Appendix F

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November 30, 2017

Via Email

Carmen Borg
Shute, Mihaly & Weinberger
396 Hayes Street
San Francisco, CA 94102
borg@smwlaw.com

Re: Review Draft Environmental Impact Report for Safari Highlands Ranch and Citywide SOI Update, SCH No. 2015091039

Dear Ms. Borg,

Per your request, I reviewed the Draft Environmental Impact Report ("Draft EIR") prepared by the City of Escondido ("City") for the Safari Highlands Ranch project and the citywide Sphere of Influence update (collectively referred to as "Project") for review under the California Environmental Quality Act ("CEQA").[1]

As discussed in the following, the Draft EIR is substantially flawed because it underestimates criteria air pollutant and greenhouse gas emissions during both construction and operation of the Project, fails to identify significant impacts, and fails to require adequate mitigation.

[1] City of Escondido, Safari Highlands Ranch and Citywide SOI Update, SCH No. 2015091039, October 2017; available at: https://www.escondido.org/environmental-impact-report.aspx, accessed November 3, 2017.

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These mitigation measures are equally feasible for the SHR project and should be required to reduce emissions associated with architectural coatings.

3. Mitigation Fees

Another approach to addressing significant emissions of air pollutants is to require a mitigation fee for emissions in excess of significance thresholds. These fees can then be used to reduce emissions off-site, *e.g.*, by retrofitting the City's municipal fleet to reduce emissions. The Sacramento Metropolitan Air Quality Management District ("SMAQMD"), for example, requires the following for construction emissions that remain significant after implementation of all feasible measures:

> When a project cannot fully mitigate construction emissions by implementing off-road and on-road measures, a fee may be assessed to achieve the remaining mitigation. Fees are adopted by the lead agency.
>
> Currently the mitigation fee rate is $30,000 per ton of emissions (July 2017). Each July the rate is adjusted. A 5% administrative fee is assessed in addition to the mitigation fee.[58]

Such a measure could be administered by the City or the SDAPCD.

III. The Draft EIR Fails to Analyze Potentially Significant Health Impacts Due to Valley Fever

Valley Fever, or coccidioidomycosis (abbreviated as cocci, also known as desert rheumatism), is an infectious disease caused by inhaling the spores of *Coccidioides ssp.*,[59] a soil-dwelling fungus. The fungus lives in the top two to 12 inches of soil. When soil containing this fungus is disturbed by activities such as digging, vehicles, construction activities, dust storms, or during earthquakes, the fungal spores become airborne.[60] The Valley Fever fungal spores are too small to be seen by the naked eye, and there is no

[58] SMAQMD, Construction Emissions Mitigation; available at: http://www.airquality.org/businesses/ceqa-land-use-planning/mitigation, accessed November 20, 2017.

[59] Two species of *Coccidioides* are known to cause Valley Fever: *C. immitis*, which is typically found in California, and *C. posadasii*, which is typically found outside California. *See* Centers for Disease Control, Coccidioidomycosis (Valley Fever), Information for Health Professionals; available at: https://www.cdc.gov/fungal/diseases/coccidioidomycosis/health-professionals.html, accessed November 15, 2017.

[60] California Department of Public Health, Valley Fever Fact Sheet, January 2016; available at: https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/ValleyFeverFactSheet.pdf, accessed November 15, 2017.

reliable way to test the soil for spores before working in a particular area.[61] The California Department of Public Health has concluded:[62]

> **Valley Fever is an illness that usually affects the lungs. It is caused by the fungus *Coccidioides immitis* that lives in soil in many parts of California.** When soil containing the fungus is disturbed by digging, vehicles, or by the wind, the fungal spores get into the air. When people breathe the spores into their lungs, they may get Valley Fever.
>
> **Is Valley Fever a serious concern in California? YES!**
>
> Often people can be infected and not have any symptoms. In some cases, however, a serious illness can develop which can cause a previously healthy individual to miss work, have long-lasting and disabling health problems, or even result in death.

A. San Diego County Is Endemic for Valley Fever

The disease is endemic (native and common) in the semiarid regions of the southwestern United States.[63] Most of San Diego County, including the Project site, is located within the established endemic range of Valley Fever,[64] as shown in Figure 2. The site itself contains conditions that are known to support Valley Fever,[65] including:

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[61] California Department of Public Health, Preventing Work-Related Coccidioidomycosis (Valley Fever), June 2013; available at: https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/HESIS/CDPH%20Document%20Library/CocciFact.pdf, accessed November 15, 2017.

[62] *Ibid.*

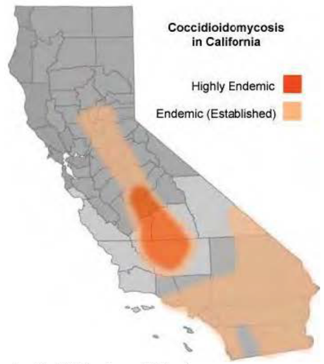
[63] Wikipedia, Coccidioidomycosis; available at: https://en.wikipedia.org/wiki/Coccidioidomycosis, accessed November 15, 2017.

[64] *See*, for example, Kellie Schmitt, Rebecca Plevin, and Tracy Wood, Just One Breath: Valley Fever Cases Reach Epidemic Levels, But Harm Remains Hidden, September 8, 2012 ("The cocci fungus is common in much of the southwest and in northwestern Mexico, especially in the dry earth of California's Central Valley and in the areas around Phoenix and Tucson in Arizona. It can be found, however, in soils of the beach haven of San Diego, the wine country of Sonoma County and inland in the Sierra foothills."); available at: https://www.centerforhealthjournalism.org/content/just-one-breath-valley-fever-cases-reach-epidemic-levels-harm-remains-hidden, accessed November 15, 2017.

[65] Kern County Public Health Services Department, Valley Fever Website, Prevention, Clues that Valley Fever May be in the Soil; available at: http://kerncountyvalleyfever.com/what-is-valley-fever/prevention/, accessed November 15, 2017.

animal burrows, old (prehistoric) Indian campsites,[66] areas with sparse vegetation,[67] areas adjacent to arroyos,[68] and areas of upper 12 inches of undisturbed soil.[69]

Figure 2: Endemic Areas for Valley Fever in California



From: Breathe California; available at: http://www.breathecalifornia.org/images/health-img/Cocci.jpg, accessed November 13, 2017

The number of Valley Fever cases in San Diego County has been rising since 1990.[70] San Diego County had the sixth highest number of reported cases statewide over the 2007–2011 period: 649 cases.[71] The number of reported cases in San Diego County

[66] Draft EIR, p. 2.4-2.

[67] Draft EIR, p. 2.1-19, Figure 2.1-4A, and Figure 2.1-5A.

[68] Draft EIR, p. 2.0-8.

[69] Draft EIR, p. 2.1-11.

[70] Janice Arenofsky, San Diego Has Sixth Highest Rate of Valley Fever in California; Concerns Voiced that Imperial County Cases May be Under-reported, July 2014, East County Magazine; available at: https://www.eastcountymagazine.org/cost-valley-fever-human-and-economic, accessed November 15, 2017.

[71] Michael L. MacLean, The Epidemiology of Coccidioidomycosis—15 California Counties, 2007–2011, January 22, 2014, Table 5; available at: http://vfce.arizona.edu/sites/vfce/files/the_epidemiology_of_coccidioidomycosis_collaborative_county_report.pdf, accessed November 15, 2017.

has continued to rise, reaching 728 over the next five-year period, as summarized in Table 6.[72]

Table 6: Reported Cases of Valley Fever in San Diego County

Year	No. of Cases
2012	159
2013	126
2014	117
2015	168
2016	158

The year 2017 is shaping up to be the worst on record in California for people infected with Valley Fever.[73] According to recent provisional data provided by the California Department of Public Health (CDPH), there has been a 34 percent increase in the number of valley fever - also known as coccidiomycosis - a fungal infection caused by fungus Coccidioides. From January 1 through October 31, 2017, 5,121 provisional cases of Valley Fever were reported in California. This is an increase of 1,294 provisional cases from the provisional 3,827 cases reported during that same time period in 2016. These cases represent presumed and confirmed cases of infection.[74]

B. Construction Workers Are an At-Risk Population

The California Department of Public Health ("CDPH") specifically notes that construction workers in endemic areas for *cocci*, such as those that would build the Project, are at risk of contracting Valley Fever:[75]

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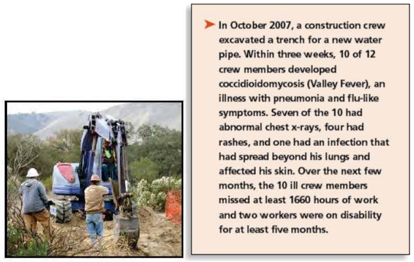
[72] County of San Diego, Reportable Diseases and Conditions by Year, 2012–2016, July 3, 2017; available at: http://www.sandiegocounty.gov/content/dam/sdc/hhsa/programs/phs/documents/Reportable_Diseases_and_Conditions_SDC_2012-2016.pdf, accessed November 15, 2017.

[73] Soumya Karlamangla, Los Angeles Times, In California, an Unexplained Increase in Valley Fever this Year, November 14, 2017; available at: http://www.latimes.com/health/la-me-ln-valley-fever-20171114-story.html, accessed November 15, 2017.

[74] Lila Abassi, American Council on Science and Health, Inexplicable Spike in Valley Fever in California, November 16, 2017; available at: https://www.acsh.org/news/2017/11/16/inexplicable-spike-valley-fever-california-12156, accessed November 17, 2017.

[75] California Department of Public Health, Preventing Work-Related Coccidioidomycosis (Valley Fever), *op. cit.*

Figure 3: Valley Fever Risk to Construction Workers



The Project involves a significant amount of grading (339 acres), requiring about 4.6 million cubic yards of cut and fill. Phase 1 would require 1,965,840 cubic yards of raw cut; Phases 2, 3, and 4 would require an estimated 840,880 cubic yards, 722,620 cubic yards, and, 1,096,590 cubic yards of raw cut, respectively. Grading would take approximately 18 months if the proposed development phases are graded concurrently. The time required to complete the grading operations for Phase 1 is estimated to be approximately five to six months. If grading is phased due to market conditions, grading for each phase may take up to six months.[76] Thus, significant opportunity exists to expose both on-site construction workers and on- and off-site sensitive receptors to Valley Fever spores.

Dust exposure is one of the primary risk factors for contracting Valley Fever.[77] Specific occupations and outdoor activities associated with dust generation such as construction, farming, road work, military training, gardening, hiking, camping, bicycling, or fossil collecting increase the risk of exposure and infection. The risk appears to be more specifically associated with the amount of time spent outdoors than

[76] Draft EIR, p. 1.0-11.

[77] Rafael Laniado-Laborin, Expanding Understanding of Epidemiology of Coccidioidomycosis in the Western Hemisphere, Annals of the New York Academy of Sciences, v. 111, 2007, pp. 20-22; available at: https://www.ncbi.nlm.nih.gov/pubmed/17395731, accessed November 15, 2017, and Frederick S. Fisher, Mark W. Bultman, Suzanne M. Johnson, Demosthenes Pappagianis, and Erik Zaborsky, Coccidioides Niches and Habitat Parameters in the Southwestern United States, a Matter of Scale, Annals of the New York Academy of Sciences, v. 111, 2007, pp. 47-72 ("All of the examined soil locations are noteworthy as generally 50% of the individuals who were exposed to the dust or were excavating dirt at the sites were infected."); available at: https://ucdavis.pure.elsevier.com/en/publications/coccidioides-niches-and-habitat-parameters-in-the-southwestern-un, accessed November 15, 2017.

with doing specific activities.[78] As the area surrounding the Project site is rural, locals and visitors who participate in outdoor activities could be exposed during construction.

The most at-risk populations are construction and agricultural workers,[79] the former the very population that would be most directly exposed by the Project. A refereed journal article on occupational exposures notes that "[l]abor groups where occupation involves close contact with the soil are at greater risk, especially if the work involves dusty digging operations."[80] One study reported that at study sites, "generally 50% of the individuals who were exposed to the dust or were excavating dirt at the sites were infected."[81]

The disease debilitates the population and thus prevents them from working.[82] The longest period of disability in California from occupational exposure is to construction workers, with 62% of the reported cases resulting in over 60 days of lost work.[83] Another study estimated the average hospital stay for each (non-construction work) case of coccidioidomycosis at 35 days.[84]

C. Sensitive Receptors Near the Project Site Are an At-Risk Population

The California Department of Public Health and the State Health Officer have warned that "[p]eople who live, work or travel in Valley Fever areas are also at a higher risk of getting infected, especially if they work or participate in activities where soil is

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78 Kern County Public Health Services Department, Prevention ("The risk appears to be more specifically associated with the amount of time spent outdoors than with doing specific activities"); available at: http://kerncountyvalleyfever.com/what-is-valley-fever/prevention/, accessed November 15, 2017.

79 Lawrence L. Schmelzer and R. Tabershaw, Exposure Factors in Occupational Coccidioidomycosis, American Journal of Public Health and the Nation's Health, v. 58, no. 1, 1968, pp. 107-113, Table 3; available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1228046/?page=1, accessed November 15, 2017.

80 *Ibid*, p. 110.

81 Fisher *et al.*, 2007, *op. cit.*

82 Frank E. Swatek, Ecology of Coccidioides immitis, Mycopathologia et Mycologia Applicata, v. 40, Nos. 1-2, pp. 3-12, 1970; available at: https://link.springer.com/article/10.1007/BF02051479#citeas, accessed November 15, 2017.

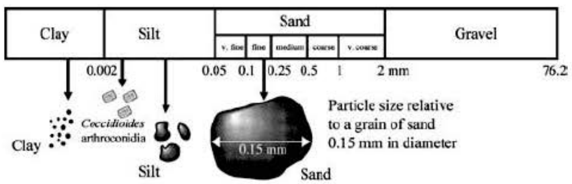
83 Schmelzer and Tabershaw, 1968, *op. cit.*, Table 4.

84 Demosthenes Pappagianis and Hans Einstein, Tempest from Tehachapi Takes Toll or Coccidioides Conveyed Aloft and Afar, Western Journal of Medicine, v. 129, Dec. 1978, pp. 527-530; available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1238466/pdf/westjmed00256-0079.pdf, accessed November 15, 2017.

disturbed."[85] Thus, those living, working, or recreating in the vicinity of the Project site during construction are also at risk of being affected from windblown dust, both during construction and after soils have been disturbed but lie fallow until mitigation has been implemented and/or the Project is built out.

The potentially exposed population in surrounding areas is much larger than construction workers because the non-selective raising of dust during Project construction will carry the very small spores, 0.002-0.005 millimeters ("mm") (*see* Figure 4)[86] off site, potentially exposing large, non-Project-related populations.[87,88] These very small particles are not controlled by conventional construction dust control mitigation measures.

Figure 4: Size of Cocci Spores Compared to Soil Particles (in mm)



Valley Fever spores have been documented to travel as much as 500 miles,[89] and, thus, dust raised during construction could potentially expose a large number of people hundreds of miles away. Thus, this is a significant concern for this Project because there are sensitive receptors around the Project site, including the predominantly single-family residential neighborhoods located immediately west of the proposed project area

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[85] California Department of Public Health, State Health Officer Warns About Dangers of Valley Fever, Number 15-055, August 4, 2015; available at: https://www.cdph.ca.gov/Programs/OPA/Pages/NR15-055.aspx, accessed November 15, 2017.

[86] Fisher *et al.*, 2007, *op. cit.*, Fig. 3.

[87] Schmelzer and Tabershaw, 1968, *op. cit.*, p. 110; Pappagianis and Einstein, 1978, *op. cit.*

[88] Pappagianis and Einstein, 1978, *op. cit.*, p. 527 ("The northern areas were not directly affected by the ground level windstorm that had struck Kern County but the dust was lifted to several thousand feet elevation and, borne on high currents, the soil and arthrospores along with some moisture were gently deposited on sidewalks and automobiles as "a mud storm" that vexed the residents of much of California." The storm originating in Kern County, for example, had major impacts in the San Francisco Bay Area and Sacramento.).

[89] David Filip and Sharon Filip, Valley Fever Epidemic, Golden Phoenix Books, 2008, p. 24.

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(there are schools, golf courses, churches, and agricultural operations in these neighborhoods located on Rockwood Road and Bear Valley Parkway). San Pasqual Union School is situated approximately 0.5 mile west of the project site on Rockwood Road. Additionally, the San Diego Zoo Safari Park is located just under a mile to the south of the project area.[90] Further, the SHR project includes residential development that would be constructed and occupied in phases; thus, occupants of the residences built in earlier phases would be potentially exposed to Valley Fever spores while construction on the later phases is ongoing.[91] An individual does not have to have direct soil contact to contract Valley Fever.[92]

D. Valley Fever Symptoms

Typical symptoms of Valley Fever include fatigue, fever, cough, headache, shortness of breath, rash, muscle aches, and joint pain. Symptoms of advanced Valley Fever include chronic pneumonia, meningitis, skin lesions, and bone or joint infections. The most common clinical presentation of Valley Fever is a self-limited acute or subacute community-acquired pneumonia that becomes evident 13 weeks after infection.[93] No vaccine or known cure currently exists for the disease. However, the U.S. Food and Drug Administration ("FDA") recently granted Fast Track designation for a proposed treatment.[94] Between 1990 and 2008, more than 3,000 people have died in the United States from Valley Fever, with about half of the deaths occurring in California.[95] Between 2000 and 2013 in California, 1,098 deaths were attributed to

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[90] Draft EIR, pp. 1.0-7, 2.2-20, and 2.10-17.

[91] Draft EIR, p. 1.0-10.

[92] Jason A. Wilken, Patricia Marquez, Dawn Terashita, Jennifer McNary, Gayle Windham, Barbara Materna, Centers for Disease Control and Prevention, Coccidioidomycosis Among Cast and Crew Members at an Outdoor Television Filming Event—California, 2012, Morbidity and Mortality Weekly Report, April 1, 2014; available at: http://europepmc.org/abstract/med/24739339, accessed November 15, 2017.

[93] *See, e.g.*, Lisa Valdivia, David Nix, Mark Wright, Elizabeth Lindberg, Timothy Fagan, Donald Lieberman, T'Prien Stoffer, Neil M. Ampel, and John N. Galgiani, Coccidioidomycosis as a Common Cause of Community-Acquired Pneumonia, Emerging Infectious Diseases, v. 12, no. 6, June 2006; available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3373055/, accessed November 15, 2017.

[94] Mathew Shanley, Valley Fever Treatment Granted FDA Fast Track Designation, July 14, 2017; available at: http://www.raredr.com/news/valley-fever-drug-fast-track-designation, accessed November 15, 2017.

[95] Jennifer Y. Huang, Benjamin Bristow, Shira Shafir, and Frank Sorvillo, Coccidioidomycosis-Associated Deaths, United States, 1990–2008, Emerging Infectious Diseases, v. 18, no. 11, November 2012; available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3559166/, accessed November 15, 2017.

Valley Fever.[96] In recent years, reported Valley Fever cases in the Southwest have increased dramatically.[97]

Infections by *Coccidioides ssp.* frequently have a seasonal pattern, with infection rates that generally spike in the first few weeks of hot dry weather that follow extended milder rainy periods. In California, infection rates are generally higher during the hot summer months especially if weather patterns bring the usual winter rains between November and April.[98] The majority of cases of Valley Fever accordingly occur during the months of June through December, which are typically periods of peak construction activity.

Typically, the risk of catching Valley Fever begins to increase in June and continues an upward trend until it peaks during the months of August, September, and October.[99] Drought periods can have an especially potent impact on Valley Fever if they follow periods of rain.[100] It is thought that during drought years the number of organisms competing with *Coccidioides ssp.* decreases and the fungus remains alive but dormant. When rain finally occurs, the spores, known as arthroconidia, germinate and multiply more than usual because of a decreased number of other competing organisms. When the soil dries out in the summer and fall, the spores can become airborne and potentially infectious.[101]

The recent drought conditions in southern California may well increase the occurrence of Valley Fever cases. Thus, major onsite and offsite soil-disturbing

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[96] Gail L. Sondermeyer, Lauren A. Lee, Debra Gilliss, and Duc J. Vugia, Coccidioidomycosis-Associated Deaths in California, 2000-2013, Public Health Reports, v. 131, no. 4, 2016; available at: http://journals.sagepub.com/doi/10.1177/0033354916662210, accessed November 15, 2017.

[97] *See* Centers for Disease Control; Fungal Pneumonia: A Silent Epidemic, Coccidioidomycosis (Valley Fever); available at: https://www.cdc.gov/fungal/pdf/cocci-fact-sheet-sw-us-508c.pdf, accessed November 15, 2017.

[98] *Ibid.*

[99] Kern County Public Health Services Department, What Is Valley Fever, Prevention, Valley Fever Risk Factors; available at: http://kerncountyvalleyfever.com/what-is-valley-fever/risk-factors/, accessed November 15, 2017.

[100] Gosia Wozniacka, Associated Press, Fever Hits Thousands in Parched West Farm Region, May 5, 2013, Updated April 29, 2016, citing Prof. John Galgiani, Director of the Valley Fever Center for Excellence at the University of Arizona; available at: http://www.denverpost.com/2013/05/05/valley-fever-hits-thousands-in-parched-west/, accessed November 15, 2017 .

[101] Theodore N. Kirkland and Joshua Fierer, Coccidioidomycosis: A Reemerging Infectious Disease, *Emerging Infectious Diseases*, v. 3, no. 2, July-September 1996; available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2626789/pdf/8903229.pdf, accessed November 15, 2017.

construction activities should be timed to occur outside of a prolonged dry period. After soil-disturbing activities conclude, all disturbed soils should be sufficiently stabilized to prevent airborne dispersal of cocci spores.

The Draft EIR makes no mention whatsoever of the potential existence of Valley Fever in the area or of the health risks posed by Valley Fever from construction and/or operation of the Project and does not require any mitigation to limit the public's or workers' potential exposure to cocci. As discussed below, conventional mitigation for construction impacts is not adequate to protect construction workers or offsite sensitive receptors from Valley Fever. Thus, the Draft EIR fails to inform the public of these potential significant consequences of Project construction. The County should amend and recirculate the Draft EIR to provide an adequate assessment of Valley Fever and propose adequate mitigation.

E. A Conventional Dust Control Plan Is Inadequate to Address Potential Health Risks Posed by Exposure to Valley Fever

The conventional dust control measures that are included in Mitigation Measure MM AIR-2[102] are not effective at controlling Valley Fever[103] as they largely focus on visible dust or larger dust particles—the PM10 fraction—not the very fine particles such as Valley Fever spores. While dust exposure is one of the primary risk factors for contracting Valley Fever and dust-control measures are an important defense against infection, it is important to note that PM10 and visible dust, the targets of conventional control mitigation, are only indicators that *Coccidioides ssp.* spores may be airborne in a given area. Freshly generated dust clouds usually contain a larger proportion of the more visible coarse particles, PM10 (</=0.01 mm), compared to cocci spores (0.002 mm). However, these larger particles settle more rapidly and the remaining fine respirable particles may be difficult to see and are not controlled by conventional dust control measures.

Spores of *Coccidioides ssp.* have slow settling rates in air due to their small size (0.002 mm) and low terminal velocity, and possibly also due to their buoyancy, barrel

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[102] Draft EIR, pp. ES-9, 2.2-17 and 2.2-18.

[103] *See, e.g.*, E. Schneider et al., A Coccidioidomycosis Outbreak Following the Northridge, Calif, Earthquake, Journal of the American Medical Association, March 19, 1997, v. 277, no. 1, p. 908 ("Primary prevention strategies (*e.g.*, dust-control measures) for coccidioidomycosis in endemic areas have limited effectiveness."); and Charles E. Smith and others, Effect of Season and Dust Control on Coccidioidomycosis, Journal of the American Medical Association, v. 132, no. 14, pp. 833-838, 1946 ("It was recognized that in highly endemic areas cocidioidomycosis is bound to occur even if local dust control is reasonably effective.").

shape, and commonly attached empty hyphae cell fragments.[104] Thus spores, whose size is well below the limits of human vision, may be present in air that appears relatively clear and dust free. Such ambient airborne spores with their low settling rates can remain aloft for long periods and be carried hundreds of miles from their point of origin. Thus, implementation of conventional dust control measures will not provide sufficient protection for both on-site workers and the general public, especially for occupants of the earlier constructed neighborhoods during construction of the later neighborhoods and other nearby off-site sensitive receptors.

Utilization of personal and employer-driven safety practices and increased coccidioidomycosis awareness among construction workers should be considered during the planning of any construction work in coccidioidomycosis-endemic regions to prevent occupational infections and outbreaks.[105] In response to an outbreak of Valley Fever in construction workers in 2007 at a construction site for a solar facility within San Luis Obispo County, its Public Health Department, in conjunction with the California Department of Public Health, developed recommendations to limit exposure to Valley Fever based on scientific information from the published literature.[106] The recommended measures go far beyond the conventional dust control measures recommended in the Draft EIR to control construction emissions, which primarily control PM10. They include the following measures that are not required in the Draft EIR to mitigate fugitive dust emissions from the Project:

1. Re-evaluate and update your Injury and Illness Prevention Program (as required by Title 8, Section 3203) and ensure safeguards to prevent Valley Fever are included.
2. Train all employees on the following issues:
   - The soils in San Diego County may contain cocci spores;
   - Inhaling cocci spores may cause Valley fever;

[104] Frederick S. Fisher, Mark W. Bultman, and Demosthenes Pappagianis, Operational Guidelines (version 1.0) for Geological Fieldwork in Areas Endemic for Coccidioidomycosis (Valley Fever), U.S. Geological Survey Open-File Report 00-348, 2000; available at https://pubs.usgs.gov/of/2000/0348/.

[105] Gail L. Sondermeyer Cooksey, Jason A. Wilken, Jennifer McNary, Debra Gilliss, Dennis Shusterman, Barbara L. Materna, and Duc J. Vugia, Dust Exposure and Coccidioidomycosis Prevention Among Solar Power Farm Construction Workers in California, accepted: March 27, 2017, published online: July 12, 2017; available at: http://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2017.303820?url_ver=Z39.88-2003&rfr_id=ori%3Arid%3Acrossref.org&rfr_dat=cr_pub%3Dpubmed&, accessed November 24, 2017.

[106] CDPH June 2013, *op. cit.,* pp. 4-6.

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- How to recognize symptoms of Valley Fever; these symptoms resemble common viral infections, and may include fatigue, cough, chest pain, fever, rash, headache, and body and joint ache);
- Work with a medical professional with expertise in cocci as you develop your training program and consult information on public health department websites;
- Workers must promptly report suspected symptoms of work-related Valley Fever to a supervisor;
- Workers are entitled to receive prompt medical care if they suspect symptoms of work-related Valley Fever. Workers should inform the health care provider that they may have been exposed to cocci;
- To protect themselves, workers should use control measures as outlined here.

3. Control dust exposure:
   - Consult with local Air Pollution Control District Compliance Assistance programs and with California Occupational Safety and Health Administration ("Cal/OSHA") compliance program regarding meeting the requirements of dust control plans and for specific methods of dust control. These methods may include wetting the soil while ensuring that the wetting process does not raise dust or adversely affect the construction process;
   - Provide high-efficiency particulate ("HEP")-filtered, air-conditioned enclosed cabs on heavy equipment. Train workers on proper use of cabs, such as turning on air conditioning prior to using the equipment and keeping windows closed.
   - Provide communication methods, such as 2-way radios, for use in enclosed cabs.
   - Employees should be medically evaluated, fit-tested, and properly trained on the use of the respirators, and a full respiratory protection program in accordance with the applicable Cal/OSHA Respiratory Protection Standard (8 CCR 5144) should be in place.
   - Provide National Institute for Occupational Safety and Health (NIOSH)-approved respirators for workers with a prior history of Valley Fever.
   - Half-face respirators equipped with N-100 or P-100 filters should be used during digging. Employees should wear respirators when working near earth moving machinery.
   - Prohibit eating and smoking at the worksite, and provide separate, clean eating areas with hand-washing facilities.
   - Avoid outdoor construction operations during unusually windy conditions or in dust storms.

- Consider limiting outdoor construction during the Fall to essential jobs only, as the risk of cocci infection is higher during this season.

4. Prevent transport of cocci outside endemic areas:
   - Thoroughly clean equipment, vehicles, and other items before they are moved off-site to other work locations.
   - Provide workers with coveralls daily, lockers (or other systems for keeping work and street clothing and shoes separate), daily changing and showering facilities.
   - Clothing should be changed after work every day, preferably at the work site.
   - Train workers to recognize that cocci may be transported offsite on contaminated equipment, clothing, and shoes; alternatively, consider installing boot-washing.
   - Post warnings onsite and consider limiting access to visitors, especially those without adequate training and respiratory protection.
5. Improve medical surveillance for employees:
   - Employees should have prompt access to medical care, including suspected work-related illnesses and injuries.
   - Work with a medical professional to develop a protocol to medically evaluate employees who have symptoms of Valley Fever.
   - Consider preferentially contracting with 1-2 clinics in the area and communicate with the health care providers in those clinics to ensure that providers are aware that Valley Fever has been reported in the area. This will increase the likelihood that ill workers will receive prompt, proper and consistent medical care.
   - Respirator clearance should include medical evaluation for all new employees, annual re-evaluation for changes in medical status, and annual training, and fit-testing.
   - Skin testing is not recommended for evaluation of Valley Fever.[107]
   - If an employee is diagnosed with Valley Fever, a physician must determine if the employee should be taken off work, when they may return to work, and what type of work activities they may perform.

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[107] Short-term skin tests that produce results within 48 hours are now available. *See* Kerry Klein, NPR for Central California, New Valley Fever Skin Test Shows Promise, But Obstacles Remain, November 21, 2016; available at http://kvpr.org/post/new-valley-fever-skin-test-shows-promise-obstacles-remain, accessed November 24, 2017.

Two other studies have developed complementary recommendations to minimize the incidence of Valley Fever. The U.S. Geological Survey ("USGS") has developed recommendations to protect geological field workers in endemic areas.[108] An occupational study of Valley Fever in California workers also developed recommendations to protect those working and living in endemic areas.[109] These two sources identified the following measures, in addition to those identified by the San Luis Obispo County Public Health Department, to minimize the exposure to Valley Fever:

- Evaluate soils to determine if each work location is within an endemic area.
- Implement a vigorous program of medical surveillance.
- Implement aggressive enforcement of respiratory use where exposures from manual digging are involved.
- Test all potential employees for previous infection to identify the immune population and assign immune workers to operations involving known heavy exposures.
- Hire resident labor whenever available, particularly for heavy dust exposure work.
- All workers in endemic areas should use dust masks to protect against inhalation of particles as small as 0.4 microns. Mustaches or beards may prevent a mask from making an airtight seal against the face and thus should be discouraged.
- Establish a medical program, including skin tests on all new employees, retesting of susceptibles, prompt treatment of respiratory illness in susceptibles; periodic medical examination or interview to discover a history of low grade or subclinical infection, including repeated skin testing of susceptible persons.

The Draft EIR's construction mitigation measures for fugitive dust do not include these measures. Projects that have implemented conventional PM10 dust control measures, such as those proposed in the Draft EIR, have experienced fugitive dust issues and reported cases of Valley Fever.

For example, construction of First Solar's Antelope Valley Solar Ranch One ("AVSR1") was officially halted in April 2013 due to the company's failure to bring the facility into compliance with ambient air quality standards, despite similar dust control measures. A dust storm in Antelope Valley on April 8, 2013 was so severe that it

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[108] Fisher et al., 2000, *op. cit.*

[109] Schmelzer and Tabershaw, 1968, *op. cit.,* pp. 111-113.

resulted in multiple car pileups in the sparsely populated region, as well as closure of the Antelope Valley Freeway. The company was issued four violations by the Antelope Valley Air Quality Management District. Dust from the project led to complaints of respiratory distress by local residents and a concern of Valley Fever. [110]

At two photovoltaic solar energy projects in San Luis Obispo County, Topaz Solar Farm and California Valley Solar Ranch, 28 construction workers contracted Valley Fever. One man was digging into the ground and inhaled dust and subsequently became ill. A blood test confirmed Valley Fever.[111]

All of the above health-protective measures recommended by the San Luis Obispo County Public Health Department and the California Department of Public Health are feasible for the Project and must be required in an enhanced dust control plan to reduce the risk to construction workers, on-site residents, and the public of contacting Valley Fever. Many of these measures have been required by the County of Monterey in other environmental impact reports.[112] They are also required in the environmental impact report for the California High-Speed Train.[113] Even if all of the above measures are adopted, a recirculated Draft EIR is required to analyze whether these measures are adequate to reduce significant impacts due to Valley Fever to a level below significance.

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[110] Herman K. Trabish, Green Tech Media, Construction Halted at First Solar's 230 MW Antelope Valley Site, April 22, 2013, available at: http://www.greentechmedia.com/articles/read/Construction-Halted-At-First-Solars-230-MW-Antelope-Valley-Site, accessed November 24, 2017.

[111] Julie Cart, Los Angeles Times, 28 Solar Workers Sickened by Valley Fever in San Luis Obispo County May 01, 2013; available at: http://articles.latimes.com/2013/may/01/local/la-me-ln-valley-fever-solar-sites-20130501, accessed November 24, 2017.

[112] County of Monterey, California Flats Solar Project Final Environmental Impact Report, December 2014; available at: www.co.monterey.ca.us/Planning/major/California%20Flats%20Solar/FEIR/FEIR_PLN120294_122314.pdf, accessed November 15, 2017.

[113] California High-Speed Rail Authority and U.S. Department of Transportation, California High-Speed Train Project Environmental Impact Report/Environmental Impact Statement, Fresno to Bakersfield, Mitigation Monitoring and Enforcement Program Amendments, September 2015; available at http://www.hsr.ca.gov/Programs/Environmental_Planning/final_merced_fresno.html, accessed November 15, 2017.

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Does noise affect learning? A short review on noise effects on cognitive performance in children

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The present paper provides an overview of research concerning both acute and chronic effects of exposure to noise on children's cognitive performance. Experimental studies addressing the impact of acute exposure showed negative effects on speech perception and listening comprehension. These effects are more pronounced in children as compared to adults. Children with language or attention disorders and second-language learners are still more impaired than age-matched controls. Noise-induced disruption was also found for non-auditory tasks, i.e., serial recall of visually presented lists and reading. The impact of chronic exposure to noise was examined in quasi-experimental studies. Indoor noise and reverberation in classroom settings were found to be associated with poorer performance of the children in verbal tasks. Regarding chronic exposure to aircraft noise, studies consistently found that high exposure is associated with lower reading performance. Even though the reported effects are usually small in magnitude, and confounding variables were not always sufficiently controlled, policy makers responsible for noise abatement should be aware of the potential impact of environmental noise on children's development.

Keywords: noise, cognitive performance, cognitive development, children, speech perception, listening comprehension, irrelevant sound effect, classroom acoustics

In everyday life, cognitive tasks are often performed in the presence of task-irrelevant environmental noise. Accordingly, numerous studies on noise effects on performance have been conducted since the middle of the 20th century (for reviews see Hellbrück and Liebl, 2007; Szalma and Hancock, 2011), showing that—depending on characteristics of sounds and tasks—noise of low to moderate intensity may in fact evoke substantial impairments in performance.

Most of these studies were conducted with adults. The present review, however, will focus on studies including children. Children are especially vulnerable to harmful effects of environmental noise, as cognitive functions are less automatized and thus more prone to disruption. We will report findings concerning effects of acute noise on performance in concurrent auditory and non-auditory tasks, as well as effects of chronic noise on children's cognitive development.

EFFECTS OF ACUTE NOISE ON CHILDREN'S PERFORMANCE IN AUDITORY TASKS

Psychoacoustic studies have consistently shown that children's speech perception is more impaired than adults' by unfavorable listening conditions. The ability to recognize speech under conditions of noise or noise combined with reverberation improves until the teenage years (Johnson, 2000; Wightman and Kistler, 2005; Talarico et al., 2007; Neuman et al., 2010). With stationary noise makers, signal-to-noise ratios (SNRs) have to be 5–7 dB higher for young children when compared to adults in order to achieve comparable levels of identification of speech or nonspeech signals, with adult-like performance reached at about 6 years of age (Schneider et al., 1989; Fallon et al., 2000; Werner, 2007). However, with maskers that vary over time, i.e., with trial-by-trial variation of the maskers' spectral composition (Oh et al., 2001; Hall et al., 2005; Leibold and Neff, 2007) or with fluctuating maskers such as single-talker speech (Wightman and Kistler, 2005), adult-like performance is usually not reached before the age of 10 years. Furthermore, children are less able than adults to make use of spectro-temporal and spatial cues for separation of signal and noise (Wightman et al., 2003; Hall et al., 2005). These findings demonstrate that children are especially prone to *informational* masking, i.e., masking that goes beyond energetic masking predicted by filter models of the auditory periphery.

Studies identified a range of linguistic and cognitive factors to be responsible for children's difficulties with speech perception in noise: concerning the former, children are less able than adults to use stored phonological knowledge to reconstruct degraded speech input. This holds for the level of individual phonemes, as children's phoneme categories are less well specified than adults' (Hazan and Barrett, 2000), but also for the lexical level since children's phonological word representations are more holistic and less segmented into phoneme units. Therefore the probability of successfully matching incomplete speech input with stored long-term representations is reduced (Nittrouer, 1996; Metsala, 1997; Mayo et al., 2003). In addition, young children are less able than older children and adults to make use of contextual cues to reconstruct noise-masked words presented in sentential context (Elliott, 1979). Concerning attention, children's immature auditory selective attention skills contribute to their difficulties with speech-in-noise perception. Children's susceptibility to informational masking has been attributed to deficits in focusing attention on auditory channels centered on signal frequencies, while ignoring nonsignal channels (Wightman and Kistler, 2005). Behavioral and ERP measures from dichotic listening paradigms provide evidence that auditory selective attention improves throughout entire childhood (Doyle, 1973; Pearson and Lane, 1991; Coch et al., 2005; Wightman et al., 2010; Gomes et al., 2012).

Owing to the mediating role of linguistic competence and selective attention, children with language or attention disorders are still more impaired than normally developing children by noise in speech perception tasks (Geffner et al., 1996; Ziegler et al., 2005, 2009). A stronger noise effect is also evident for children tested in their second language when compared to native children (Crandell and Smaldino, 1996). Studies with adults revealed that even skilled non-native listeners, whose performance in quiet is comparable to that of native listeners, are outperformed by native listeners under conditions of noise or noise combined with reverberation (Rogers et al., 2006; for review see Lecumberri et al., 2010).

Studies reviewed so far focused on simple tasks requiring identification of isolated speech targets in noise. However, listening in everyday situations, e.g., in classrooms, goes far beyond identification of single words or syllables. Effective listening in these situations requires semantic and syntactic processing of complex oral information while developing a coherent mental model of the story meaning (Kintsch, 1988). Thus, the question arises how noise affects performance in *complex* listening tasks. Studies addressing this topic revealed noise-induced decrements in adults' memory for paired associates, sequences of unrelated words, sentences, or discourse, even with SNRs allowing perfect or near-perfect identification of the speech targets (Rabbitt, 1968; Pichora-Fuller et al., 1995; Murphy et al., 2000; Ljung et al., 2009). Only a few studies in this field included children. Klatte et al. (2010a) used a listening task requiring execution of complex oral instructions and found substantial decrements due to single-talker speech and classroom noise in elementary school children. Adults were less affected. Valente et al. (2012) reported significant impairments in discourse comprehension in 8- to 12-year-olds due to broadband noise combined with reverberation. The noise effects found in these studies could not be attributed to impaired identification. A possible explanation is that identification of degraded speech requires extra resources which are then unavailable for encoding, storage, and processing of the information (McCoy et al., 2005). In addition, age-related improvements in attentional control (e.g., Davidson et al., 2006) may contribute to children's difficulties when performing listening tasks in the presence of noise. Children are less able than adults to ignore irrelevant sounds, and thus are more susceptible to sound-induced disruption in both auditory and non-auditory tasks. We will return to this point in the following section.

To summarize, the reviewed studies document that children need more favorable listening conditions than adults for decoding and processing of oral information [but see Söderlund et al. (2007, 2010) for contrasting findings in inattentive children]. This has practical implications for the acoustical design of classrooms, since effective listening is a linchpin of school learning. The issue of classroom acoustics has thus gained much interest during the past decades. Studies simulating classroom-like conditions of noise and reverberation reported severe impairments in children's listening performance (Yacullo and Hawkins, 1987; Jamieson et al., 2004; Bradley and Sato, 2008; Klatte et al., 2010a; Neuman et al., 2010; Valente et al., 2012). But even though international and national standards concerning ambient noise levels and reverberation in classrooms were developed in the past decades, many classrooms still do not fit the needs of young listeners (Bradley and Sato, 2008; Klatte et al., 2010b).

EFFECTS OF ACUTE NOISE ON CHILDREN'S PERFORMANCE IN NONAUDITORY TASKS

Concerning tasks that do not involve auditory targets, studies with adults have consistently shown that especially short-term memory is sensitive to negative effects of noise. Immediate serial recall of visually presented verbal items is reliably impaired by task-irrelevant sounds (for reviews see Hughes and Jones, 2001; Beaman, 2005; Schlittmeier et al., 2012). Impairments occur with single talker speech and non-speech sounds such as tones or instrumental music, but not with continuous broadband noise or babble noise. This so-called irrelevant sound effect (ISE) occurs reliably even with low-intensity sounds, with meaningless speech (e.g., speech in a language unknown to participants), and when sound presentation is confined to a rehearsal phase after encoding of the list items. However, the ISE magnitude is determined by inherent properties of the irrelevant sound. Recall performance is specifically impaired by sounds with a changing-state characteristic, i.e., by auditory streams which consist of distinct auditory–perceptive objects that vary consecutively. For example, irrelevant sounds consisting of different syllables or tones evoke an ISE, whereas steady state sounds, e.g., continuous broadband noise or repetitions of single syllables or tones, have a minor or no effect.

Different theories have been proposed concerning the underlying mechanisms of ISE evocation. Some of these assume that irrelevant sounds have automatic access to working memory, causing specific interference with the retention of cues to serial order (Jones et al., 1995) or—in case of speech—with the retention of phonological codes (Salamé and Baddeley, 1982; Neath, 2000). Other accounts attribute the ISE to the attentional burden caused by the necessity to ignore the sounds (Elliott, 2002).

Several studies found the ISE in elementary school children (Elliott, 2002; Elliott and Cowan, 2005; Klatte et al., 2007, 2010b; Elliott and Briganti, 2012), three of which including different age groups in order to learn about the role of attention in ISE evocation by analyzing developmental change. Elliott (2002) reported a dramatic increase in the magnitude of the ISE on serial recall of visually presented digits with decreasing age. Performance drop relative to quiet was 39% in the second-graders, as opposed to 11% in the adults. The age effect was interpreted as evidence for a dominant role of attentional control in ISE evocation. In a recent study of this group (Elliott and Briganti, 2012), the age effect was replicated—albeit smaller in magnitude—but other experiments in the series yielded convincing evidence against the attentional account of the ISE. Klatte et al. (2010b) used serial recall of common nouns presented pictorially and found detrimental effects

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due to background speech which did not differ in magnitude between first-grade children and adults. These and other findings (Hughes et al., 2007, 2012; Röer et al., 2011) suggest that two separate mechanisms contribute to noise-induced impairments in serial recall. On the one hand, irrelevant sounds with a changing state characteristic automatically interfere with maintenance of item or order information in short-term memory. This mechanism is the dominant source of disruption in the standard ISE paradigm, and seems to be adult-like in first-graders. On the other hand, irrelevant sounds may capture attention. The impact of attention capture depends on characteristics of the sound, and on the attentional abilities of the participants. Auditory events that are salient (e.g., of personal significance, such as one's own name), unexpected (e.g., slamming of a door), or deviant from the recent auditory context (e.g., change in voice in a speech stream) have a strong potential to capture attention. Children are more susceptible to sound-induced distraction due to limited attentional control. Accordingly, in Klatte et al. (2010b), first-graders were also impaired by a mixture of nonverbal classroom sounds, whereas older children and adults were unaffected.

Outside the realm of research on ISE, studies addressed effects of moderate-intensity environmental noise on children's performance in academic tasks. Early studies in this field provided little support for noise-induced impairments (Kassinove, 1972; Johansson, 1983). More recent results are inconsistent. Dockrell and Shield (2006) analyzed effects of babble and babble mixed with traffic sounds on third-graders performance in tests assessing reading, spelling, arithmetic, and attention. For all tests, overall scores were lower with babble noise when compared to quiet. Contrary to prediction, however, reading and spelling was even better in the babble plus traffic noise condition when compared to quiet and babble, and error rates in the attention test were higher in quiet when compared to both noise conditions. These results are difficult to interpret as children were not randomly assigned to noise conditions and instead were tested in their original class settings. As only two classes were assigned to each noise condition and class membership is known to affect academic performance (e.g., Kyriakides et al., 2009), a-priori group differences in the dependent variables cannot be ruled out.

A number of studies investigated the effects of background speech and transportation noise on delayed memory for texts in teenagers. Participants read prose paragraphs under different noise conditions and were later tested for prose memory in silence. Recall performance was impaired by meaningful speech (Hygge et al., 2003; Boman, 2004; Sörqvist, 2010), but not by meaningless speech (Hygge, 2003). Concerning transportation noise, results are inconsistent. Hygge (2003) found impairments due to aircraft noise during encoding. Sörqvist (2010) used a within-subjects design and found no effect of aircraft noise, but severe impairments due to meaningful speech. Hygge et al. (2003) and Hygge (2003) found impairments due to road traffic noise while Boman (2004) did not. Ljung et al. (2009) used a direct measure of online reading comprehension and found no effect of road traffic noise and meaningful speech on 12- to 13-year olds' comprehension scores.

Thus, all except one of the studies found impairments due to meaningful speech. This is in line with studies with adults, showing that meaningful speech evokes stronger impairments than meaningless speech in school-related verbal tasks involving reading (Jones et al., 1990; Oswald et al., 2000; Bell et al., 2008) or story writing (Sörqvist et al., 2012). According to the interference-by-process-account (Marsh et al., 2009), meaningful speech automatically evokes semantic processes which compete with the semantic processes involved in the task. As transportation noise does not evoke such processes, its effect on reading found in some, but not all studies, is presumably due to a more general attention-capture process. In line with this argument, Sörqvist (2010) provided evidence that the participants' attentional abilities have a stronger impact on disruption evoked by transportation noise when compared to meaningful speech. Note, however, that category membership (e.g., transportation noise vs. speech) is not sufficient to predict whether or not a sound will evoke distraction. As outlined earlier, the potential of a sound to capture attention depends on characteristics such as salience, predictability, and deviance from the recent auditory context. Thus, in addition to its specific effects on semantic processing and serial recall, speech noise containing such features is able to act as distractor (Hughes et al., 2012). On the other hand, transportation noise lacking such features has no effect on performance (Klatte et al., 2007).

CHRONIC EFFECTS OF NOISE ON CHILDREN'S COGNITIVE DEVELOPMENT

In view of the harmful effects of acute noise, the question arises whether enduring exposure to environmental noise may cause persisting deficits in children's cognitive development. Research in this field focused on indoor noise at school and aircraft noise. Concerning the former, studies yielded evidence for chronic effects on children's reading and prereading skills (Maxwell and Evans, 2000; Shield and Dockrell, 2008; Klatte et al., 2010c). Concerning aircraft noise, mixed results were reported with respect to chronic effects on children's attention (Stansfeld et al., 2005; van Kempen et al., 2010; Belojevic et al., 2012) and memory (Haines et al., 2001; Matheson et al., 2010), but exposure to aircraft noise was consistently associated with lower reading performance (see for review, Clark and Sörqvist, 2012). However, some of these studies are difficult to interpret due to methodological limitations. For example, cognitive abilities were usually measured in the children's regular classrooms, but acute noise levels were not always controlled. Thus, testing was done in noisy conditions for the exposed and in quiet conditions for the non-exposed children, resulting in confound of acute and chronic exposure (e.g., Seabi et al., 2012). In addition, aircraft noise has been found to be associated with socioeconomic status (SES) which in turn is strongly related to children's reading abilities. Thus, insufficient control of SES variables in early studies may have lead to an overestimation of the noise effect (Haines et al., 2002).

The hitherto most comprehensive study in this field, the cross-sectional RANCH (road-traffic and aircraft noise exposure and children's cognition and health) study (Stansfeld et al., 2005) included children ($N = 2844$) living in the vicinity of huge international airports in the UK, the Netherlands, and Spain. Whereas prior studies confined to comparisons of highly exposed and non- exposed children, noise exposure in the RANCH study was included as continuous variable, aiming to reveal the noise levels at which the harmful effects on children's cognition begin. With SES being controlled, the authors found no effect of aircraft noise exposure on sustained attention, working memory, and delayed recall of orally presented stories, but a linear exposure–effect relationship between aircraft noise and decreasing reading comprehension. This effect is often cited as evidence for a causal role of aircraft noise in reading impairment. What is often unreported in the secondary literature is, however, that there was another exposure–effect relationship, revealing *enhanced* performance in episodic memory with increasing exposure to road traffic noise. This counter-intuitive finding remains unexplained.

Concerning the underlying mechanisms of chronic noise effects, some authors proposed that enduring exposure to noise in early childhood affects the development of basic language functions which are of special importance in reading acquisition (Evans and Maxwell, 1997; Maxwell and Evans, 2000; Klatte et al., 2010c). This is a reasonable argument in view of, on the one hand, the vulnerability of children's speech perception and short-term memory for disruption due to acute noise, and on the other hand, the important role of these functions in reading acquisition (Baddeley et al., 1998; Steinbrink and Klatte, 2008; Ziegler et al., 2009). In line with this argument, electrophysiological studies revealed alterations in the cortical responses to speech sounds in individuals with a long-term exposure to occupational noise (Brattico et al., 2005).

CONCLUSIONS

The reviewed studies document harmful effects of noise on children's learning. Children are much more impaired than adults by noise in tasks involving speech perception and listening comprehension. Non-auditory tasks such as short-term memory, reading and writing are also impaired by noise. Depending on the nature of the tasks and sounds, these impairments may result from specific interference with perceptual and cognitive processes involved in the focal task, and/or from a more general attention capture process.

Concerning chronic effects, despite inconsistencies within and across studies, the available evidence indicates that enduring exposure to environmental noise may affect children's cognitive development. Even though the reported effects are usually small in magnitude, they have to be taken seriously in view of possible long-term effects and the accumulation of risk factors in noise-exposed children (Evans, 2004). Obviously, the findings reported in this review have practical implications for the acoustical design of schools, for the placement of schools in the vicinity of airports, and for the policy of noise abatement.

REFERENCES

Baddeley, A., Gathercole, S., and Papagno, C. (1998). The phonological loop as a language learning device. *Psychol. Rev.* 105, 158–173. doi: 10.1037/0033-295X.105.1.158

Beaman, C. P. (2005). Auditory distraction from low-intensity noise: a review of the consequences for learning and workplace environments. *Appl. Cogn. Psychol.* 19, 1041–1064. doi: 10.1002/acp.1134

Bell, R., Buchner, A., and Mund, I. (2008). Age-related differences in irrelevant-speech effects. *Psychol. Aging* 23, 377–391. doi: 10.1037/0882-7974.23.2.377

Belojevic, G., Evans, G. W., Paunovic, K., and Jakovljevic, B. (2012). Traffic noise and executive functioning in urban primary school children: the moderating role of gender. *J. Environ. Psychol.* 32, 337–341. doi: 10.1016/j.jenvp.2012.05.005

Boman, E. (2004). The effects of noise and gender on children's episodic and semantic memory. *Scand. J. Psychol.* 45, 407–416. doi: 10.1111/j.1467-9450.2004.00422.x

Bradley, J. S., and Sato, H. (2008). The intelligibility of speech in elementary school classrooms. *J. Acoust. Soc. Am.* 123, 2078–2086. doi: 10.1121/1.2839285

Brattico, E., Kujala, T., Tervaniemi, M., Alku, P., Ambrosi, L. and Monitillo V. (2005). Long-term exposure to occupational noise alters the cortical organization of sound processing. *Clin. Neurophysiol.* 116, 190–203. doi: 10.1016/j.clinph.2004.07.030

Clark, C., and Sörqvist, P. (2012). A 3 year update on the influence of noise on performance and behavior. *Noise Health* 14, 292–296. doi: 10.4103/1463-1741.104896

Coch, D., Sanders, L. D., and Neville, H. J. (2005). An event-related potential study of selective auditory attention in children and adults. *J. Cogn. Neurosci.* 17, 605–622. doi: 10.1162/0898929053467631

Crandell, C. C., and Smaldino, J. J. (1996). Speech perception in noise by children for whom english is a second language. *Am. J. Audiol.* 5, 47–51.

Davidson, M., Amso, D., Anderson, L., and Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia* 44, 2037–2078. doi: 10.1016/j.neuropsychologia.2006.02.006

Dockrell, J. E., and Shield, B. M. (2006). Acoustical barriers in classrooms: the impact of noise on performance in the classroom. *Br. Educ. Res. J.* 32, 509–525. doi: 10.1080/01411920600635494

Doyle, A.-B. (1973). Listening to distraction: a developmental study of selective attention. *J. Exp. Child Psychol.* 15, 100–115. doi: 10.1016/0022-0965(73)90134-3

Elliott, E. M. (2002). The irrelevant-speech effect and children: theoretical implications of developmental change. *Mem. Cognit.* 30, 478–487. doi: 10.3758/BF03194948

Elliott, E. M., and Briganti, A. M. (2012). Investigating the role of attentional resources in the irrelevant speech effect. *Acta Psychol.* 140, 64–74. doi: 10.1016/j.actpsy.2012.02.009

Elliott, E. M., and Cowan, N. (2005). Coherence of the irrelevant-sound effect: individual profiles of short-term memory and susceptibility to task-irrelevant materials. *Mem. Cognit.* 33, 664–675. doi: 10.3758/BF03195333

Elliott, L. L. (1979). Performance of children aged 9 to 17 years on a test of speech intelligibility in noise using sentence material with controlled word predictability. *J. Acoust. Soc. Am.* 66, 651. doi: 10.1121/1.383691

Evans, G. W. (2004). The environment of childhood poverty. *Am. Psychol.* 59, 77–92. doi: 10.1037/0003-066X.59.2.77

Evans, G., and Maxwell, L. (1997). Chronic noise exposure and reading deficits: the mediating effects of language acquisition. *Environ. Behav.* 29, 638–656. doi: 10.1177/0013916597295003

Fallon, M., Trehub, S. E., and Schneider, B. A. (2000). Children's perception of speech in multitalker babble. *J. Acoust. Soc. Am.* 108, 3023–3029. doi: 10.1121/1.1323233

Geffner, D., Lucker, J. R., and Koch, W. (1996). Evaluation of auditory discrimination in children with ADD and without ADD. *Child Psychiatry Hum. Dev.* 26, 169–180. doi: 10.1007/BF02353358

Gomes, H., Duff, M., Ramos, M., Molholm, S., Foxe, J. J., and Halperin, J. (2012). Auditory selective attention and processing in children with attention-deficit/hyperactivity disorder. *Clin. Neurophysiol.* 123, 293–302. doi: 10.1016/j.clinph.2011.07.030

Haines, M. M., Stansfeld, S. A., Head, J., and Job, R. (2002). Multilevel modelling of aircraft noise on performance tests in schools around Heathrow Airport London. *J. Epidemiol. Community Health* 56, 139–144. doi: 10.1136/jech.56.2.139

Haines, M. M., Stansfeld, S. A., Job, R. F., Berglund, B., and Head, J. (2001). Chronic aircraft noise exposure, stress responses, mental health and cognitive performance in school children. *Psychol. Med.* 31, 265–277.

Hall, J. W., Buss, E., and Grose, J. H. (2005). Informational masking release in children and adults. *J. Acoust. Soc. Am.* 118, 1605–1613. doi: 10.1121/1.1992675

Hazan, V., and Barrett, S. (2000). The development of phonemic categorization in children aged 6–12. *J. Phonetics* 28, 377–396. doi: 10.1006/jpho.2000.0121

Hellbrück, J., and Liebl, A. (2007). "Effects of noise on cognitive performance: an overview and resent results," in *Recent Topics in Environmental Psychoacoustics,* ed S. Kuwano (Osaka: University Press), 153–184.

Hughes, R., and Jones, D. M. (2001). The intrusiveness of sound: laboratory findings and their implications for noise abatement. *Noise Health* 4, 51–70.

Hughes, R., Vachon, F., and Jones, D. M. (2007). Disruption of short-term memory by changing and deviant sounds: support for a duplex-mechanism account of auditory distraction. *J. Exp. Psychol. Learn. Mem. Cogn.* 33, 1050–1061. doi: 10.1037/0278-7393.33.6.1050

Hughes, R., Hurlstone, M., Marsh, J., Vachon, F., and Jones, D. M. (2012). Cognitive control of auditory distraction. impact of task difficulty, foreknowledge, and working memory capacity supports duplex-mechanism account. *J. Exp. Psychol. Hum. Percept. Perform.* 39, 539–553. doi: 10.1037/a0029064

Hygge, S. (2003). Classroom experiments on the effects of different noise sources and sound levels on long-term recall and recognition in children. *Appl. Cogn. Psychol.* 17, 895–914. doi: 10.1002/acp.926

Hygge, S., Boman, E., and Enmarker, I. (2003). The effects of road traffic noise and meaningful irrelevant speech on different memory systems. *Scand. J. Psychol.* 44, 13–21. doi: 10.1111/1467-9450.00316

Jamieson, D. G., Kranjc, G., Yu, K., and Hodgetts, W. E. (2004). Speech intelligibility of young school-aged children in the presence of real-life classroom noise. *J. Am. Acad. Audiol.* 15, 508–517. doi: 10.3766/jaaa.15.7.5

Johansson, C. R. (1983). Effects of low intensity, continuous and intermittent noise on mental performance and writing pressure of children with different intelligence and personality characteristics. *Ergonomics* 26, 275–288. doi: 10.1080/00140138308963341

Johnson, C. E. (2000). Children's phoneme identification in reverberation and noise. *J. Speech Lang. Hear. Res.* 43, 144–157.

Jones, D., Farrand, P., Stuart, G., and Morris, N. (1995). Functional equivalence of verbal and spatial information in serial short-term memory. *J. Exp. Psychol. Learn. Mem. Cogn.* 21, 1008–1018. doi: 10.1037/0278-7393.21.4.1008

Jones, D. M., Miles, C., and Page, J. (1990). Disruption of proofreading by irrelevant speech: effects of attention, arousal or memory? *Appl. Cogn. Psychol.* 4, 89–108. doi: 10.1002/acp.2350040203

Kassinove, H. (1972). Effects of meaningful auditory stimulation on children's scholastic performance. *J. Educ. Psychol.* 63, 526–530. doi: 10.1037/h0033747

Kintsch, W. (1988). The role of knowledge in discourse comprehension: a construction-integration model. *Psychol. Rev.* 95, 163–182. doi: 10.1037/0033-295X.95.2.163

Klatte, M., Lachmann, T., and Meis, M. (2010a). Effects of noise and reverberation on speech perception and listening comprehension of children and adults in a classroom-like setting. *Noise Health* 12, 270. doi: 10.4103/1463-1741.70506

Klatte, M., Lachmann, T., Schlittmeier, S., and Hellbrück, J. (2010b). The irrelevant sound effect in short-term memory: is there developmental change? *Eur. J. Cogn. Psychol.* 22, 1168–1191. doi: 10.1080/09541440903378250

Klatte, M., Hellbrück, J., Seidel, J., and Leistner, P. (2010c). Effects of classroom acoustics on performance and well-being in elementary school children: a field study. *Environ. Behav.* 42, 659–692. doi: 10.1177/0013916509336813

Klatte, M., Meis, M., Sukowski, H., and Schick, A. (2007). Effects of irrelevant speech and traffic noise on speech perception and cognitive performance in elementary school children. *Noise Health* 9, 64–74. doi: 10.4103/1463-1741.36982

Kyriakides, L., Creemers, B., and Antoniou, P. (2009). Teacher behaviour and student outcomes: suggestions for research on teacher training and professional development. *Teach. Teach. Educ.* 25, 12–23. doi: 10.1016/j.tate.2008.06.001

Lecumberri, M. L. G., Cooke, M., and Cutler, A. (2010). Non-native speech perception in adverse conditions: a review. *Speech Commun.* 52, 864–886. doi: 10.1016/j.specom.2010.08.014

Leibold, L. J., and Neff, D. L. (2007). Effects of masker-spectral variability and masker fringes in children and adults. *J. Acoust. Soc. Am.* 121, 3666–3676. doi: 10.1121/1.2723664

Ljung, R., Sörqvist, P., and Hygge, S. (2009). Effects of traffic noise and irrelevant speech on children's reading and mathematical performance. *Noise Health* 11, 194–198. doi: 10.4103/1463-1741.56212

Ljung, R., Sörqvist, P., Kjellberg, A., and Green, A. (2009). Poor listening conditions impair memory for intelligible lectures: implications for acoustic classroom standards. *Build. Acoust.* 16, 257–265. doi: 10.1260/135101009789877031

Marsh, J. E., Hughes, R. W., and Jones, D. M. (2009). Interference by process, not content, determines semantic auditory distraction. *Cognition* 110, 23–38. doi: 10.1016/j.cognition.2008.08.003

Matheson, M., Clark, C., van Martin, R. K. E., Haines, M., Lopez Barrio, I., Hygge, S., et al. (2010). The effects of road traffic and aircraft noise exposure on children's episodic memory: the RANCH Project. *Noise Health* 12, 244–254. doi: 10.4103/1463-1741.70503

Maxwell, L. E., and Evans, G. W. (2000). The effects of noise on pre-school children's pre-reading skills. *J. Environ. Psychol.* 20, 91–97. doi: 10.1006/jevp.1999.0144

Mayo, C., Scobbie, J. M., Hewlett, N., and Waters, D. (2003). The influence of phonemic awareness development on acoustic cue weighting strategies in children's speech perception. *J. Speech Lang. Hear. Res.* 46, 1184–1196. doi: 10.1044/1092-4388(2003/092)

McCoy, S. L., Tun, P. A., Cox, L. C., Colangelo, M., Stewart, R. A., and Wingfield, A. (2005). Hearing loss and perceptual effort: downstream effects on older adults' memory for speech. *Q. J. Exp. Psychol. A* 58, 22–33. doi: 10.1080/02724980443000151

Metsala, J. L. (1997). An examination of word frequency and neighborhood density in the development of spoken-word recognition. *Mem. Cognit.* 25, 47–56. doi: 10.3758/BF03197284

Murphy, D. R., Craik, F. I. M., Li, K. Z. H., and Schneider, B. A. (2000). Comparing the effects of aging and background noise of short-term memory performance. *Psychol. Aging* 15, 323–334. doi: 10.1037/0882-7974.15.2.323

Neath, I. (2000). Modeling the effects of irrelevant speech on memory. *Psychon. Bull. Rev.* 7, 403–423. doi: 10.3758/BF03214356

Neuman, A. C., Wroblewski, M., Hajicek, J., and Rubinstein, A. (2010). Combined effects of noise and reverberation on speech recognition performance of normal-hearing children and adults. *Ear Hear.* 31, 336–344. doi: 10.1097/AUD.0b013e3181d3d514

Nittrouer, S. (1996). The relation between speech perception and phonemic awareness: evidence from low-SES children and children with chronic OM. *J. Speech Lang. Hear. Res.* 39, 1059–1070.

Oh, E. L., Wightman, F., and Lutfi, R. A. (2001). Children's detection of pure-tone signals with random multitone maskers. *J. Acoust. Soc. Am.* 109, 2888–2895. doi: 10.1121/1.1371764

Oswald, C. J. P., Tremblay, S., and Jones, D. M. (2000). Disruption of comprehension by the meaning of irrelevant sound. *Memory* 8, 345–350. doi: 10.1080/09658210050117762

Pearson, D. A., and Lane, D. M. (1991). Auditory attention switching: a developmental study. *J. Exp. Child Psychol.* 51, 320–334. doi: 10.1016/0022-0965(91)90039-U

Pichora-Fuller, M. K., Schneider, B. A., and Daneman, M. (1995). How young and old adults listen to and remember speech in noise. *J. Acoust. Soc. Am.* 97, 593–608. doi: 10.1121/1.412282

Rabbitt, P. M. A. (1968). Channel-capacity, intelligibility and immediate memory. *Q. J. Exp. Psychol.* 20, 241–248. doi: 10.1080/14640746808400158

Röer, J. P., Bell, R., Dentale, S., and Buchner, A. (2011). The role of habituation and attentional orienting in the disruption of short-term memory performance. *Mem. Cognit.* 39, 839–850. doi: 10.3758/s13421-010-0070-z

Rogers, C. L., Lister, J. J., Febo, D. M., Besing, J. M., and Abrams, H. B. (2006). Effects of bilingualism, noise, and reverberation on speech perception by listeners with normal hearing. *Appl. Psycholinguist.* 27, 465–485. doi: 10.1017/S014271640606036X

Salamé, P., and Baddeley, A. (1982). Disruption of short-term memory by unattended speech: implications for the structure of working memory. *J. Verbal Learn. Verbal Behav.* 21, 150–164. doi: 10.1016/S0022-5371(82)90521-7

Schlittmeier, S. J., Weißgerber, T., Kerber, S., Fastl, H., and Hellbrück, J. (2012). Algorithmic modeling of the irrelevant sound effect (ISE) by the hearing sensation fluctuation strength. *Atten. Percept. Psychophys.* 74, 194–203. doi: 10.3758/s13414-011-0230-7

Schneider, B. A., Trehub, S. E., Morrongiello, B. A., and Thorpe, L. A. (1989). Developmental changes in masked thresholds. *J. Acoust. Soc. Am.* 86, 1733–1742. doi: 10.1121/1.398604

Seabi, J., Cockcroft, K., Goldschagg, P., and Greyling, M. (2012). The impact of aircraft noise exposure on South African children's reading comprehension: the moderating effect of home language. *Noise Health* 14, 244–252. doi: 10.4103/1463-1741.102963

Shield, B. M., and Dockrell, J. E. (2008). The effects of environmental and classroom noise on the academic attainments of primary school children. *J. Acoust. Soc. Am.* 123, 133–144. doi: 10.1121/1.2812596

Söderlund, G., Sikström, S., and Smart, A. (2007). Listen to the noise: noise is beneficial for cognitive performance in ADHD. *J. Child Psychol. Psychiatry* 48, 840–847. doi: 10.1111/j.1469-7610.2007.01749.x

Söderlund, G., Sikström, S., Loftesnes, J., and Sonuga-Barke, E. (2010). The effects of background white noise on memory performance in inattentive school children. *Behav. Brain Funct.* 6, 55. doi: 10.1186/1744-9081-6-55

Sörqvist, P. (2010). Effects of aircraft noise and speech on prose memory: what role for working memory capacity? *J. Environ. Psychol.* 30, 112–118. doi: 10.1016/j.jenvp.2009.11.004

Sörqvist, P., Nöstl, A., and Halin, N. (2012). Disruption of writing processes by the semanticity of background speech. *Scand. J. Psychol.* 53, 97–102. doi: 10.1111/j.1467-9450.2011.00936.x

Stansfeld, S. A., Berglund, B., Clark, C., Lopez-Barrio, I., Fischer, P., Öhrström, E., et al. (2005). Aircraft and road traffic noise and children's cognition and health: a cross-national study. *Lancet* 365, 1942–1949. doi: 10.1016/S0140-6736(05)66660-3

Steinbrink, C., and Klatte, M. (2008). Phonological working memory in German children with poor reading and spelling abilities. *Dyslexia* 14, 271–290. doi: 10.1002/dys.357

Szalma, J. L., and Hancock, P. A. (2011). Noise effects on human performance: a meta-analytic synthesis. *Psychol. Bull.* 137, 682–707. doi: 10.1037/a0023987

Talarico, M., Abdilla, G., Aliferis, M., Balazic, I., Giaprakis, I., Stefanakis, T., et al. (2007). Effect of age and cognition on childhood speech in noise perception abilities. *Audiol. Neurotol.* 12, 13–19. doi: 10.1159/000096153

Valente, D. L., Plevinsky, H. M., Franco, J. M., Heinrichs-Graham, E. C., and Lewis, D. E. (2012). Experimental investigation of the effects of the acoustical conditions in a simulated classroom on speech recognition and learning in children. *J. Acoust. Soc. Am.* 131, 232–246. doi: 10.1121/1.3662059

van Kempen, E., van Kamp, I., Lebret, E., Lammers, J., Emmen, H., and Stansfeld, S. (2010). Neurobehavioral effects of transportation noise in primary schoolchildren: a cross-sectional study. *Environ. Health* 9, 2–13. doi: 10.1186/1476-069X-9-25

Werner, L. A. (2007). Issues in human auditory development. *J. Commun. Disord.* 40, 275–283. doi: 10.1016/j.jcomdis.2007.03.004

Wightman, F. L., Callahan, M. R., Lutfi, R. A., Kistler, D. J., and Oh, E. (2003). Children's detection of pure-tone signals: informational masking with contralateral maskers. *J. Acoust. Soc. Am.* 113, 3297. doi: 10.1121/1.1570443

Wightman, F. L., and Kistler, D. J. (2005). Informational masking of speech in children: effects of ipsilateral and contralateral distracters. *J. Acoust. Soc. Am.* 118, 3164–3176. doi: 10.1121/1.2082567

Wightman, F. L., Kistler, D. J., and O'Bryan, A. (2010). Individual differences and age effects in a dichotic informational masking paradigm. *J. Acoust. Soc. Am.* 128, 270–279. doi: 10.1121/1.3436536

Yacullo, W. S., and Hawkins, D. B. (1987). Speech recognition in noise and reverberation by school-age children. *Audiology* 26, 235–246. doi: 10.3109/00206098709081552

Ziegler, J. C., Pech-Georgel, C., George, F., Alario, F., and Lorenzi, C. (2005). Deficits in speech perception predict language learning impairment. *Proc. Natl. Acad. Sci. U.S.A.* 102, 14110–14115. doi: 10.1073/pnas.0504446102

Ziegler, J. C., Pech-Georgel, C., George, F., and Lorenzi, C. (2009). Speech-perception-in-noise deficits in dyslexia. *Dev. Sci.* 12, 732–745. doi: 10.1111/j.1467-7687.2009.00817.x

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Appendix G


Cottonwood
GOLF CLUB
We Are Open!
Willow Glen
Google

SPRING VALLEY COMMUNITY PLANNING GROUP

P.O. Box 1637, Spring Valley, CA 91979-1637

January 16, 2022

From: Spring Valley Community Planning Group

Re: Opposition to the Proposed Cottonwood Sand Mining Project

D-O9-1

At the regularly noticed meeting of January 11, 2022, the elected members of the Spring Valley Community Planning Group (SVCPG) voted to oppose the proposed Cottonwood Sand Mining Project.

Although the Cottonwood Sand Mining Project is not within our planning area, the project has the potential for increased traffic congestion on Jamacha Blvd and State Route 94 caused by frequent sand truck trips throughout the week. The additional noise from this project on these and adjacent roads and the project's trucks potentially damaging the local roads are significant factors that could harm local communities for many years to come.

The resulting excavated pit from the mine could produce significant environmental impact to wildlife, erosion to the Sweetwater River effecting water quality downstream, operational noise and dust disrupting wildlife well beyond the immediate project area, and other environmental concerns. Local air quality could significantly deteriorate and the resulting pit may require massive remediation for years after the project is complete, with potentially little guarantee that the scarred watershed would not be permanently damaged.

The Spring Valley Community Planning Group unanimously opposes this project.

Sincerely,

Tim Snyder, Chair
Spring Valley Community Planning Group

D-O9 – Spring Valley Community Planning Group

D-O9-1 Please see Topical Response 7 and Response to Comment D-O8-39 regarding potential noise impacts on wildlife species.