La, M.; Hesse, R.C.; **Rosenfeld, P.E.** (June 20-23, 2010). Bringing Environmental Justice to East St. Louis, Illinois. *Urban Environmental Pollution*. Lecture conducted from Boston, MA.

Rosenfeld, P.E. (April 19-23, 2009). Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) Contamination in Drinking Water From the Use of Aqueous Film Forming Foams (AFFF) at Airports in the United States. *2009 Ground Water Summit and 2009 Ground Water Protection Council Spring Meeting*, Lecture conducted from Tuscon, AZ.

Rosenfeld, P.E. (April 19-23, 2009). Cost to Filter Atrazine Contamination from Drinking Water in the United States” Contamination in Drinking Water From the Use of Aqueous Film Forming Foams (AFFF) at Airports in the United States. *2009 Ground Water Summit and 2009 Ground Water Protection Council Spring Meeting*. Lecture conducted from Tuscon, AZ.

Wu, C., Tam, L., Clark, J., **Rosenfeld, P.** (20-22 July, 2009). Dioxin and furan blood lipid concentrations in populations living near four wood treatment facilities in the United States. Brebbia, C.A. and Popov, V., eds., *Air Pollution XVII: Proceedings of the Seventeenth International Conference on Modeling, Monitoring and Management of Air Pollution*. Lecture conducted from Tallinn, Estonia.

Rosenfeld, P. E. (October 15-18, 2007). Moss Point Community Exposure To Contaminants From A Releasing Facility. *The 23rd Annual International Conferences on Soils Sediment and Water*. Platform lecture conducted from University of Massachusetts, Amherst MA.

Rosenfeld, P. E. (October 15-18, 2007). The Repeated Trespass of Tritium-Contaminated Water Into A Surrounding Community Form Repeated Waste Spills From A Nuclear Power Plant. *The 23rd Annual International Conferences on Soils Sediment and Water*. Platform lecture conducted from University of Massachusetts, Amherst MA.

Rosenfeld, P. E. (October 15-18, 2007). Somerville Community Exposure To Contaminants From Wood Treatment Facility Emissions. *The 23rd Annual International Conferences on Soils Sediment and Water*. Lecture conducted from University of Massachusetts, Amherst MA.

Rosenfeld P. E. (March 2007). Production, Chemical Properties, Toxicology, & Treatment Case Studies of 1,2,3-Trichloropropane (TCP). *The Association for Environmental Health and Sciences (AEHS) Annual Meeting*. Lecture conducted from San Diego, CA.

Rosenfeld P. E. (March 2007). Blood and Attic Sampling for Dioxin/Furan, PAH, and Metal Exposure in Florala, Alabama. *The AEHS Annual Meeting*. Lecture conducted from San Diego, CA.

Hensley A.R., Scott, A., **Rosenfeld P.E.**, Clark, J.J.J. (August 21 – 25, 2006). Dioxin Containing Attic Dust And Human Blood Samples Collected Near A Former Wood Treatment Facility. *The 26th International Symposium on Halogenated Persistent Organic Pollutants – DIOXIN2006*. Lecture conducted from Radisson SAS Scandinavia Hotel in Oslo Norway.

Hensley A.R., Scott, A., **Rosenfeld P.E.**, Clark, J.J.J. (November 4-8, 2006). Dioxin Containing Attic Dust And Human Blood Samples Collected Near A Former Wood Treatment Facility. *APHA 134 Annual Meeting & Exposition*. Lecture conducted from Boston Massachusetts.

Paul Rosenfeld Ph.D. (October 24-25, 2005). Fate, Transport and Persistence of PFOA and Related Chemicals. Mealey's C8/PFOA. *Science, Risk & Litigation Conference*. Lecture conducted from The Rittenhouse Hotel, Philadelphia, PA.

Paul Rosenfeld Ph.D. (September 19, 2005). Brominated Flame Retardants in Groundwater: Pathways to Human Ingestion, *Toxicology and Remediation PEMA Emerging Contaminant Conference*. Lecture conducted from Hilton Hotel, Irvine California.

Paul Rosenfeld Ph.D. (September 19, 2005). Fate, Transport, Toxicity, And Persistence of 1,2,3-TCP. *PEMA Emerging Contaminant Conference*. Lecture conducted from Hilton Hotel in Irvine, California.

Paul Rosenfeld Ph.D. (September 26-27, 2005). Fate, Transport and Persistence of PDBEs. *Mealey's Groundwater Conference*. Lecture conducted from Ritz Carlton Hotel, Marina Del Ray, California.

Paul Rosenfeld Ph.D. (June 7-8, 2005). Fate, Transport and Persistence of PFOA and Related Chemicals. *International Society of Environmental Forensics: Focus On Emerging Contaminants*. Lecture conducted from Sheraton Oceanfront Hotel, Virginia Beach, Virginia.

Paul Rosenfeld Ph.D. (July 21-22, 2005). Fate Transport, Persistence and Toxicology of PFOA and Related Perfluorochemicals. *2005 National Groundwater Association Ground Water And Environmental Law Conference*. Lecture conducted from Wyndham Baltimore Inner Harbor, Baltimore Maryland.

Paul Rosenfeld Ph.D. (July 21-22, 2005). Brominated Flame Retardants in Groundwater: Pathways to Human Ingestion, Toxicology and Remediation. *2005 National Groundwater Association Ground Water and Environmental Law Conference*. Lecture conducted from Wyndham Baltimore Inner Harbor, Baltimore Maryland.

Paul Rosenfeld, Ph.D. and James Clark Ph.D. and Rob Hesse R.G. (May 5-6, 2004). Tert-butyl Alcohol Liability and Toxicology, A National Problem and Unquantified Liability. *National Groundwater Association. Environmental Law Conference*. Lecture conducted from Congress Plaza Hotel, Chicago Illinois.

Paul Rosenfeld, Ph.D. (March 2004). Perchlorate Toxicology. *Meeting of the American Groundwater Trust*. Lecture conducted from Phoenix Arizona.

Hagemann, M.F., **Paul Rosenfeld, Ph.D.** and Rob Hesse (2004). Perchlorate Contamination of the Colorado River. *Meeting of tribal representatives*. Lecture conducted from Parker, AZ.

Paul Rosenfeld, Ph.D. (April 7, 2004). A National Damage Assessment Model For PCE and Dry Cleaners. *Drycleaner Symposium. California Ground Water Association*. Lecture conducted from Radison Hotel, Sacramento, California.

Rosenfeld, P. E., Grey, M., (June 2003) Two stage biofilter for biosolids composting odor control. *Seventh International In Situ And On Site Bioremediation Symposium Battelle Conference* Orlando, FL.

Paul Rosenfeld, Ph.D. and James Clark Ph.D. (February 20-21, 2003) Understanding Historical Use, Chemical Properties, Toxicity and Regulatory Guidance of 1,4 Dioxane. *National Groundwater Association. Southwest Focus Conference. Water Supply and Emerging Contaminants.*. Lecture conducted from Hyatt Regency Phoenix Arizona.

Paul Rosenfeld, Ph.D. (February 6-7, 2003). Underground Storage Tank Litigation and Remediation. *California CUPA Forum*. Lecture conducted from Marriott Hotel, Anaheim California.

Paul Rosenfeld, Ph.D. (October 23, 2002) Underground Storage Tank Litigation and Remediation. *EPA Underground Storage Tank Roundtable*. Lecture conducted from Sacramento California.

Rosenfeld, P.E. and Suffet, M. (October 7- 10, 2002). Understanding Odor from Compost, Wastewater and Industrial Processes. *Sixth Annual Symposium On Off Flavors in the Aquatic Environment. International Water Association.* Lecture conducted from Barcelona Spain.

Rosenfeld, P.E. and Suffet, M. (October 7- 10, 2002). Using High Carbon Wood Ash to Control Compost Odor. *Sixth Annual Symposium On Off Flavors in the Aquatic Environment. International Water Association.* Lecture conducted from Barcelona Spain.

Rosenfeld, P.E. and Grey, M. A. (September 22-24, 2002). Biocycle Composting For Coastal Sage Restoration. *Northwest Biosolids Management Association.* Lecture conducted from Vancouver Washington..

Rosenfeld, P.E. and Grey, M. A. (November 11-14, 2002). Using High-Carbon Wood Ash to Control Odor at a Green Materials Composting Facility. *Soil Science Society Annual Conference.* Lecture conducted from Indianapolis, Maryland.

Rosenfeld, P.E. (September 16, 2000). Two stage biofilter for biosolids composting odor control. *Water Environment Federation.* Lecture conducted from Anaheim California.

Rosenfeld, P.E. (October 16, 2000). Wood ash and biofilter control of compost odor. *Biofest.* Lecture conducted from Ocean Shores, California.

Rosenfeld, P.E. (2000). Bioremediation Using Organic Soil Amendments. *California Resource Recovery Association.* Lecture conducted from Sacramento California.

Rosenfeld, P.E., C.L. Henry, R. Harrison. (1998). Oat and Grass Seed Germination and Nitrogen and Sulfur Emissions Following Biosolids Incorporation With High-Carbon Wood-Ash. *Water Environment Federation 12th Annual Residuals and Biosolids Management Conference Proceedings.* Lecture conducted from Bellevue Washington.

Rosenfeld, P.E., and C.L. Henry. (1999). An evaluation of ash incorporation with biosolids for odor reduction. *Soil Science Society of America.* Lecture conducted from Salt Lake City Utah.

Rosenfeld, P.E., C.L. Henry, R. Harrison. (1998). Comparison of Microbial Activity and Odor Emissions from Three Different Biosolids Applied to Forest Soil. *Brown and Caldwell.* Lecture conducted from Seattle Washington.

Rosenfeld, P.E., C.L. Henry. (1998). Characterization, Quantification, and Control of Odor Emissions from Biosolids Application To Forest Soil. *Biofest.* Lecture conducted from Lake Chelan, Washington.

Rosenfeld, P.E., C.L. Henry, R. Harrison. (1998). Oat and Grass Seed Germination and Nitrogen and Sulfur Emissions Following Biosolids Incorporation With High-Carbon Wood-Ash. *Water Environment Federation 12th Annual Residuals and Biosolids Management Conference Proceedings.* Lecture conducted from Bellevue Washington.

Rosenfeld, P.E., C.L. Henry, R. B. Harrison, and R. Dills. (1997). Comparison of Odor Emissions From Three Different Biosolids Applied to Forest Soil. *Soil Science Society of America.* Lecture conducted from Anaheim California.

Teaching Experience:

UCLA Department of Environmental Health (Summer 2003 through 20010) Taught Environmental Health Science 100 to students, including undergrad, medical doctors, public health professionals and nurses. Course focused on the health effects of environmental contaminants.

National Ground Water Association, Successful Remediation Technologies. Custom Course in Sante Fe, New Mexico. May 21, 2002. Focused on fate and transport of fuel contaminants associated with underground storage tanks.

National Ground Water Association; Successful Remediation Technologies Course in Chicago Illinois. April 1, 2002. Focused on fate and transport of contaminants associated with Superfund and RCRA sites.

California Integrated Waste Management Board, April and May, 2001. Alternative Landfill Caps Seminar in San Diego, Ventura, and San Francisco. Focused on both prescriptive and innovative landfill cover design.

UCLA Department of Environmental Engineering, February 5, 2002. Seminar on Successful Remediation Technologies focusing on Groundwater Remediation.

University Of Washington, Soil Science Program, Teaching Assistant for several courses including: Soil Chemistry, Organic Soil Amendments, and Soil Stability.

U.C. Berkeley, Environmental Science Program Teaching Assistant for Environmental Science 10.

Academic Grants Awarded:

California Integrated Waste Management Board. \$41,000 grant awarded to UCLA Institute of the Environment. Goal: To investigate effect of high carbon wood ash on volatile organic emissions from compost. 2001.

Synagro Technologies, Corona California: \$10,000 grant awarded to San Diego State University. Goal: investigate effect of biosolids for restoration and remediation of degraded coastal sage soils. 2000.

King County, Department of Research and Technology, Washington State. \$100,000 grant awarded to University of Washington: Goal: To investigate odor emissions from biosolids application and the effect of polymers and ash on VOC emissions. 1998.

Northwest Biosolids Management Association, Washington State. \$20,000 grant awarded to investigate effect of polymers and ash on VOC emissions from biosolids. 1997.

James River Corporation, Oregon: \$10,000 grant was awarded to investigate the success of genetically engineered Poplar trees with resistance to round-up. 1996.

United State Forest Service, Tahoe National Forest: \$15,000 grant was awarded to investigating fire ecology of the Tahoe National Forest. 1995.

Kellogg Foundation, Washington D.C. \$500 grant was awarded to construct a large anaerobic digester on St. Kitts in West Indies. 1993.

Deposition and/or Trial Testimony:

In The Superior Court of the State of California, County of Alameda
Charles Spain., Plaintiff vs. Thermo Fisher Scientific, et al., Defendants
Case No.: RG14711115
Rosenfeld Deposition, September, 2015

In The Iowa District Court In And For Poweshiek County
Russell D. Winburn, et al., Plaintiffs vs. Doug Hoksbergen, et al., Defendants
Case No.: LALA002187
Rosenfeld Deposition, August 2015

In The Iowa District Court For Wapello County
Jerry Dovico, et al., Plaintiffs vs. Valley View Sine LLC, et al., Defendants
Law No.: LALA105144 - Division A
Rosenfeld Deposition, August 2015

In The Iowa District Court For Wapello County
Doug Pauls, et al., et al., Plaintiffs vs. Richard Warren, et al., Defendants
Law No.: LALA105144 - Division A
Rosenfeld Deposition, August 2015

In The Circuit Court of Ohio County, West Virginia
Robert Andrews, et al. v. Antero, et al.
Civil Action N0. 14-C-30000
Rosenfeld Deposition, June 2015

In The Third Judicial District County of Dona Ana, New Mexico
Betty Gonzalez, et al. Plaintiffs vs. Del Oro Dairy, Del Oro Real Estate LLC, Jerry Settles and Deward
DeRuyter, Defendants
Rosenfeld Deposition: July 2015

In The Iowa District Court For Muscatine County
Laurie Freeman et. al. Plaintiffs vs. Grain Processing Corporation, Defendant
Case No 4980
Rosenfeld Deposition: May 2015

In the Circuit Court of the 17th Judicial Circuit, in and For Broward County, Florida
Walter Hinton, et. al. Plaintiff, vs. City of Fort Lauderdale, Florida, a Municipality, Defendant.
Case Number CACE07030358 (26)
Rosenfeld Deposition: December 2014

In the United States District Court Western District of Oklahoma
Tommy McCarty, et al., Plaintiffs, v. Oklahoma City Landfill, LLC d/b/a Southeast Oklahoma City
Landfill, et al. Defendants.
Case No. 5:12-cv-01152-C
Rosenfeld Deposition: July 2014

In the County Court of Dallas County Texas
Lisa Parr et al, *Plaintiff*, vs. Aruba et al, *Defendant*.
Case Number cc-11-01650-E
Rosenfeld Deposition: March and September 2013
Rosenfeld Trial: April 2014

In the Court of Common Pleas of Tuscarawas County Ohio

John Michael Abicht, et al., *Plaintiffs*, vs. Republic Services, Inc., et al., *Defendants*
Case Number: 2008 CT 10 0741 (Cons. w/ 2009 CV 10 0987)
Rosenfeld Deposition: October 2012

In the Court of Common Pleas for the Second Judicial Circuit, State of South Carolina, County of Aiken
David Anderson, et al., *Plaintiffs*, vs. Norfolk Southern Corporation, et al., *Defendants*.
Case Number: 2007-CP-02-1584

In the Circuit Court of Jefferson County Alabama
Jaeanette Moss Anthony, et al., *Plaintiffs*, vs. Drummond Company Inc., et al., *Defendants*
Civil Action No. CV 2008-2076
Rosenfeld Deposition: September 2010

In the Ninth Judicial District Court, Parish of Rapides, State of Louisiana
Roger Price, et al., *Plaintiffs*, vs. Roy O. Martin, L.P., et al., *Defendants*.
Civil Suit Number 224,041 Division G
Rosenfeld Deposition: September 2008

In the United States District Court, Western District Lafayette Division
Ackle et al., *Plaintiffs*, vs. Citgo Petroleum Corporation, et al., *Defendants*.
Case Number 2:07CV1052
Rosenfeld Deposition: July 2009

In the United States District Court for the Southern District of Ohio
Carolyn Baker, et al., *Plaintiffs*, vs. Chevron Oil Company, et al., *Defendants*.
Case Number 1:05 CV 227
Rosenfeld Deposition: July 2008

In the Fourth Judicial District Court, Parish of Calcasieu, State of Louisiana
Craig Steven Arabie, et al., *Plaintiffs*, vs. Citgo Petroleum Corporation, et al., *Defendants*.
Case Number 07-2738 G

In the Fourteenth Judicial District Court, Parish of Calcasieu, State of Louisiana
Leon B. Brydels, *Plaintiffs*, vs. Conoco, Inc., et al., *Defendants*.
Case Number 2004-6941 Division A

In the District Court of Tarrant County, Texas, 153rd Judicial District
Linda Faust, *Plaintiff*, vs. Burlington Northern Santa Fe Rail Way Company, Witco Chemical Corporation
A/K/A Witco Corporation, Solvents and Chemicals, Inc. and Koppers Industries, Inc., *Defendants*.
Case Number 153-212928-05
Rosenfeld Deposition: December 2006, October 2007
Rosenfeld Trial: January 2008

In the Superior Court of the State of California in and for the County of San Bernardino
Leroy Allen, et al., *Plaintiffs*, vs. Nutro Products, Inc., a California Corporation and DOES 1 to 100,
inclusive, *Defendants*.
John Loney, Plaintiff, vs. James H. Didion, Sr.; Nutro Products, Inc.; DOES 1 through 20, inclusive,
Defendants.
Case Number VCVVS044671
Rosenfeld Deposition: December 2009
Rosenfeld Trial: March 2010

In the United States District Court for the Middle District of Alabama, Northern Division
James K. Benefield, et al., *Plaintiffs*, vs. International Paper Company, *Defendant*.
Civil Action Number 2:09-cv-232-WHA-TFM
Rosenfeld Deposition: July 2010, June 2011

In the Superior Court of the State of California in and for the County of Los Angeles
Leslie Hensley and Rick Hensley, *Plaintiffs*, vs. Peter T. Hoss, as trustee on behalf of the Cone Fee Trust;
Plains Exploration & Production Company, a Delaware corporation; Rayne Water Conditioning, Inc., a
California Corporation; and DOES 1 through 100, *Defendants*.
Case Number SC094173
Rosenfeld Deposition: September 2008, October 2008

In the Superior Court of the State of California in and for the County of Santa Barbara, Santa Maria Branch
Clifford and Shirley Adelhelm, et al., all individually, *Plaintiffs*, vs. Unocal Corporation, a Delaware
Corporation; Union Oil Company of California, a California corporation; Chevron Corporation, a
California corporation; ConocoPhillips, a Texas corporation; Kerr-McGee Corporation, an Oklahoma
corporation; and DOES 1 through 100, *Defendants*.
Case Number 1229251 (Consolidated with case number 1231299)
Rosenfeld Deposition: January 2008

In the United States District Court for Eastern District of Arkansas, Eastern District of Arkansas
Harry Stephens Farms, Inc, and Harry Stephens, individual and as managing partner of Stephens
Partnership, *Plaintiffs*, vs. Helena Chemical Company, and Exxon Mobil Corp., successor to Mobil
Chemical Co., *Defendants*.
Case Number 2:06-CV-00166 JMM (Consolidated with case number 4:07CV00278 JMM)
Rosenfeld Deposition: July 2010

In the United States District Court for the Western District of Arkansas, Texarkana Division
Rhonda Brasel, et al., *Plaintiffs*, vs. Weyerhaeuser Company and DOES 1 through 100, *Defendants*.
Civil Action Number 07-4037
Rosenfeld Deposition: March 2010
Rosenfeld Trial: October 2010

In the District Court of Texas 21st Judicial District of Burleson County
Dennis Davis, *Plaintiff*, vs. Burlington Northern Santa Fe Rail Way Company, *Defendant*.
Case Number 25,151
Rosenfeld Trial: May 2009

In the United States District Court of Southern District of Texas Galveston Division
Kyle Cannon, Eugene Donovan, Genaro Ramirez, Carol Sassler, and Harvey Walton, each Individually and
on behalf of those similarly situated, *Plaintiffs*, vs. BP Products North America, Inc., *Defendant*.
Case 3:10-cv-00622
Rosenfeld Deposition: February 2012
Rosenfeld Trial: April 2013

In the Circuit Court of Baltimore County Maryland
Philip E. Cvach, II et al., *Plaintiffs* vs. Two Farms, Inc. d/b/a Royal Farms, Defendants
Case Number: 03-C-12-012487 OT
Rosenfeld Deposition: September 2013



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Email: mhagemann@swape.com

Matthew F. Hagemann, P.G., C.Hg., QSD, QSP

**Geologic and Hydrogeologic Characterization
Industrial Stormwater Compliance
Investigation and Remediation Strategies
Litigation Support and Testifying Expert
CEQA Review**

Education:

M.S. Degree, Geology, California State University Los Angeles, Los Angeles, CA, 1984.

B.A. Degree, Geology, Humboldt State University, Arcata, CA, 1982.

Professional Certifications:

California Professional Geologist

California Certified Hydrogeologist

Qualified SWPPP Developer and Practitioner

Professional Experience:

Matt has 25 years of experience in environmental policy, assessment and remediation. He spent nine years with the U.S. EPA in the RCRA and Superfund programs and served as EPA's Senior Science Policy Advisor in the Western Regional Office where he identified emerging threats to groundwater from perchlorate and MTBE. While with EPA, Matt also served as a Senior Hydrogeologist in the oversight of the assessment of seven major military facilities undergoing base closure. He led numerous enforcement actions under provisions of the Resource Conservation and Recovery Act (RCRA) while also working with permit holders to improve hydrogeologic characterization and water quality monitoring.

Matt has worked closely with U.S. EPA legal counsel and the technical staff of several states in the application and enforcement of RCRA, Safe Drinking Water Act and Clean Water Act regulations. Matt has trained the technical staff in the States of California, Hawaii, Nevada, Arizona and the Territory of Guam in the conduct of investigations, groundwater fundamentals, and sampling techniques.

Positions Matt has held include:

- Founding Partner, Soil/Water/Air Protection Enterprise (SWAPE) (2003 – present);
- Geology Instructor, Golden West College, 2010 – 2014;
- Senior Environmental Analyst, Komex H2O Science, Inc. (2000 -- 2003);

- Executive Director, Orange Coast Watch (2001 – 2004);
- Senior Science Policy Advisor and Hydrogeologist, U.S. Environmental Protection Agency (1989–1998);
- Hydrogeologist, National Park Service, Water Resources Division (1998 – 2000);
- Adjunct Faculty Member, San Francisco State University, Department of Geosciences (1993 – 1998);
- Instructor, College of Marin, Department of Science (1990 – 1995);
- Geologist, U.S. Forest Service (1986 – 1998); and
- Geologist, Dames & Moore (1984 – 1986).

Senior Regulatory and Litigation Support Analyst:

With SWAPE, Matt's responsibilities have included:

- Lead analyst and testifying expert in the review of over 100 environmental impact reports since 2003 under CEQA that identify significant issues with regard to hazardous waste, water resources, water quality, air quality, Valley Fever, greenhouse gas emissions, and geologic hazards. Make recommendations for additional mitigation measures to lead agencies at the local and county level to include additional characterization of health risks and implementation of protective measures to reduce worker exposure to hazards from toxins and Valley Fever.
- Stormwater analysis, sampling and best management practice evaluation at industrial facilities.
- Manager of a project to provide technical assistance to a community adjacent to a former Naval shipyard under a grant from the U.S. EPA.
- Technical assistance and litigation support for vapor intrusion concerns.
- Lead analyst and testifying expert in the review of environmental issues in license applications for large solar power plants before the California Energy Commission.
- Manager of a project to evaluate numerous formerly used military sites in the western U.S.
- Manager of a comprehensive evaluation of potential sources of perchlorate contamination in Southern California drinking water wells.
- Manager and designated expert for litigation support under provisions of Proposition 65 in the review of releases of gasoline to sources drinking water at major refineries and hundreds of gas stations throughout California.
- Expert witness on two cases involving MTBE litigation.
- Expert witness and litigation support on the impact of air toxins and hazards at a school.
- Expert witness in litigation at a former plywood plant.

With Komex H2O Science Inc., Matt's duties included the following:

- Senior author of a report on the extent of perchlorate contamination that was used in testimony by the former U.S. EPA Administrator and General Counsel.
 - Senior researcher in the development of a comprehensive, electronically interactive chronology of MTBE use, research, and regulation.
 - Senior researcher in the development of a comprehensive, electronically interactive chronology of perchlorate use, research, and regulation.
 - Senior researcher in a study that estimates nationwide costs for MTBE remediation and drinking water treatment, results of which were published in newspapers nationwide and in testimony against provisions of an energy bill that would limit liability for oil companies.
 - Research to support litigation to restore drinking water supplies that have been contaminated by MTBE in California and New York.
-

- Expert witness testimony in a case of oil production-related contamination in Mississippi.
- Lead author for a multi-volume remedial investigation report for an operating school in Los Angeles that met strict regulatory requirements and rigorous deadlines.

- Development of strategic approaches for cleanup of contaminated sites in consultation with clients and regulators.

Executive Director:

As Executive Director with Orange Coast Watch, Matt led efforts to restore water quality at Orange County beaches from multiple sources of contamination including urban runoff and the discharge of wastewater. In reporting to a Board of Directors that included representatives from leading Orange County universities and businesses, Matt prepared issue papers in the areas of treatment and disinfection of wastewater and control of the discharge of grease to sewer systems. Matt actively participated in the development of countywide water quality permits for the control of urban runoff and permits for the discharge of wastewater. Matt worked with other nonprofits to protect and restore water quality, including Surfrider, Natural Resources Defense Council and Orange County CoastKeeper as well as with business institutions including the Orange County Business Council.

Hydrogeology:

As a Senior Hydrogeologist with the U.S. Environmental Protection Agency, Matt led investigations to characterize and cleanup closing military bases, including Mare Island Naval Shipyard, Hunters Point Naval Shipyard, Treasure Island Naval Station, Alameda Naval Station, Moffett Field, Mather Army Airfield, and Sacramento Army Depot. Specific activities were as follows:

- Led efforts to model groundwater flow and contaminant transport, ensured adequacy of monitoring networks, and assessed cleanup alternatives for contaminated sediment, soil, and groundwater.
- Initiated a regional program for evaluation of groundwater sampling practices and laboratory analysis at military bases.
- Identified emerging issues, wrote technical guidance, and assisted in policy and regulation development through work on four national U.S. EPA workgroups, including the Superfund Groundwater Technical Forum and the Federal Facilities Forum.

At the request of the State of Hawaii, Matt developed a methodology to determine the vulnerability of groundwater to contamination on the islands of Maui and Oahu. He used analytical models and a GIS to show zones of vulnerability, and the results were adopted and published by the State of Hawaii and County of Maui.

As a hydrogeologist with the EPA Groundwater Protection Section, Matt worked with provisions of the Safe Drinking Water Act and NEPA to prevent drinking water contamination. Specific activities included the following:

- Received an EPA Bronze Medal for his contribution to the development of national guidance for the protection of drinking water.
 - Managed the Sole Source Aquifer Program and protected the drinking water of two communities through designation under the Safe Drinking Water Act. He prepared geologic reports, conducted public hearings, and responded to public comments from residents who were very concerned about the impact of designation.
-

- Reviewed a number of Environmental Impact Statements for planned major developments, including large hazardous and solid waste disposal facilities, mine reclamation, and water transfer.

Matt served as a hydrogeologist with the RCRA Hazardous Waste program. Duties were as follows:

- Supervised the hydrogeologic investigation of hazardous waste sites to determine compliance with Subtitle C requirements.
- Reviewed and wrote "part B" permits for the disposal of hazardous waste.
- Conducted RCRA Corrective Action investigations of waste sites and led inspections that formed the basis for significant enforcement actions that were developed in close coordination with U.S. EPA legal counsel.
- Wrote contract specifications and supervised contractor's investigations of waste sites.

With the National Park Service, Matt directed service-wide investigations of contaminant sources to prevent degradation of water quality, including the following tasks:

- Applied pertinent laws and regulations including CERCLA, RCRA, NEPA, NRDA, and the Clean Water Act to control military, mining, and landfill contaminants.
- Conducted watershed-scale investigations of contaminants at parks, including Yellowstone and Olympic National Park.
- Identified high-levels of perchlorate in soil adjacent to a national park in New Mexico and advised park superintendent on appropriate response actions under CERCLA.
- Served as a Park Service representative on the Interagency Perchlorate Steering Committee, a national workgroup.
- Developed a program to conduct environmental compliance audits of all National Parks while serving on a national workgroup.
- Co-authored two papers on the potential for water contamination from the operation of personal watercraft and snowmobiles, these papers serving as the basis for the development of nation-wide policy on the use of these vehicles in National Parks.
- Contributed to the Federal Multi-Agency Source Water Agreement under the Clean Water Action Plan.

Policy:

Served senior management as the Senior Science Policy Advisor with the U.S. Environmental Protection Agency, Region 9. Activities included the following:

- Advised the Regional Administrator and senior management on emerging issues such as the potential for the gasoline additive MTBE and ammonium perchlorate to contaminate drinking water supplies.
 - Shaped EPA's national response to these threats by serving on workgroups and by contributing to guidance, including the Office of Research and Development publication, *Oxygenates in Water: Critical Information and Research Needs*.
 - Improved the technical training of EPA's scientific and engineering staff.
 - Earned an EPA Bronze Medal for representing the region's 300 scientists and engineers in negotiations with the Administrator and senior management to better integrate scientific principles into the policy-making process.
 - Established national protocol for the peer review of scientific documents.
-

Geology:

With the U.S. Forest Service, Matt led investigations to determine hillslope stability of areas proposed for timber harvest in the central Oregon Coast Range. Specific activities were as follows:

- Mapped geology in the field, and used aerial photographic interpretation and mathematical models to determine slope stability.
- Coordinated his research with community members who were concerned with natural resource protection.
- Characterized the geology of an aquifer that serves as the sole source of drinking water for the city of Medford, Oregon.

As a consultant with Dames and Moore, Matt led geologic investigations of two contaminated sites (later listed on the Superfund NPL) in the Portland, Oregon, area and a large hazardous waste site in eastern Oregon. Duties included the following:

- Supervised year-long effort for soil and groundwater sampling.
- Conducted aquifer tests.
- Investigated active faults beneath sites proposed for hazardous waste disposal.

Teaching:

From 1990 to 1998, Matt taught at least one course per semester at the community college and university levels:

- At San Francisco State University, held an adjunct faculty position and taught courses in environmental geology, oceanography (lab and lecture), hydrogeology, and groundwater contamination.
- Served as a committee member for graduate and undergraduate students.
- Taught courses in environmental geology and oceanography at the College of Marin.

Matt taught physical geology (lecture and lab and introductory geology at Golden West College in Huntington Beach, California from 2010 to 2014.

Invited Testimony, Reports, Papers and Presentations:

Hagemann, M.F., 2008. Disclosure of Hazardous Waste Issues under CEQA. Presentation to the Public Environmental Law Conference, Eugene, Oregon.

Hagemann, M.F., 2008. Disclosure of Hazardous Waste Issues under CEQA. Invited presentation to U.S. EPA Region 9, San Francisco, California.

Hagemann, M.F., 2005. Use of Electronic Databases in Environmental Regulation, Policy Making and Public Participation. Brownfields 2005, Denver, Colorado.

Hagemann, M.F., 2004. Perchlorate Contamination of the Colorado River and Impacts to Drinking Water in Nevada and the Southwestern U.S. Presentation to a meeting of the American Groundwater Trust, Las Vegas, NV (served on conference organizing committee).

Hagemann, M.F., 2004. Invited testimony to a California Senate committee hearing on air toxins at schools in Southern California, Los Angeles.

Brown, A., Farrow, J., Gray, A. and **Hagemann, M.**, 2004. An Estimate of Costs to Address MTBE Releases from Underground Storage Tanks and the Resulting Impact to Drinking Water Wells. Presentation to the Ground Water and Environmental Law Conference, National Groundwater Association.

Hagemann, M.F., 2004. Perchlorate Contamination of the Colorado River and Impacts to Drinking Water in Arizona and the Southwestern U.S. Presentation to a meeting of the American Groundwater Trust, Phoenix, AZ (served on conference organizing committee).

Hagemann, M.F., 2003. Perchlorate Contamination of the Colorado River and Impacts to Drinking Water in the Southwestern U.S. Invited presentation to a special committee meeting of the National Academy of Sciences, Irvine, CA.

Hagemann, M.F., 2003. Perchlorate Contamination of the Colorado River. Invited presentation to a tribal EPA meeting, Pechanga, CA.

Hagemann, M.F., 2003. Perchlorate Contamination of the Colorado River. Invited presentation to a meeting of tribal representatives, Parker, AZ.

Hagemann, M.F., 2003. Impact of Perchlorate on the Colorado River and Associated Drinking Water Supplies. Invited presentation to the Inter-Tribal Meeting, Torres Martinez Tribe.

Hagemann, M.F., 2003. The Emergence of Perchlorate as a Widespread Drinking Water Contaminant. Invited presentation to the U.S. EPA Region 9.

Hagemann, M.F., 2003. A Deductive Approach to the Assessment of Perchlorate Contamination. Invited presentation to the California Assembly Natural Resources Committee.

Hagemann, M.F., 2003. Perchlorate: A Cold War Legacy in Drinking Water. Presentation to a meeting of the National Groundwater Association.

Hagemann, M.F., 2002. From Tank to Tap: A Chronology of MTBE in Groundwater. Presentation to a meeting of the National Groundwater Association.

Hagemann, M.F., 2002. A Chronology of MTBE in Groundwater and an Estimate of Costs to Address Impacts to Groundwater. Presentation to the annual meeting of the Society of Environmental Journalists.

Hagemann, M.F., 2002. An Estimate of the Cost to Address MTBE Contamination in Groundwater (and Who Will Pay). Presentation to a meeting of the National Groundwater Association.

Hagemann, M.F., 2002. An Estimate of Costs to Address MTBE Releases from Underground Storage Tanks and the Resulting Impact to Drinking Water Wells. Presentation to a meeting of the U.S. EPA and State Underground Storage Tank Program managers.

Hagemann, M.F., 2001. From Tank to Tap: A Chronology of MTBE in Groundwater. Unpublished report.

Hagemann, M.F., 2001. Estimated Cleanup Cost for MTBE in Groundwater Used as Drinking Water. Unpublished report.

Hagemann, M.F., 2001. Estimated Costs to Address MTBE Releases from Leaking Underground Storage Tanks. Unpublished report.

Hagemann, M.F., and VanMouwerik, M., 1999. Potential Water Quality Concerns Related to Snowmobile Usage. Water Resources Division, National Park Service, Technical Report.

VanMouwerik, M. and **Hagemann, M.F.** 1999, Water Quality Concerns Related to Personal Watercraft Usage. Water Resources Division, National Park Service, Technical Report.

Hagemann, M.F., 1999, Is Dilution the Solution to Pollution in National Parks? The George Wright Society Biannual Meeting, Asheville, North Carolina.

Hagemann, M.F., 1997, The Potential for MTBE to Contaminate Groundwater. U.S. EPA Superfund Groundwater Technical Forum Annual Meeting, Las Vegas, Nevada.

Hagemann, M.F., and Gill, M., 1996, Impediments to Intrinsic Remediation, Moffett Field Naval Air Station, Conference on Intrinsic Remediation of Chlorinated Hydrocarbons, Salt Lake City.

Hagemann, M.F., Fukunaga, G.L., 1996, The Vulnerability of Groundwater to Anthropogenic Contaminants on the Island of Maui, Hawaii. Hawaii Water Works Association Annual Meeting, Maui, October 1996.

Hagemann, M. F., Fukanaga, G. L., 1996, Ranking Groundwater Vulnerability in Central Oahu, Hawaii. Proceedings, Geographic Information Systems in Environmental Resources Management, Air and Waste Management Association Publication VIP-61.

Hagemann, M.F., 1994. Groundwater Characterization and Cleanup at Closing Military Bases in California. Proceedings, California Groundwater Resources Association Meeting.

Hagemann, M.F. and Sabol, M.A., 1993. Role of the U.S. EPA in the High Plains States Groundwater Recharge Demonstration Program. Proceedings, Sixth Biennial Symposium on the Artificial Recharge of Groundwater.

Hagemann, M.F., 1993. U.S. EPA Policy on the Technical Impracticability of the Cleanup of DNAPL-contaminated Groundwater. California Groundwater Resources Association Meeting.

Hagemann, M.F., 1992. Dense Nonaqueous Phase Liquid Contamination of Groundwater: An Ounce of Prevention... Proceedings, Association of Engineering Geologists Annual Meeting, v. 35.

Other Experience:

Selected as subject matter expert for the California Professional Geologist licensing examination, 2009-2011.

EXHIBIT C

Shawn Smallwood, PhD
3108 Finch Street
Davis, CA 95616

14 June 2021

Paige Fennie
Lozeau Drury LLP
1939 Harrison Street, Suite 150
Oakland, California 94612

RE: Commercial Street Hotels project

Dear Ms. Fennie,

After reviewing the site and architectural plans (Lowney Arch 2021) for the proposed Commercial Street Hotels project on 1 acre, and after reviewing the biological resources assessment prepared by Rincon (2020), I write to share my concern that the project, as proposed in the architectural plans, would cause inordinate impacts to resident and migratory birds, and would contribute to cumulative impacts on migratory birds caused by the recent proliferation of extensive glass in building façades.

My qualifications for preparing expert comments are the following. I hold a Ph.D. degree in Ecology from University of California at Davis, where I also completed four years of post-graduate research in the Department of Agronomy and Range Sciences. My research is on animal density and distribution, habitat selection, wildlife interactions with human infrastructure and activities, conservation of rare and endangered species, and the ecology of invading species. I study wildlife mortality caused by wind turbines, electric distribution lines, agricultural practices, and road traffic. I authored numerous papers on special-status species issues. I served as Chair of the Conservation Affairs Committee for The Wildlife Society – Western Section. I am a member of The Wildlife Society and the Raptor Research Foundation, and I've been a part-time lecturer at California State University, Sacramento. I was Associate Editor of wildlife biology's premier scientific journal, The Journal of Wildlife Management, as well as of Biological Conservation, and I was on the Editorial Board of Environmental Management. I have performed wildlife surveys in California for thirty-three years, including at many proposed project sites. My CV is attached.

EXISTING ENVIRONMENTAL CONDITIONS

Most anyone considering environmental conditions at the site of the proposed project would likely react like I did when first reviewing imagery of it. At first look, they would see automobile towing services and their accompanying office structures and car lots. They would see a highly disturbed environment that is rarely if ever viewed as habitat to special-status species of wildlife. Perhaps a few birds might stop-over or even nest in the Eucalyptus towering above the cars and trucks parked on the lots. But habitat to special-status species?

Missed by this first look is a large portion of habitat that is essential to many species. To understand this part of their habitat, one must consider the very definition of habitat. Habitat is defined by a species' use of the environment (Hall et al. 1997, Morrison et al. 1998, Smallwood 2002). Every species on Earth is morphologically adapted through thousands of generations of life and death to exist within an environmental medium. The central medium for many species is life itself: mosses grown on trees, barnacles on whales, and tapeworms in gut. For many other species it is soil, including for many species of nematode, pocket gophers, and even California tiger salamander. For a vast number of species, it is water. Indeed, most people do not hesitate to characterize whales, fishes, squid, and shrimp as aquatic animals living in aquatic habitats. Less often appreciated is the gaseous atmosphere as a medium of life (Davy et al. 2017, Diehl et al. 2017), but it is one of the most important habitat mediums of our planet. Indeed, an entire discipline of ecology has emerged to study this essential aspect of habitat – the discipline of aeroecology (Kunz et al. 2008).

Many species of flora and fauna are morphologically adapted to living in that part of the atmosphere referred to as the aerosphere. Plants disseminate pollen via the aerosphere. Plant pollinators travel from one plant to the next via the aerosphere. Spiders disperse by deploying web-parachutes to catch the winds of the aerosphere. Vast numbers of insects disperse and migrate through it. Many species of vertebrate wildlife depend on it for olfactory and acoustic communication, forage, dispersal, migration, and home range patrol. Birds and bats evolved two of their four ambulatory limbs into wings that are specifically adapted to particular uses of the atmosphere: short powerful wings for speed, long slender wings for glide, and broad wings for maneuverability, as examples. The atmosphere is so important an element of habitat to wildlife that some birds sleep while in flight, and bats and owls hunt in it, even in the pitch-dark of the moonless night. The aerosphere is an essential element of habitat for a vast number of wildlife species.

Certainly, we have all witnessed plants and animals using the aerosphere as habitat. Those of us vulnerable to allergic rhinitis are aware of pollen in the aerosphere. Mosquitos are hard to ignore. And all of us have seen birds flying from one place to another. Some of us have also had the privilege to study volant animals – animals that fly. As one of the privileged, I have observed and recorded flights of birds and bats across thousands of hours of directed surveys. I have recorded flight patterns in behavior surveys and in 1,000 hours of nocturnal surveys by use of a thermal-imaging camera, and I have studied flying golden eagles using GPS-telemetry. My studies have particularly focused on how flights result in collisions with anthropogenic structures. I study impacts to wildlife caused by insertions of human structures into the aerosphere.

Most insertions of anthropogenic structures into the aerosphere are inserted without a thought given to their potential impacts to volant wildlife. Impacts can include habitat loss, energetic costs of having to navigate around the structure, increased predation risk from predators using the structures as hunting perches or foraging screens, and collision mortality. Electric transmission and distribution lines are hung from towers and poles with little regard for their near invisibility to birds. Communication towers are likewise

installed where convenient rather than where least harmful to volant wildlife. The same is true for wind turbines (Smallwood et al. 2017) and utility-scale solar projects (Smallwood 2020). Buildings also go up without much of a thought to wildlife impacts. But buildings often pose a second, and perhaps more deadly, threat to volant wildlife, and that is their windows. Without evolutionary experience with windows, birds are vulnerable to the transparency of many windows, to the reflectance of vegetation and other birds in many windows, to the false perception of cavity space of some windows, and to confusion caused by interior lighting issuing from windows at night.

BIOLOGICAL IMPACTS

Rincon (2020) viewed the project site with the typical terrestrial focus I discussed earlier. According to Rincon (2020:5), “Of the 44 species evaluated..., ...no special-status species are expected to occur in the study area. This is due to species-specific habitat requirements not present on the site and the overall lack of suitable habitat such as natural vegetation communities or natural wetland habitats (marshes or seeps).” Rincon’s analysis fell short because it considered only what occurs on the ground. Volant animals rely on the aerosphere as not only part of their habitat, but as an indispensable part of their habitat. Without access to their airspace, volant animals cannot persist. Worse, if artificial structures are inserted into their airspace, and if those structures function as lethal traps, then those structures destroy habitat at the same time they introduce anthropogenic sources of mortality.

Window collisions are often characterized as either the second or third largest source or human-caused bird mortality. The numbers behind these characterizations are often attributed to Klem’s (1990) and Dunn’s (1993) estimates of about 100 million to 1 billion bird fatalities in the USA, or more recently Loss et al.’s (2014) estimate of 365-988 million bird fatalities in the USA or Calvert et al.’s (2013) and Machtans et al.’s (2013) estimates of 22.4 million and 25 million bird fatalities in Canada, respectively. However, these estimates were likely biased too low, because they were based on opportunistic sampling, volunteer study participation, fatality monitoring by more inexperienced than experienced searchers, and usually no adjustments made for scavenger removals of carcasses before searchers could detect them (Bracey et al. 2016). A high rate of bird-window collisions has been measured in the Bay Area (Kahle et al. 2016), which is within the prominent bird migration route known as the Pacific Flyway.

At least one million birds pass through the South Bay annually (City of San Jose 2014), and at least 40 special-status species of bird are known to the project area (Table 1). With the release of a study just this year, we also know that 22 of these special-status species have been documented as window collision fatalities and are therefore susceptible to new structural glass installations (Basilio et al. 2020: Supplemental Material). Many more species of migratory birds, newly protected by California’s revised Fish and Game Code section 3513, have also been documented as window collision victims (Basilio et al. 2020).

I am concerned about the extent and context of glass proposed for the buildings' façades. Recent advances in structural glass engineering have contributed to a proliferation of glass windows on building façades. This proliferation is readily observable in newer buildings and in recent project planning documents, and it is represented by a worldwide 20% increase in glass manufacturing for building construction since 2016. Glass markets in the USA experienced 5% growth in both 2011 and 2016, and was forecast to grow 2.3% per year since 2016 (TMCapital 2019). Increasing window to wall ratios and glass façades have become popular for multiple reasons, including a growing demand for 'daylighting.' Consistent with the trends just outlined, glass windows comprise a major feature of the proposed project.

My concern is heightened by the recent report of a 29% decline in overall bird abundance across North America over the past 48 years (Rosenberg et al. 2019). This stunning loss comports with my own impression from decades of monitoring of bird populations in California, and it comports with the impressions of colleagues who have been performing their own monitoring programs. This loss poses dire ecological and economic consequences that have yet to be fully understood, but which must be considered in any serious analysis of cumulative impacts.

Bird-Safe Guidelines

Depictions of the building's façades in the project site and architectural plans (Lowney Arch 2021) are not entirely consistent with the standards identified in City of Sunnyvale's own Bird-Safe Guidelines (City of Sunnyvale 2014). The guidelines under Option 2 of City of Sunnyvale (2014) would apply. The first standard of the Bird-Safe Guidelines is to "Avoid large expanse of glass near open areas, especially when tall landscaping is immediately adjacent to the glass walls." However, the project site and architectural plans depict large glass windows that would reflect tall vegetation in adjacent landscaping (Figure 1). The project would not be consistent with the first standard of the City's guidelines. It could improve safety in other ways, as well, as discussed below.



Figure 1. Lowney Arch's (2021) rendering of project depicts large windows across from tall trees.

Project Impact Prediction

Predicting the impacts caused by loss of aerial habitat and the energetic costs of birds having to navigate around the buildings is possible, but I am unprepared to make such predictions. However, I am prepared to predict bird-window collision mortality. By the time of these comments I had reviewed and processed results of bird collision monitoring at 213 buildings and façades for which bird collisions per m² of glass per year could be calculated and averaged (Johnson and Hudson 1976, O'Connell 2001, Somerlot 2003, Hager et al. 2008, Borden et al. 2010, Hager et al. 2013, Porter and Huang 2015, Parkins et al. 2015, Kahle et al. 2016, Ocampo-Peñuela et al. 2016, Sabo et al. 2016, Barton et al. 2017, Gomez-Moreno et al. 2018, Schneider et al. 2018, Loss et al. 2019, Brown et al. 2020, , City of Portland Bureau of Environmental Services and Portland Audubon 2020, Riding et al. 2020). These study results averaged 0.073 bird deaths per m² of glass per year (95% CI: 0.042-0.102). Looking over the proposed building design, I estimated the buildings would include at least 1,477 m² of glass panels, which applied to the mean fatality rate would predict at least **108 bird deaths per year (95% CI: 64-152)** at the buildings. The 100-year toll from this average annual fatality rate would be at least **10,800 bird deaths (95% CI: 6,600-15,200)**. These estimates would be perhaps 3 times higher after accounting for the proportions of fatalities removed by scavengers or missed by fatality searchers where studies have been performed. The mortality of collision fatalities would continue until the buildings are either renovated to reduce bird collisions or they come down. If the project moves forward as proposed, and annually more than 100 birds protected by state and federal laws, the project will cause significant unmitigated impacts.

Table 1. Special-status species of bird reported nearby the project site (<https://eBird.org>) and whether found as window collision victims.

Species	Scientific name	Status ¹	eBird posts	Window victims
Turkey vulture	<i>Cathartes aura</i>	BOP	Recent nearby	Yes
Osprey	<i>Pandion haliaetus</i>	WL, BOP	Nearby	Yes
California gull	<i>Larus californicus</i>	WL	Recent very close	
Caspian tern	<i>Hydropogone caspia</i>	WL	Nearby	
Red-tailed hawk	<i>Buteo jamaicensis</i>	BOP	Recent very close	Yes
Swainson's hawk	<i>Buteo swainsoni</i>	CT, BOP	Nearby	
Ferruginous hawk	<i>Buteo regalis</i>	BOP, WL	Recent nearby	
Red-shouldered hawk	<i>Buteo lineatus</i>	BOP	Recent very close	Yes
Sharp-shinned hawk	<i>Accipiter striatus</i>	BOP, WL	Recent nearby	Yes
Cooper's hawk	<i>Accipiter cooperi</i>	BOP, WL	Recent nearby	Yes
Northern harrier	<i>Circus cyaneus</i>	SSC3, BOP	Recent nearby	
White-tailed kite	<i>Elanus leucurus</i>	CFP, WL, BOP	Recent nearby	
American kestrel	<i>Falco sparverius</i>	BOP	Recent nearby	Yes
Merlin	<i>Falco columbarius</i>	BOP, WL	Recent nearby	Yes
Peregrine falcon	<i>Falco peregrinus</i>	BCC, CFP, BOP	Recent nearby	Yes
Great-horned owl	<i>Bubo virginianus</i>	BOP	Recent nearby	Yes
Western screech-owl	<i>Megascops kennicotti</i>	BOP	Recent nearby	Yes
Barn owl	<i>Tyto alba</i>	BOP	Recent nearby	Yes
Burrowing owl	<i>Athene cunicularia</i>	BCC, SSC2, BOP	Recent nearby	Yes
Vaux's swift	<i>Chaetura vauxi</i>	SCC2	Nearby	
Costa's hummingbird	<i>Calypte costae</i>	BCC	Nearby	Yes
Allen's hummingbird	<i>Selasphorus sasin</i>	BCC	Recent nearby	Many
Nuttall's woodpecker	<i>Picoides nuttallii</i>	BCC	Recent very close	
Willow flycatcher	<i>Empidonax trailii</i>	CE	Nearby	
Olive-sided flycatcher	<i>Contopus cooperi</i>	SSC2	Nearby	
Least Bell's vireo	<i>Vireo belli pusillus</i>	FE, CE	In region	
Yellow-billed magpie	<i>Pica nuttalli</i>	BCC	Nearby	
Oak titmouse	<i>Baeolophus inornatus</i>	BCC	Recent nearby	Yes
Horned lark	<i>Eremophila alpestris actia</i>	WL	Nearby	
Purple martin	<i>Progne subis</i>	SSC2	Nearby	Yes

Species	Scientific name	Status¹	eBird posts	Window victims
Loggerhead shrike	<i>Lanius ludovicianus</i>	BCC, SSC2	Recent nearby	
Yellow warbler	<i>Setophaga petechia</i>	BCC, SSC2	Recent nearby	Yes
Yellow-breasted chat	<i>Icteria virens</i>	SSC3	Nearby	Yes
San Francisco common yellowthroat	<i>Geothlypis trichas sinuosa</i>	BCC, SSC3	Recent nearby	Yes
Summer tanager	<i>Piranga rubra</i>	SSC1	Nearby	Yes
Oregon vesper sparrow	<i>Poocetes gramineus affinis</i>	SSC2	Nearby	
Grasshopper sparrow	<i>Ammodramus savannarum</i>	SSC2	Nearby	Yes
Yellow-headed blackbird	<i>X. xanthocephalus</i>	SSC3	Nearby	
Tricolored blackbird	<i>Agelaius tricolor</i>	CT, BCC	Nearby	
Lawrence's goldfinch	<i>Spinus lawrencei</i>	BCC	Nearby	

¹ Listed as FT or FE = federally threatened or endangered, BCC = U.S. Fish and Wildlife Service Bird Species of Conservation Concern, CT or CE = California threatened or endangered, CFP = California Fully Protected (California Fish and Game Code 3511), BOP = Fish and Game Code 3503.5 = Birds of prey, and SSC1, SSC2 and SSC3 = California Species of Special Concern priorities 1, 2 and 3, respectively, and WL = Taxa to Watch List (Shuford and Gardali 2008).

Bird-Window Collision Factors

Below is a list of collision factors I found in the scientific literature, and which I suggest ought to be used to both revise City of Sunnyvale's Bird-Safe Guidelines and formulate a bird-safe plan for the proposed project. Following this list are specific notes and findings taken from the literature and my own experience.

- (1) Inherent hazard of a structure in the airspace used for nocturnal migration or other flights
- (2) Window transparency, falsely revealing passage through structure or to indoor plants
- (3) Window reflectance, falsely depicting vegetation, competitors, or open airspace
- (4) Black hole or passage effect
- (5) Window or façade extent, or proportion of façade consisting of window or other reflective surface
- (6) Size of window
- (7) Type of glass
- (8) Lighting, which is correlated with window extent and building operations
- (9) Height of structure (collision mechanisms shift with height above ground)
- (10) Orientation of façade with respect to winds and solar exposure
- (11) Structural layout causing confusion and entrapment
- (12) Context in terms of urban-rural gradient, or surrounding extent of impervious surface vs vegetation
- (13) Height, structure, and extent of vegetation grown near home or building
- (14) Presence of birdfeeders or other attractants
- (15) Relative abundance
- (16) Season of the year
- (17) Ecology, demography and behavior
- (18) Predatory attacks or cues provoking fear of attack
- (19) Aggressive social interactions

(1) Inherent hazard of structure in airspace.—Not all of a structure's collision risk can be attributed to windows. Overing (1938) reported 576 birds collided with the Washington Monument in 90 minutes on one night, 12 September 1937. The average annual fatality count had been 328 birds from 1932 through 1936. Gelb and Delacretaz (2009) and Klem et al. (2009) also reported finding collision victims at buildings lacking windows, although many fewer than they found at buildings fitted with windows. The takeaway is that any building going up at the project site would likely kill birds, although mortality would increase with larger expanses of glass.

(2) Window transparency.—Widely believed as one of the two principal factors contributing to avian collisions with buildings is the transparency of glass used in windows on the buildings (Klem 1989). Gelb and Delacretaz (2009) felt that many of the collisions they detected occurred where transparent windows revealed interior vegetation.

(3) Window reflectance.—Widely believed as one of the two principal factors contributing to avian collisions with buildings is the reflectance of glass used in windows on the buildings (Klem 1989). Reflectance can deceptively depict open airspace, vegetation as habitat destination, or competitive rivals as self-images (Klem 1989). Gelb and Delacretaz (2009) felt that many of the collisions they detected occurred toward the lower parts of buildings where large glass exteriors reflected outdoor vegetation. Klem et al. (2009) and Borden et al. (2010) also found that reflected outdoor vegetation associated positively with collisions.

(4) Black hole or passage effect.—Although this factor was not often mentioned in the bird-window collision literature, it was suggested in Sheppard and Phillips (2015). The black hole or passage effect is the deceptive appearance of a cavity or darkened ledge that certain species of bird typically approach with speed when seeking roosting sites. The deception is achieved when shadows from awnings or the interior light conditions give the appearance of cavities or protected ledges. This factor appears potentially to be nuanced variations on transparency or reflectance or possibly an interaction effect of both of these factors. It might play a significant role in the proposed project, which includes extruded window frames of many windows.

(5) Window or façade extent.—Klem et al. (2009), Borden et al. (2010), Hager et al. (2013), Ocampo-Peñuela et al. (2016), Loss et al. (2019), Rebolo-Ifrán et al. (2019), and Riding et al. (2020) reported increased collision fatalities at buildings with larger reflective façades or higher proportions of façades composed of windows. However, Porter and Huang (2015) found a negative relationship between fatalities found and proportion of façade that was glazed.

(6) Size of window.—According to Kahle et al. (2016), collision rates were higher on large-pane windows compared to small-pane windows. Many of the windows of the proposed project would be large, with 172 of them each about 4.85 m² in area and 83 of them each about 3.66 m², in addition to the expansive bottom-floor storefront windows.

(7) Type of glass.—Klem et al. (2009) found that collision fatalities associated with the type of glass used on buildings. Otherwise, little attention has been directed towards the types of glass in buildings.

(8) Lighting.—Parkins et al. (2015) found that light emission from buildings correlated positively with percent glass on the façade, suggesting that lighting is linked to the extent of windows. Zink and Eckles (2010) reported fatality reductions, including an 80% reduction at a Chicago high-rise, upon the initiation of the Lights-out Program. However, Zink and Eckles (2010) provided no information on their search effort, such as the number of searches or search interval or search area around each building.

(9) Height of structure.—Except for Riding et al. (2020), I found little if any hypothesis-testing related to building height, including whether another suite of factors might relate to collision victims of high-rises. Are migrants more commonly the victims of high-rises or of smaller buildings? Some of the most notorious buildings are low-rise buildings.

(10) Orientation of façade.—Some studies tested façade orientation, but not convincingly. Some evidence that orientation affects collision rates was provided by Winton et al. (2018). Confounding factors such as the extent and types of windows would require large sample sizes of collision victims to parse out the variation so that some portion of it could be attributed to orientation of façade. Whether certain orientations cause disproportionately stronger or more realistic-appearing reflections ought to be testable through measurement, but counting dead birds under façades of different orientations would help.

(11) Structural layout.—Bird-safe building guidelines have illustrated examples of structural layouts associated with high rates of bird-window collisions, but little attention has been directed towards hazardous structural layouts in the scientific literature. An exception was Johnson and Hudson (1976), who found high collision rates at 3 stories of glassed-in walkways atop an open breezeway, located on a break in slope with trees on one side of the structure and open sky on the other, Washington State University.

(12) Context in urban-rural gradient.—Numbers of fatalities found in monitoring have associated negatively with increasing developed area surrounding the building (Hager et al. 2013), and positively with more rural settings (Kummer et al. 2016).

(13) Height, structure and extent of vegetation near building.—Correlations have sometimes been found between collision rates and the presence or extent of vegetation near windows (Hager et al. 2008, Borden et al. 2010, Kummer et al. 2016, Ocampo-Peñuela et al. 2016). However, Porter and Huang (2015) found a negative relationship between fatalities found and vegetation cover near the building. In my experience, what probably matters most is the distance from the building that vegetation occurs. If the vegetation that is used by birds is very close to a glass façade, then birds coming from that glass will be less likely to attain sufficient speed upon arrival at the façade to result in a fatal injury. Too far away and there is probably no relationship. But 30 to 50 m away, as proposed for this project, and birds alighting from vegetation can attain lethal speeds by the time they arrive at the windows.

(14) Presence of birdfeeders.—Dunn (1993) reported a weak correlation ($r = 0.13$, $P < 0.001$) between number of birds killed by home windows and the number of birds counted at feeders. However, Kummer and Bayne (2015) found that experimental installment of birdfeeders at homes increased bird collisions with windows 1.84-fold.

(15) Relative abundance.—Collision rates have often been assumed to increase with local density or relative abundance (Klem 1989), and positive correlations have been measured (Dunn 1993, Hager et al. 2008). However, Hager and Craig (2014) found a negative correlation between fatality rates and relative abundance near buildings.

(16) Season of the year.—Borden et al. (2010) found 90% of collision fatalities during spring and fall migration periods. The significance of this finding is magnified by 7-day

carcass persistence rates of 0.45 and 0.35 in spring and fall, rates which were considerably lower than during winter and summer (Hager et al. 2012). In other words, the concentration of fatalities during migration seasons would increase after applying seasonally-explicit adjustments for carcass persistence. Fatalities caused by collisions into the glass façades of the project's building would likely be concentrated in fall and spring migration periods.

(17) Ecology, demography and behavior.—Klem (1989) noted that certain types of birds were not found as common window-caused fatalities, including soaring hawks and waterbirds. Cusa et al. (2015) found that species colliding with buildings surrounded by higher levels of urban greenery were foliage gleaners, and species colliding with buildings surrounded by higher levels of urbanization were ground foragers. Sabo et al. (2016) found no difference in age class, but did find that migrants are more susceptible to collision than resident birds.

(18) Predatory attacks.—Panic flights caused by raptors were mentioned in 16% of window strike reports in Dunn's (1993) study. I have witnessed Cooper's hawks chasing birds into windows, including house finches next door to my home and a northern mocking bird chased directly into my office window. Predatory birds likely to collide with the project's windows would include Peregrine falcon, red-shouldered hawk, Cooper's hawk, and sharp-shinned hawk.

(19) Aggressive social interactions.—I found no hypothesis-testing of the roles of aggressive social interactions in the literature other than the occasional anecdotal account of birds attacking their self-images reflected from windows. However, I have witnessed birds chasing each other and sometimes these chases resulting in one of the birds hitting a window.

For most of the known or suspected collision risk factors, the proposed project's design would either contribute amply to collision risk, or its contribution remains unknown (Table 2). Focused study of birds in the area could reduce the uncertainty of potential project impacts. Such studies could make use of radar (Gauthreaux et al. 2008) or visual scan surveys (Smallwood 2017).

Window Collision Solutions

Given the magnitude of bird-window collision impacts, there are obviously great opportunities for reducing and minimizing these impacts going forward. Existing structures can be modified or retrofitted to reduce impacts, and proposed new structures can be more carefully sited, designed, and managed to minimize impacts. However, the costs of some of these measures can be high and can vary greatly, but most importantly the efficacies of many of these measures remain uncertain. Both the costs and effectiveness of all of these measures can be better understood through experimentation and careful scientific investigation. **Post-construction fatality monitoring should be an essential feature of any new building project.**

Below is a listing of mitigation options, along with some notes and findings from the literature.

Table 2. Window collision risk factors, their weightings based on the scientific literature, and the level of risk introduced by the proposed project.

Collision risk to volant wildlife		
Factor	Weighting	Added by project
Inherent hazard of structure	Universal	Likely
Window transparency	Very high	Amplify
Window reflectance	Very high	Unknown
Black hole or passage effect	High	Amplify
Window or façade extent	Very high	Amplify
Size of window	High	Amplify
Type of glass	High	Unknown
Lighting	High	Unknown
Height of structure	High	Amplify
Orientation of façade	Unknown	Unknown
Structural layout	High	Unknown
Context in urban-rural gradient	Likely high	Less
Height, structure and extent of vegetation near building	High	Amplify
Presence of birdfeeders	Moderate	Unknown
Relative abundance	Uncertain	Unknown
Season of the year	Nonspatial	Not applicable
Ecology, demography and behavior	Uncertain	Unknown
Predatory attacks	Uncertain	Unknown
Aggressive social interactions	Uncertain	Unknown

Any new project should be informed by preconstruction surveys of daytime and nocturnal flight activity. Such surveys can reveal the one or more façades facing the prevailing approach direction of birds, and these revelations can help prioritize where certain types of mitigation can be targeted. It is critical to formulate effective measures prior to construction, because post-construction options will be limited, likely more expensive, and probably less effective.

(1) Retrofitting to reduce impacts

- (1A) Marking windows
- (1B) Managing outdoor landscape vegetation
- (1C) Managing indoor landscape vegetation
- (1D) Managing nocturnal lighting

(1A) Marking windows.— Whereas Klem (1990) found no deterrent effect from decals on windows, Johnson and Hudson (1976) reported a fatality reduction of about 69% after placing decals on windows. In an experiment of opportunity, Ocampo-Peñuela et al. (2016) found only 2 of 86 fatalities at one of 6 buildings – the only building with

windows treated with a bird deterrent film. At the building with fritted glass, bird collisions were 82% lower than at other buildings with untreated windows. Kahle et al. (2016) added external window shades to some windowed façades to reduce fatalities 82% and 95%. Brown et al. (2020) reported an 84% lower collision probability among fritted glass windows and windows treated with ORNILUX R UV. City of Portland Bureau of Environmental Services and Portland Audubon (2020) reduced bird collision fatalities 94% by affixing marked Solyx window film to existing glass panels of Portland's Columbia Building. Many external and internal glass markers have been tested experimentally, some showing no effect and some showing strong deterrent effects (Klem 1989, 1990, 2009, 2011; Klem and Saenger 2013; Rössler et al. 2015).

Following up on the results of Johnson and Hudson (1976), I decided to mark windows of my home, where I have documented 5 bird collision fatalities between the time I moved in and 6 years later. I marked my windows with decals delivered to me via US Postal Service from a commercial vendor. I have documented no fatalities at my windows during the 10 years hence. In my assessment, markers can be effective in some situations.

(2) Siting and Designing to minimize impacts

- (2A) Deciding on location of structure
- (2B) Deciding on façade and orientation
- (2C) Selecting type and sizes of windows
- (2D) Designing to minimize transparency through two parallel façades
- (2E) Designing to minimize views of interior plants
- (2F) Landscaping to increase distances between windows and trees and shrubs

(3) Monitoring for adaptive management to reduce impacts

- (3A) Systematic monitoring for fatalities to identify seasonal and spatial patterns
- (3B) Adjust light management, window marking and other measures as needed.

CUMULATIVE IMPACTS

An analysis of cumulative impacts on birds caused by window collisions is needed, especially in light of the recently documented 29% decline in bird abundance across North America over the last 48 years (Rosenberg et al. 2019). The proposed project alone is predicted to cause 108 bird deaths per year. These deaths would add to many thousands more killed by windows in Sunnyvale, San Jose and other cities in the region. City of Sunnyvale needs to provide an estimate of the extent of windows already constructed, as well as an estimate of projected future extent of windows in the City. From such estimates, the City's cumulative toll on birds colliding with windows can be estimated and appropriate mitigation formulated. A project-specific EIR is needed to do this.

I predicted annual bird collision fatalities at the following recently proposed projects in the area:

- 1,023 (95% CI: 608-1,439) at Cityline Sun-block 3 South
- 62 (95% CI: 32-88) at 1296 Lawrence Station Road, Cupertino
- 274 (95% CI: 142-391) at Stockton Ave., San Jose
- 221 (95% CI: 125-316) at 1700 Dell Ave, San Jose
- 334 (95% CI: 189-478) at 27 South First Street, San Jose
- 476 (95% CI: 119-830) at Cupertino Village Hotel, Cupertino
- 1,215 (95% CI: 688-1,738) at Santana West, San Jose
- 509 (95% CI: 288-728) at AMD Sunnyvale
- 262 (95% CI: 136-374) at Avalon West Valley Expansion
- 2,170 (95% CI: 1,228-3,103) at Harbor View, Redwood City
- 126 (95% CI: 71-180) at 1180 Main Street Office Project.

These projects combined with the proposed project discussed herein would cause 6,780 bird deaths per year (95% CI: 3,690-9,817). Over 100 years, these projects – if constructed as proposed – would kill 678,000 birds (95% CI: 369,000-981,700). The unmitigated taking of two-thirds of a million birds over 100 years would qualify as a significant cumulative impact. This exercise ought to be extended to all glass windows of façades recently build, under construction, or reasonably foreseeable in the region of the project. To do this, the preparation of a project-specific EIR is warranted.

MITIGATION

Guidelines on Building Design

If the project goes forward, it should adhere to City of Sunnyvale's Bird-Safe Guidelines, and additionally to the available guidelines prepared by American Bird Conservancy and New York and San Francisco. The American Bird Conservancy (ABC) produced an excellent set of guidelines recommending actions to: (1) Minimize use of glass; (2) Placing glass behind some type of screening (grilles, shutters, exterior shades); (3) Using glass with inherent properties to reduce collisions, such as patterns, window films, decals or tape; and (4) Turning off lights during migration seasons (Sheppard and Phillips 2015). The City of San Francisco (San Francisco Planning Department 2011) also has a set of building design guidelines, based on the excellent guidelines produced by the New York City Audubon Society (Orff et al. 2007). The ABC document and both the New York and San Francisco documents provide excellent alerting of potential bird-collision hazards as well as many visual examples. The San Francisco Planning Department's (2011) building design guidelines are more comprehensive than those of New York City, but they could have gone further. For example, the San Francisco guidelines probably should have also covered scientific monitoring of impacts as well as compensatory mitigation for impacts that could not be avoided, minimized or reduced.

Additional Measures

Monitoring and the use of compensatory mitigation should be incorporated at any new building project because the measures recommended in the available guidelines remain

of uncertain efficacy, and even if these measures are effective, they will not reduce collision fatalities to zero. The only way to assess efficacy and to quantify post-construction fatalities is to monitor the project for fatalities.

Compensatory mitigation ought also to include funding contributions to wildlife rehabilitation facilities to cover the costs of injured animals that will be delivered to these facilities for care. Most of the injuries will likely be caused by bird-window collisions, but some will be injured for other reasons. Many of these animals would need treatment caused by collision injuries.

Thank you for your attention,



Shawn Smallwood, Ph.D.

REFERENCES CITED

- Barton, C. M., C. S. Riding, and S. R. Loss. 2017. Magnitude and correlates of bird collisions at glass bus shelters in an urban landscape. Plos One 12. (6): e0178667. <https://doi.org/10.1371/journal.pone.0178667>
- Basilio, L. G., D. J. Moreno, and A. J. Piratelli. 2020. Main causes of bird-window collisions: a review. Anais da Academia Brasileira de Ciências 92(1): e20180745 DOI 10.1590/0001-3765202020180745.
- Borden, W. C., O. M. Lockhart, A. W. Jones, and M. S. Lyons. 2010. Seasonal, taxonomic, and local habitat components of bird-window collisions on an urban university campus in Cleveland, OH. Ohio Journal of Science 110(3):44-52.
- Bracey, A. M., M. A. Etterson, G. J. Niemi, and R. F. Green. 2016. Variation in bird-window collision mortality and scavenging rates within an urban landscape. The Wilson Journal of Ornithology 128:355-367.
- Brown, B. B., L. Hunter, and S. Santos. 2020. Bird-window collisions: different fall and winter risk and protective factors. PeerJ 8:e9401 <http://doi.org/10.7717/peerj.9401>
- City of Portland Bureau of Environmental Services and Portland Audubon. 2020. Collisions at the Columbia Building: A synthesis of pre- and post-retrofit monitoring. Environmental Services of City of Portland, Oregon.
- Calvert, A. M., C. A. Bishop, R. D. Elliot, E. A. Krebs, T. M. Kydd, C. S. Machtans, and G. J. Robertson. 2013. A synthesis of human-related avian mortality in Canada. Avian Conservation and Ecology 8(2): 11. <http://dx.doi.org/10.5751/ACE-00581-080211>

- City of San Jose. 2014. Bird-safe building design standards.
- Cusa M, Jackson DA, Mesure M. 2015. Window collisions by migratory bird species: urban geographical patterns and habitat associations. *Urban Ecosystems* 18(4):1–20. DOI 10.1007/s11252-015-0459-3.
- Davy, C. M., A. T. Ford, and K. C. Fraser. 2017. Aeroconservation for the fragmented skies. *Conservation Letters* 10(6): 773–780.
- Diehl, R. H., A. C. Peterson, R. T. Bolus, and D. Johnson. 2017. Extending the habitat concept to the airspace. USGS Staff -- Published Research. 1129. <https://digitalcommons.unl.edu/usgsstaffpub/1129>
- Dunn, E. H. 1993. Bird mortality from striking residential windows in winter. *Journal of Field Ornithology* 64:302-309.
- Gauthreaux, Jr., S. A., J. W. Livingston, and C. G. Belser. 2008. Detection and discrimination of fauna in the aerosphere using Doppler weather surveillance radar. *Integrative and Comparative Biology* 48:12-23.
- Gelb, Y. and N. Delacretaz. 2009. Windows and vegetation: Primary factors in Manhattan bird collisions. *Northeastern Naturalist* 16:455-470.
- Gómez-Moreno, V. del C., J. R. Herrera-Herrera, and S. Niño-Maldonado. 2018. Bird collisions in windows of Centro Universitario Victoria, Tamaulipas, México. *Huitzil, Revista Mexicana de Ornitología* 19(2): 227-236. <https://doi.org/10.28947/hrmo.2018.19.2.347>
- Hager, S. B, and M. E. Craig. 2014. Bird-window collisions in the summer breeding season. *PeerJ* 2:e460 DOI 10.7717/peerj.460.
- Hager, S. B., H. Trudell, K. J. McKay, S. M. Crandall, and L. Mayer. 2008. Bird density and mortality at windows. *Wilson Journal of Ornithology* 120:550-564.
- Hager, S. B., B. J. Cosentino, and K. J. McKay. 2012. Scavenging effects persistence of avian carcasses resulting from window collisions in an urban landscape. *Journal of Field Ornithology* 83:203-211.
- Hager S. B., B. J. Cosentino, K J. McKay, C. Monson, W. Zuurdeeg, and B. Blevins. 2013. Window area and development drive spatial variation in bird-window collisions in an urban landscape. *PLoS ONE* 8(1): e53371. doi:10.1371/journal.pone.0053371
- Hall, L. S., P. R. Krausman, and M. L. Morrison. 1997. “The Habitat Concept and a Plea for Standard Terminology.” *Wildlife Society Bulletin* 25:173-82.

- Johnson, R. E., and G. E. Hudson. 1976. Bird mortality at a glassed-in walkway in Washington State. *Western Birds* 7:99-107.
- Kahle, L. Q., M. E. Flannery, and J. P. Dumbacher. 2016. Bird-window collisions at a west-coast urban park museum: analyses of bird biology and window attributes from Golden Gate Park, San Francisco. *PLoS ONE* 11(1):e144600 DOI 10.1371/journal.pone.0144600.
- Klem, D., Jr. 1989. Bird-window collisions. *Wilson Bulletin* 101:606-620.
- Klem, D., Jr. 1990. Collisions between birds and windows: mortality and prevention. *Journal of Field Ornithology* 61:120-128.
- Klem, D., Jr. 2009. Preventing bird-window collisions. *The Wilson Journal of Ornithology* 121:314-321.
- Klem, D., Jr. 2010. Avian mortality at windows: the second largest human source of bird mortality on earth. Pages 244-251 in *Proc. Fourth Int. Partners in Flight Conference: Tundra to Tropics*.
- Klem, D., Jr. 2011. Evaluating the effectiveness of Acopian Birdsavers to deter or prevent bird-glass collisions. Unpublished report.
- Klem, D., Jr. and P. G. Saenger. 2013. Evaluating the effectiveness of select visual signals to prevent bird-window collisions. *The Wilson Journal of Ornithology* 125:406-411.
- Klem, D. Jr., C. J. Farmer, N. Delacretaz, Y. Gelb and P. G. Saenger. 2009. Architectural and landscape risk factors associated with bird-glass collisions in an urban environment. *Wilson Journal of Ornithology* 121:126-134.
- Kummer J. A., and E. M. Bayne. 2015. Bird feeders and their effects on bird-window collisions at residential houses. *Avian Conservation and Ecology* 10(2):6 DOI 10.5751/ACE-00787-100206.
- Kummer, J. A., E. M. Bayne, and C. S. Machtans. 2016. Use of citizen science to identify factors affecting bird-window collision risk at houses. *The Condor: Ornithological Applications* 118:624-639. DOI: 10.1650/CONDOR-16-26.1
- Kunz, T. H., S. A. Gauthreaux Jr., N. I. Hristov, J. W. Horn, G. Jones, E. K. V. Kalko, R. P. Larkin, G. F. McCracken, S. M. Swartz, R. B. Srygley, R. Dudley, J. K. Westbrook, and M. Wikelski. 2008. Aeroecology: probing and modelling the aerosphere. *Integrative and Comparative Biology* 48:1-11. doi:10.1093/icb/icn037

- Loss, S. R., T. Will, S. S. Loss, and P. P. Marra. 2014. Bird–building collisions in the United States: Estimates of annual mortality and species vulnerability. *The Condor: Ornithological Applications* 116:8-23. DOI: 10.1650/CONDOR-13-090.1
- Loss, S. R., S. Lao, J. W. Eckles, A. W. Anderson, R. B. Blair, and R. J. Turner. 2019. Factors influencing bird-building collisions in the downtown area of a major North American city. *PLoS ONE* 14(11): e0224164. <https://doi.org/10.1371/journal.pone.0224164>
- Lowney Arch. 2021. Commercial Street Hotels 01/05/2021, 247 / 295 Commercial St, Sunnyvale, CA.
- Machtans, C. S., C. H. R. Wedeles, and E. M. Bayne. 2013. A first estimate for Canada of the number of birds killed by colliding with building windows. *Avian Conservation and Ecology* 8(2):6. <http://dx.doi.org/10.5751/ACE-00568-080206>
- Morrison, M. L., B. G. Marcot, and R. W. Mannan. 1998. *Wildlife-Habitat Relationships: Concepts and Applications*. 2nd edition. University of Wisconsin Press Madison, WI.
- Ocampo-Peñuela, N., R. S. Winton, C. J. Wu, E. Zambello, T. W. Wittig and N. L. Cagle . 2016. Patterns of bird-window collisions inform mitigation on a university campus. *PeerJ* 4:e1652;DOI10.7717/peerj.1652
- O’Connell, T. J. 2001. Avian window strike mortality at a suburban office park. *The Raven* 72:141-149.
- Orff, K., H. Brown, S. Caputo, E. J. McAdams, M. Fowle, G. Phillips, C. DeWitt, and Y. Gelb. 2007. Bird-safe buildings guidelines. New York City Audubon, New York.
- Overing, R. 1938. High mortality at the Washington Monument. *The Auk* 55:679.
- Parkins, K. L., S. B. Elbin, and E. Barnes. 2015. Light, glass, and bird–building collisions in an urban park. *Northeastern Naturalist* 22:84-94.
- Porter, A., and A. Huang. 2015. Bird collisions with glass: UBC pilot project to assess bird collision rates in Western North America. UBC Social Ecological Economic Development Studies (SEEDS) Student Report. Report to Environment Canada, UBC SEEDS and UBC BRITE.
- Rebolo-Ifrán, N., A. di Virgilio, and S. A. Lambertucci. 2019. Drivers of bird-window collisions in southern South America: a two-scale assessment applying citizen science. *Scientific Reports* 9:18148 | <https://doi.org/10.1038/s41598-019-54351-3>
- Riding, C. S., T. J. O’Connell, and S. R. Loss. 2020. Building façade-level correlates of bird–window collisions in a small urban area. *The Condor: Ornithological Applications* 122:1–14.

- Rincon. 2020. Biological Resources Assessment for 247 and 295 Commercial Street, Sunnyvale, California 94085. Prepared for Doa Development LLC, San Jose, California.
- Rosenberg, K. V., A. M. Dokter, P. J. Blancher, J. R. Sauer, A. C. Smith, P. A. Smith, J. C. Stanton, A. Panjabi, L. Helft, M. Parr, and P. P. Marra. 2019. Decline of the North American avifauna. *Science* 10.1126/science.aaw1313 (2019).
- Rössler, M., E. Nemeth, and A. Bruckner. 2015. Glass pane markings to prevent bird-window collisions: less can be more. *Biologia* 70: 535–541. DOI: 10.1515/biolog-2015-0057
- Sabo, A. M., N. D. G. Hagemeyer, A. S. Lahey, and E. L. Walters. 2016. Local avian density influences risk of mortality from window strikes. *PeerJ* 4:e2170; DOI 10.7717/peerj.2170
- San Francisco Planning Department. 2011. Standards for bird-safe buildings. San Francisco Planning Department, City and County of San Francisco, California.
- Schneider, R. M., C. M. Barton, K. W. Zirkle, C. F. Greene, and K. B. Newman. 2018. Year-round monitoring reveals prevalence of fatal bird-window collisions at the Virginia Tech Corporate Research Center. *PeerJ* 6:e4562 <https://doi.org/10.7717/peerj.4562>
- Sheppard, C., and G. Phillips. 2015. Bird-friendly building design, 2nd Ed., American Bird Conservancy, The Plains, Virginia.
- Shuford, W. D., and T. Gardali, [eds.]. 2008. California bird species of special concern: a ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. *Studies of Western Birds* 1. Western Field Ornithologists, Camarillo, California.
- Smallwood, K.S. 2002. Habitat models based on numerical comparisons. Pages 83-95 in *Predicting species occurrences: Issues of scale and accuracy*, J. M. Scott, P. J. Heglund, M. Morrison, M. Raphael, J. Haufler, and B. Wall, editors. Island Press, Covello, California.
- Smallwood, K. S. 2017. Monitoring birds. M. Perrow, Ed., *Wildlife and Wind Farms - Conflicts and Solutions*, Volume 2. Pelagic Publishing, Exeter, United Kingdom. www.bit.ly/2v3cR9Q
- Smallwood, K. S., L. Neher, and D. A. Bell. 2017. Siting to Minimize Raptor Collisions: an example from the Repowering Altamont Pass Wind Resource Area. M. Perrow, Ed., *Wildlife and Wind Farms - Conflicts and Solutions*, Volume 2. Pelagic Publishing, Exeter, United Kingdom. www.bit.ly/2v3cR9Q

- Smallwood, K. S. 2020. Comparison of bird and bat fatality rates among utility-scale solar projects in California. Report to undisclosed client.
- Somerlot, K. E. 2003. Survey of songbird mortality due to window collisions on the Murray State University campus. *Journal of Service Learning in Conservation Biology* 1:1–19.
- TMCapital. 2019. 2019 Building products report: enduring growth beyond short-term challenges. https://www.tmcapital.com/wp-content/uploads/2019/08/BuildingProd_AnnualReport_2019-08-14.pdf
- Winton, R. S., N. Ocampo-Peñuela, and N. Cagle. 2018. Geo-referencing bird-window collisions for targeted mitigation. *PeerJ* 6:e4215; DOI 10.7717/peerj.4215
- Zink, R. M., and J. Eckles. 2010. Twin cities bird-building collisions: a status update on “Project Birdsafe.” *The Loon* 82:34-37.

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Curriculum Vitae

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Born May 3, 1963 in
Sacramento, California.
Married, father of two.

Ecologist

Expertise

- Finding solutions to controversial problems related to wildlife interactions with human industry, infrastructure, and activities;
- Wildlife monitoring and field study using GPS, thermal imaging, behavior surveys;
- Using systems analysis and experimental design principles to identify meaningful ecological patterns that inform management decisions.

Education

Ph.D. Ecology, University of California, Davis. September 1990.
M.S. Ecology, University of California, Davis. June 1987.
B.S. Anthropology, University of California, Davis. June 1985.
Corcoran High School, Corcoran, California. June 1981.

Experience

- 477 professional publications, including:
 - 81 peer reviewed publications
 - 24 in non-reviewed proceedings
- 370 reports, declarations, posters and book reviews
- 8 in mass media outlets
- 87 public presentations of research results at meetings
- Reviewed many professional papers and reports
- Testified in 4 court cases.

Editing for scientific journals: Guest Editor, *Wildlife Society Bulletin*, 2012-2013, of invited papers representing international views on the impacts of wind energy on wildlife and how to mitigate the impacts. Associate Editor, *Journal of Wildlife Management*, March 2004 to 30 June 2007. Editorial Board Member, *Environmental Management*, 10/1999 to 8/2004. Associate Editor, *Biological Conservation*, 9/1994 to 9/1995.

Member, Alameda County Scientific Review Committee (SRC), August 2006 to April 2011. The

five-member committee investigated causes of bird and bat collisions in the Altamont Pass Wind Resource Area, and recommended mitigation and monitoring measures. The SRC reviewed the science underlying the Alameda County Avian Protection Program, and advised the County on how to reduce wildlife fatalities.

Consulting Ecologist, 2004-2007, California Energy Commission (CEC). Provided consulting services as needed to the CEC on renewable energy impacts, monitoring and research, and produced several reports. Also collaborated with Lawrence-Livermore National Lab on research to understand and reduce wind turbine impacts on wildlife.

Consulting Ecologist, 1999-2013, U.S. Navy. Performed endangered species surveys, hazardous waste site monitoring, and habitat restoration for the endangered San Joaquin kangaroo rat, California tiger salamander, California red-legged frog, California clapper rail, western burrowing owl, salt marsh harvest mouse, and other species at Naval Air Station Lemoore; Naval Weapons Station, Seal Beach, Detachment Concord; Naval Security Group Activity, Skaggs Island; National Radio Transmitter Facility, Dixon; and, Naval Outlying Landing Field Imperial Beach.

Fulbright Research Fellow, Indonesia, 1988. Tested use of new sampling methods for numerical monitoring of Sumatran tiger and six other species of endemic felids, and evaluated methods used by other researchers.

Peer Reviewed Publications

Smallwood, K. S. 2017. Long search intervals under-estimate bird and bat fatalities caused by wind turbines. *Wildlife Society Bulletin* 41:224-230.

Smallwood, K. S. 2017. The challenges of addressing wildlife impacts when repowering wind energy projects. Pages 175-187 in Köppel, J., Editor, *Wind Energy and Wildlife Impacts: Proceedings from the CWW2015 Conference*. Springer. Cham, Switzerland.

May, R., Gill, A. B., Köppel, J. Langston, R. H.W., Reichenbach, M., Scheidat, M., Smallwood, S., Voigt, C. C., Hüppop, O., and Portman, M. 2017. Future research directions to reconcile wind turbine–wildlife interactions. Pages 255-276 in Köppel, J., Editor, *Wind Energy and Wildlife Impacts: Proceedings from the CWW2015 Conference*. Springer. Cham, Switzerland.

Smallwood, K. S. 2017. Monitoring birds. M. Perrow, Ed., *Wildlife and Wind Farms - Conflicts and Solutions*, Volume 2. Pelagic Publishing, Exeter, United Kingdom. www.bit.ly/2v3cR9Q

Smallwood, K. S., L. Neher, and D. A. Bell. 2017. Siting to Minimize Raptor Collisions: an example from the Repowering Altamont Pass Wind Resource Area. M. Perrow, Ed., *Wildlife and Wind Farms - Conflicts and Solutions*, Volume 2. Pelagic Publishing, Exeter, United Kingdom. www.bit.ly/2v3cR9Q

Johnson, D. H., S. R. Loss, K. S. Smallwood, W. P. Erickson. 2016. Avian fatalities at wind energy facilities in North America: A comparison of recent approaches. *Human–Wildlife Interactions* 10(1):7-18.

- Sadar, M. J., D. S.-M. Guzman, A. Mete, J. Foley, N. Stephenson, K. H. Rogers, C. Grosset, K. S. Smallwood, J. Shipman, A. Wells, S. D. White, D. A. Bell, and M. G. Hawkins. 2015. Mange Caused by a novel *Micnemidocoptes* mite in a Golden Eagle (*Aquila chrysaetos*). *Journal of Avian Medicine and Surgery* 29(3):231-237.
- Smallwood, K. S. 2015. Habitat fragmentation and corridors. Pages 84-101 in M. L. Morrison and H. A. Mathewson, Eds., *Wildlife habitat conservation: concepts, challenges, and solutions*. John Hopkins University Press, Baltimore, Maryland, USA.
- Mete, A., N. Stephenson, K. Rogers, M. G. Hawkins, M. Sadar, D. Guzman, D. A. Bell, J. Shipman, A. Wells, K. S. Smallwood, and J. Foley. 2014. Emergence of *Knemidocoptic* mange in wild Golden Eagles (*Aquila chrysaetos*) in California. *Emerging Infectious Diseases* 20(10):1716-1718.
- Smallwood, K. S. 2013. Introduction: Wind-energy development and wildlife conservation. *Wildlife Society Bulletin* 37: 3-4.
- Smallwood, K. S. 2013. Comparing bird and bat fatality-rate estimates among North American wind-energy projects. *Wildlife Society Bulletin* 37:19-33. + Online Supplemental Material.
- Smallwood, K. S., L. Neher, J. Mount, and R. C. E. Culver. 2013. Nesting Burrowing Owl Abundance in the Altamont Pass Wind Resource Area, California. *Wildlife Society Bulletin*: 37:787-795.
- Smallwood, K. S., D. A. Bell, B. Karas, and S. A. Snyder. 2013. Response to Huso and Erickson Comments on Novel Scavenger Removal Trials. *Journal of Wildlife Management* 77: 216-225.
- Bell, D. A., and K. S. Smallwood. 2010. Birds of prey remain at risk. *Science* 330:913.
- Smallwood, K. S., D. A. Bell, S. A. Snyder, and J. E. DiDonato. 2010. Novel scavenger removal trials increase estimates of wind turbine-caused avian fatality rates. *Journal of Wildlife Management* 74: 1089-1097 + Online Supplemental Material.
- Smallwood, K. S., L. Neher, and D. A. Bell. 2009. Map-based repowering and reorganization of a wind resource area to minimize burrowing owl and other bird fatalities. *Energies* 2009(2):915-943. <http://www.mdpi.com/1996-1073/2/4/915>
- Smallwood, K. S. and B. Nakamoto. 2009. Impacts of West Nile Virus Epizootic on Yellow-Billed Magpie, American Crow, and other Birds in the Sacramento Valley, California. *The Condor* 111:247-254.
- Smallwood, K. S., L. Rugge, and M. L. Morrison. 2009. Influence of Behavior on Bird Mortality in Wind Energy Developments: The Altamont Pass Wind Resource Area, California. *Journal of Wildlife Management* 73:1082-1098.
- Smallwood, K. S. and B. Karas. 2009. Avian and Bat Fatality Rates at Old-Generation and

- Repowered Wind Turbines in California. *Journal of Wildlife Management* 73:1062-1071.
- Smallwood, K. S. 2008. Wind power company compliance with mitigation plans in the Altamont Pass Wind Resource Area. *Environmental & Energy Law Policy Journal* 2(2):229-285.
- Smallwood, K. S., C. G. Thelander. 2008. Bird Mortality in the Altamont Pass Wind Resource Area, California. *Journal of Wildlife Management* 72:215-223.
- Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. *Journal of Wildlife Management* 71:2781-2791.
- Smallwood, K. S., C. G. Thelander, M. L. Morrison, and L. M. Rugge. 2007. Burrowing owl mortality in the Altamont Pass Wind Resource Area. *Journal of Wildlife Management* 71:1513-1524.
- Cain, J. W. III, K. S. Smallwood, M. L. Morrison, and H. L. Loffland. 2005. Influence of mammal activity on nesting success of Passerines. *J. Wildlife Management* 70:522-531.
- Smallwood, K.S. 2002. Habitat models based on numerical comparisons. Pages 83-95 in *Predicting species occurrences: Issues of scale and accuracy*, J. M. Scott, P. J. Heglund, M. Morrison, M. Raphael, J. Haufler, and B. Wall, editors. Island Press, Covello, California.
- Morrison, M. L., K. S. Smallwood, and L. S. Hall. 2002. Creating habitat through plant relocation: Lessons from Valley elderberry longhorn beetle mitigation. *Ecological Restoration* 21: 95-100.
- Zhang, M., K. S. Smallwood, and E. Anderson. 2002. Relating indicators of ecological health and integrity to assess risks to sustainable agriculture and native biota. Pages 757-768 in D.J. Rapport, W.L. Lasley, D.E. Rolston, N.O. Nielsen, C.O. Qualset, and A.B. Damania (eds.), *Managing for Healthy Ecosystems*, Lewis Publishers, Boca Raton, Florida USA.
- Wilcox, B. A., K. S. Smallwood, and J. A. Kahn. 2002. Toward a forest Capital Index. Pages 285-298 in D.J. Rapport, W.L. Lasley, D.E. Rolston, N.O. Nielsen, C.O. Qualset, and A.B. Damania (eds.), *Managing for Healthy Ecosystems*, Lewis Publishers, Boca Raton, Florida USA.
- Smallwood, K.S. 2001. The allometry of density within the space used by populations of Mammalian Carnivores. *Canadian Journal of Zoology* 79:1634-1640.
- Smallwood, K.S., and T.R. Smith. 2001. Study design and interpretation of Sorex density estimates. *Annales Zoologici Fennici* 38:141-161.
- Smallwood, K.S., A. Gonzales, T. Smith, E. West, C. Hawkins, E. Stitt, C. Keckler, C. Bailey, and K. Brown. 2001. Suggested standards for science applied to conservation issues. *Transactions of the Western Section of the Wildlife Society* 36:40-49.
- Geng, S., Yixing Zhou, Minghua Zhang, and K. Shawn Smallwood. 2001. A Sustainable Agro-ecological Solution to Water Shortage in North China Plain (Huabei Plain). *Environmental Planning and Management* 44:345-355.

- Smallwood, K. Shawn, Lourdes Rugge, Stacia Hoover, Michael L. Morrison, Carl Thelander. 2001. Intra- and inter-turbine string comparison of fatalities to animal burrow densities at Altamont Pass. Pages 23-37 in S. S. Schwartz, ed., Proceedings of the National Avian-Wind Power Planning Meeting IV. RESOLVE, Inc., Washington, D.C.
- Smallwood, K.S., S. Geng, and M. Zhang. 2001. Comparing pocket gopher (*Thomomys bottae*) density in alfalfa stands to assess management and conservation goals in northern California. *Agriculture, Ecosystems & Environment* 87: 93-109.
- Smallwood, K. S. 2001. Linking habitat restoration to meaningful units of animal demography. *Restoration Ecology* 9:253-261.
- Smallwood, K. S. 2000. A crosswalk from the Endangered Species Act to the HCP Handbook and real HCPs. *Environmental Management* 26, Supplement 1:23-35.
- Smallwood, K. S., J. Beyea and M. Morrison. 1999. Using the best scientific data for endangered species conservation. *Environmental Management* 24:421-435.
- Smallwood, K. S. 1999. Scale domains of abundance among species of Mammalian Carnivora. *Environmental Conservation* 26:102-111.
- Smallwood, K.S. 1999. Suggested study attributes for making useful population density estimates. *Transactions of the Western Section of the Wildlife Society* 35: 76-82.
- Smallwood, K. S. and M. L. Morrison. 1999. Estimating burrow volume and excavation rate of pocket gophers (*Geomyidae*). *Southwestern Naturalist* 44:173-183.
- Smallwood, K. S. and M. L. Morrison. 1999. Spatial scaling of pocket gopher (*Geomyidae*) density. *Southwestern Naturalist* 44:73-82.
- Smallwood, K. S. 1999. Abating pocket gophers (*Thomomys* spp.) to regenerate forests in clearcuts. *Environmental Conservation* 26:59-65.
- Smallwood, K. S. 1998. Patterns of black bear abundance. *Transactions of the Western Section of the Wildlife Society* 34:32-38.
- Smallwood, K. S. 1998. On the evidence needed for listing northern goshawks (*Accipiter gentilis*) under the Endangered Species Act: a reply to Kennedy. *J. Raptor Research* 32:323-329.
- Smallwood, K. S., B. Wilcox, R. Leidy, and K. Yarris. 1998. Indicators assessment for Habitat Conservation Plan of Yolo County, California, USA. *Environmental Management* 22: 947-958.
- Smallwood, K. S., M. L. Morrison, and J. Beyea. 1998. Animal burrowing attributes affecting hazardous waste management. *Environmental Management* 22: 831-847.
- Smallwood, K. S. and C. M. Schonewald. 1998. Study design and interpretation for mammalian

- carnivore density estimates. *Oecologia* 113:474-491.
- Zhang, M., S. Geng, and K. S. Smallwood. 1998. Nitrate contamination in groundwater of Tulare County, California. *Ambio* 27(3):170-174.
- Smallwood, K. S. and M. L. Morrison. 1997. Animal burrowing in the waste management zone of Hanford Nuclear Reservation. *Proceedings of the Western Section of the Wildlife Society Meeting* 33:88-97.
- Morrison, M. L., K. S. Smallwood, and J. Beyea. 1997. Monitoring the dispersal of contaminants by wildlife at nuclear weapons production and waste storage facilities. *The Environmentalist* 17:289-295.
- Smallwood, K. S. 1997. Interpreting puma (*Puma concolor*) density estimates for theory and management. *Environmental Conservation* 24(3):283-289.
- Smallwood, K. S. 1997. Managing vertebrates in cover crops: a first study. *American Journal of Alternative Agriculture* 11:155-160.
- Smallwood, K. S. and S. Geng. 1997. Multi-scale influences of gophers on alfalfa yield and quality. *Field Crops Research* 49:159-168.
- Smallwood, K. S. and C. Schonewald. 1996. Scaling population density and spatial pattern for terrestrial, mammalian carnivores. *Oecologia* 105:329-335.
- Smallwood, K. S., G. Jones, and C. Schonewald. 1996. Spatial scaling of allometry for terrestrial, mammalian carnivores. *Oecologia* 107:588-594.
- Van Vuren, D. and K. S. Smallwood. 1996. Ecological management of vertebrate pests in agricultural systems. *Biological Agriculture and Horticulture* 13:41-64.
- Smallwood, K. S., B. J. Nakamoto, and S. Geng. 1996. Association analysis of raptors on an agricultural landscape. Pages 177-190 in D.M. Bird, D.E. Varland, and J.J. Negro, eds., *Raptors in human landscapes*. Academic Press, London.
- Erichsen, A. L., K. S. Smallwood, A. M. Commandatore, D. M. Fry, and B. Wilson. 1996. White-tailed Kite movement and nesting patterns in an agricultural landscape. Pages 166-176 in D. M. Bird, D. E. Varland, and J. J. Negro, eds., *Raptors in human landscapes*. Academic Press, London.
- Smallwood, K. S. 1995. Scaling Swainson's hawk population density for assessing habitat-use across an agricultural landscape. *J. Raptor Research* 29:172-178.
- Smallwood, K. S. and W. A. Erickson. 1995. Estimating gopher populations and their abatement in forest plantations. *Forest Science* 41:284-296.
- Smallwood, K. S. and E. L. Fitzhugh. 1995. A track count for estimating mountain lion *Felis*

concolor californica population trend. Biological Conservation 71:251-259

Smallwood, K. S. 1994. Site invasibility by exotic birds and mammals. Biological Conservation 69:251-259.

Smallwood, K. S. 1994. Trends in California mountain lion populations. Southwestern Naturalist 39:67-72.

Smallwood, K. S. 1993. Understanding ecological pattern and process by association and order. Acta Oecologica 14(3):443-462.

Smallwood, K. S. and E. L. Fitzhugh. 1993. A rigorous technique for identifying individual mountain lions *Felis concolor* by their tracks. Biological Conservation 65:51-59.

Smallwood, K. S. 1993. Mountain lion vocalizations and hunting behavior. The Southwestern Naturalist 38:65-67.

Smallwood, K. S. and T. P. Salmon. 1992. A rating system for potential exotic vertebrate pests. Biological Conservation 62:149-159.

Smallwood, K. S. 1990. Turbulence and the ecology of invading species. Ph.D. Thesis, University of California, Davis.