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Health Risks of Close-Proximity Highways

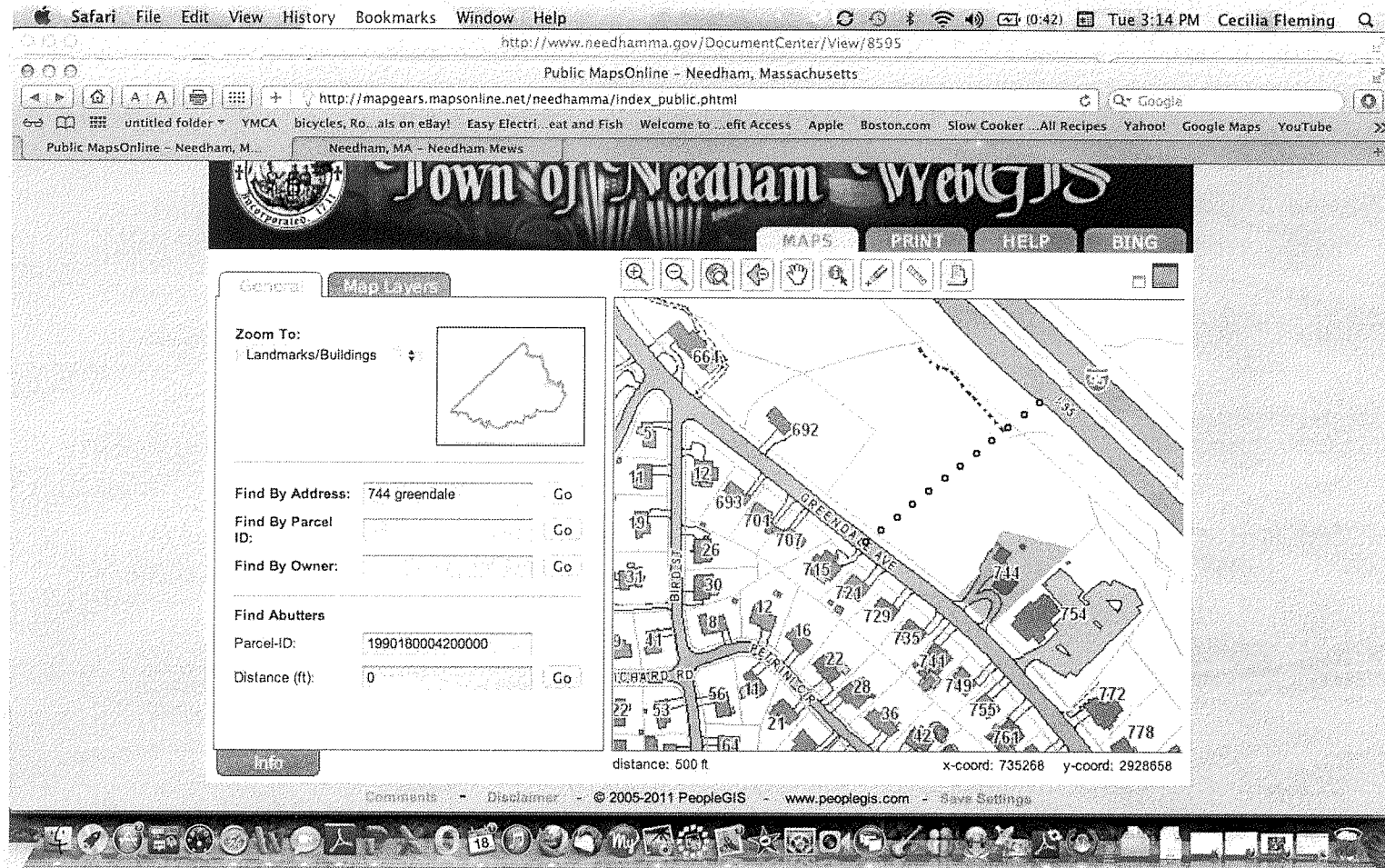
July, 2013

**Needham Zoning Board RE:
Proposed Greendale Mews Apartments**

By Mike Kraft, Ph.D.

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GIS mapping quantifies distance from last travel lane
128/95 to middle of Greendale Ave = ~500ft



Lead (Pb) in soil (2 slides)

Why is lead (Pb) a problem?

- “The preponderance of experimental and human data indicates that there are persistent and deleterious effects of blood lead levels $> 10 \mu\text{g/dL}$ on brain function, including **lowered intelligence, behavioral problems, and diminished school performance, violent assaults, cardiovascular disease, adverse birth outcomes** (Baghurst et al. 1992; Bellinger et al. 1992; Cory-Slechta 1997; Dietrich et al. 1993; Ernhart et al. 1989; Mielke HW, Zahran S. 2013 National Research Council 1993; Needleman and Gatsonis 1990; Pocock et al. 1994; Rice 1993; Wasserman et al. 1997; Yule et al. 1981)”.

At what levels, is it a problem?

- “Lead toxicity, defined as whole **blood lead $\geq 10 \mu\text{g/dL}$** , was based on numerous cross-sectional and prospective studies. [Bellinger et al. 1987; Centers for Disease Control and Prevention (CDC) 1991; World Health Organization (WHO) 1995]. “
- “There is emerging evidence that lead-associated intellectual deficits **occur at blood lead levels $\leq 10 \mu\text{g/dL}$** . “(**$\sim 5 \mu\text{g/dL}$**) (Canfield et al. 2003, Bellinger and Needleman 2003, Rogan and Ware 2003).

Lead (Pb) soil test needed @Mews site:

→ Even decades after Pb removed from gasoline, it is still a problem for residents near high traffic areas

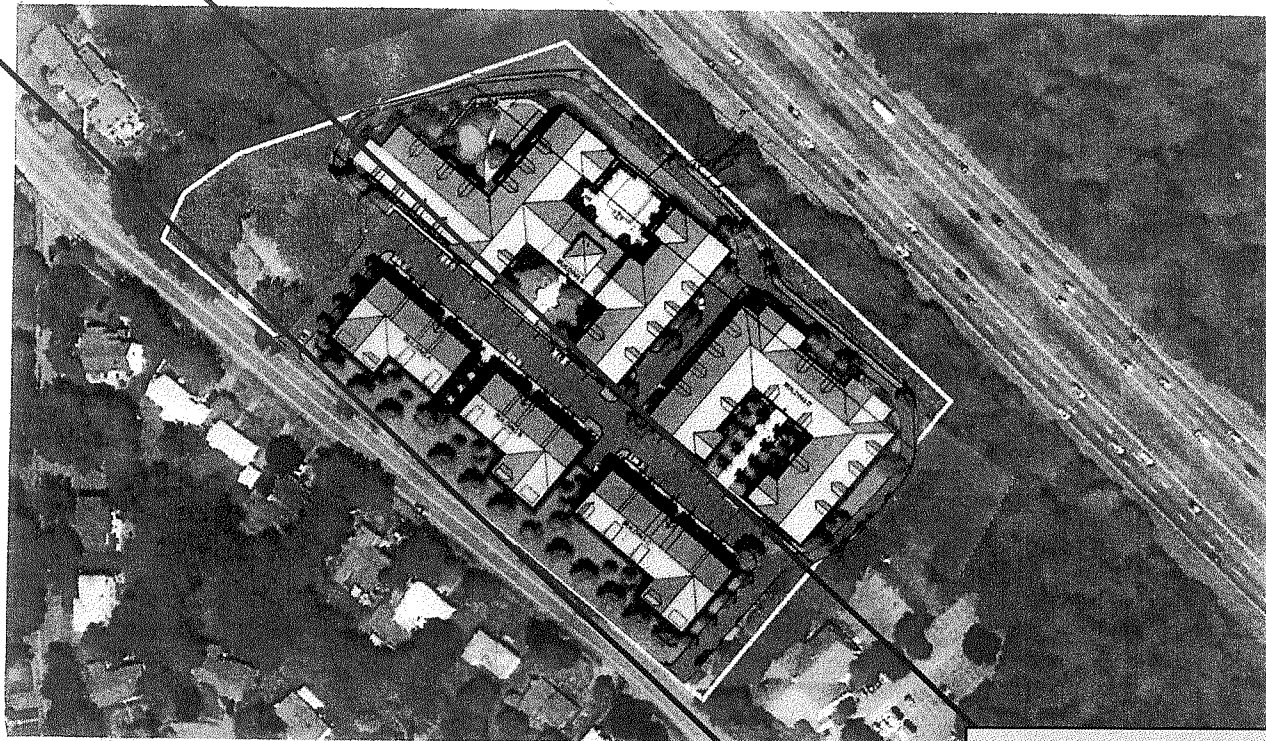
- Environ Geochem Health. 2008 Jun;30(3):231-42.
- **Urban soil-lead (Pb) footprint: retrospective comparison of public and private properties in New Orleans.**
- Mielke HW, Gonzales C, Powell E, Mielke PW Jr.

Abstract

- Lead (Pb) is a toxin that after childhood exposure poses a lifetime of health risks.. **Pb accumulated in soil of the community is a good predictor for blood Pb of children living there.** This retrospective study compares the soil-Pb on Housing Authority of New Orleans (HANO) properties with adjacent private residential (RES) properties within a 0.8 km (0.5 mile) radius. The sample subset (n = 951) is from two soil-Pb surveys (total n = 9,493) conducted between 1989 and 2000. The properties were in both the inner city (CORE) and outlying (OUTER) communities. The data were analyzed using multiresponse permutation procedures (MRPP). The soil-Pb results differ significantly (P-value < 0.001) on same-aged HANO properties at different locations; thus, year of construction does not give adequate explanation for the soil-Pb differences. HANO and RES soils are significantly more Pb contaminated in the CORE than in OUTER communities (P-value < 0.001). **The CORE has many more years of traffic congestion than OUTER communities; therefore, the lead additives to gasoline, and not lead-based paint, best elucidate the differences of the soil-Pb footprint at HANO and RES properties in the CORE and OUTER communities.** Currently HANO properties are being redeveloped with cleaner soil, but soil on RES properties in the CORE of New Orleans remains a large source of Pb (median = 707 mg/kg in this study) for human exposure, especially children.
- See also: **New Orleans soil lead (Pb) cleanup using Mississippi River alluvium: need, feasibility, and cost.** Mielke HW, Powell ET, Gonzales CR, Mielke PW Jr, Ottesen RT, Langedal M. Environ Sci Technol. 2006 Apr 15;40(8):2784-9.

- 2/3 of development is within 300ft (~100m)
- Entire development is within 500ft (152m)

Existing Conditions

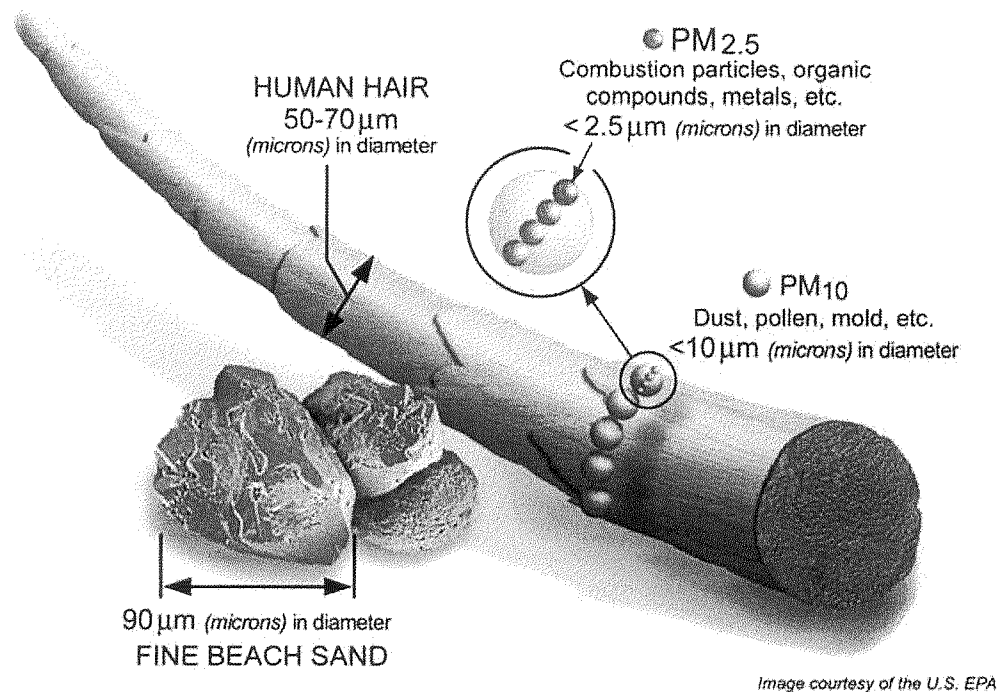


300 ft (~91m)

500 ft (~152m)

MILL CREEK

Ultrafine particle size/problem



- Even the best HEPA filters do not filter down to 0.1 microns

-Ultrafine particles (not even pictured here) are smaller than 0.1 micron in diameter and “are small enough to pass through the lung tissue into the blood stream, circulating like the oxygen molecules themselves”.

-Ultrafine particles are thought to contribute to inflammation, CVD.

-- the best (& most expensive) residential HEPA filters go down to 3 microns, or 1 micron in rare (& \$\$\$) machines

Health risks *empirically associated* with close-proximity highway pollution:

- exacerbation of asthma,
- asthma onset in children,
- impaired lung function,
- risk of new - onset chronic obstructive pulmonary disease (COPD),
- increased (exacerbated) heart disease,
- a faster progression of atherosclerosis if living within 100 m of major highways,
- increased risk of premature death from circulatory disease,
- increased incidence of new heart disease,
- increased risk of low birth weight,
- increased risk of pre-term delivery,
- increased association with Autism for children of mothers exposed to ozone and small particulates prenatal.
- lower immune function in post-menopausal women <150m of arterial roads,
- increased risk of Type 2 diabetes in post- menopausal women,

“Empirically associated” means: multiple studies, consistent results, and in peer reviewed journals

Distances of affliction:

- Near roadway pollutant levels show concentrations of pollutants emitted from vehicles are highest right at the roadway and decreased substantially in the **first 300-500 feet from the roadway** (Zhu et al., 2002b; Knape 1999).
 - These results were consistent with health studies that showed a stronger association of **health impacts** for those living within 300-500 ft of the roadway compared to those living farther than 500 ft from the roadway (Brunekreef et al., 1997; Venn et al., 2001; English et al., 1999).
- More recent studies have shown a somewhat longer plume of increased pollutant concentrations farther from the roadway, returning to background only after 160 -570 meters (**525 –1870 ft**; variability dependent upon conditions)

Exposure to small particulate matter (PM2.5):

Lit. review: Pooled effects from 1950-2007:

- mortality from lung cancer, an increased risk of
> 15% to 21% per a 10 microg/m³ increase of PM2.5.
- total cardiovascular mortality, increased risk of
> 12% to 14% per a 10 microg/m³ increase.
- 6% increase in all cause non-accidental mortality.

- Rev Environ Health. 2008 Oct-Dec;23(4):243-97.

A systematic review of the relation between long-term exposure to ambient air pollution and chronic diseases.

- Chen H, Goldberg MS, Villeneuve PJ.

Abstract

- We conducted a systematic review of all studies published between 1950 and 2007 of associations between long-term exposure to ambient air pollution and the risks in adults of nonaccidental mortality and the incidence and mortality from cancer and cardiovascular and respiratory diseases. We searched bibliographic databases for cohort and case-control studies, abstracted characteristics of their design and conduct, and synthesized the quantitative findings in tabular and graphic form. We assessed heterogeneity, estimated pooled effects for specific pollutants, and conducted sensitivity analyses according to selected characteristics of the studies. Our analysis showed that long-term exposure to PM2.5 increases the risk of nonaccidental mortality by 6% per a 10 microg/m³ increase, independent of age, gender, and geographic region. Exposure to PM2.5 was also associated with an increased risk of mortality from lung cancer (range: 15% to 21% per a 10 microg/m³ increase) and total cardiovascular mortality (range: 12% to 14% per a 10 microg/m³ increase). In addition, living close to busy traffic appears to be associated with elevated risks of these three outcomes. Suggestive evidence was found that exposure to PM2.5 is positively associated with mortality from coronary heart diseases and exposure to SO₂ increases mortality from lung cancer. For the other pollutants and health outcomes, the data were insufficient data to make solid conclusions.

Cardio and Pulmonary risks from near-highway pollutants:

- “Short-term exposure to fine particulate pollution exacerbates existing pulmonary and cardiovascular disease”
- “Long-term repeated exposures increases the risk of cardiovascular disease and death [25,26].
(Specific mechanisms have been implicated)

Near-highway pollutants in motor vehicle exhaust: A review of epidemiologic evidence of cardiac and pulmonary health risks

Doug Brugge^{1*}, John L Durant² and Christine Rioux³

Environmental Health 2007, 6:23

- Results from clinical, epidemiological, and animal studies are converging to indicate that short-term and long-term exposures to traffic-related pollution, especially particulates, have adverse cardiovascular effects [16-18].
- Short-term exposure to fine particulate pollution exacerbates existing pulmonary and cardiovascular disease and long-term repeated exposures increases the risk of cardiovascular disease and death [25,26].
- Much of the epidemiological research has focused on assessing the early physiological responses to short-term fluctuations in air pollution in order to understand how these exposures may alter cardiovascular risk profiles and exacerbate cardiovascular disease [31]. Heart rate variability, a risk factor for future cardiovascular outcomes, is altered by traffic-related pollutants particularly in older people and people with heart disease [22,23,32]. With decreased heart rate variability as the adverse outcome, negative associations between HRV and particulates were strongest for the smallest size fraction studied [33] (PM_{0.3-1.0}); [34] (PM_{0.02-1}). In two studies that included other pollutants, black carbon, an indicator of traffic particles, also elicited a strong association with both time and frequency domain HRV variables; associations were also strong for PM_{2.5} for both time and frequency HRV variables in the Adar et al study [[23];

Childhood Asthma and highway exposures

– most well-established (ill-health condition) for both general air pollution and close-proximity dose-dependent studies.

Directly from Brugge, et al.

“Evidence that near highway exposures present elevated risk is relatively well developed with respect to child asthma studies.

Most recent child asthma studies have used increasingly narrow definitions of proximity to traffic, including air monitoring or modeling) and have focused on major highways instead of street traffic [54-59]. **All of these (6) studies have found statistically significant associations between the prevalence of asthma or wheezing and living very close to high volume vehicle roadways.** Confounders considered included housing conditions (pests, pets, gas stoves, water damage), exposure to tobacco smoke, various measures of socioeconomic status (SES), age, sex, and atopy, albeit self-reported and not all in a single study.”

- **Other multi-year decade+ research:** <http://www.arb.ca.gov/research/chs/chs.htm>
- **Air Pollution Harms Children's Lungs for Life** - Children exposed to higher levels of particulate matter, nitrogen dioxide, acid vapor and elemental carbon, had significantly lower lung function at age 18, an age when the lungs are nearly mature and lung function deficits are unlikely to be reversed. [USC, N Engl J Med 2004; 351:1057 - 1067 ([Link to the article - May require registration](#))]

Adverse birth outcomes – literature review, 2012

- low birth weight
- preterm birth

- <http://www.ncbi.nlm.nih.gov/pubmed/22726801>
- *Environ Res.* 2012 Aug;117:100-11. doi: 10.1016/j.envres.2012.05.007. Epub 2012 Jun 21.
- **Ambient air pollution, birth weight and preterm birth: a systematic review and meta-analysis.**
- Stieb DM, Chen L, Eshoul M, Judek S.

Abstract

- Low birth weight and preterm birth have a substantial public health impact. Studies examining their association with outdoor air pollution were identified using searches of bibliographic databases and reference lists of relevant papers. Pooled estimates of effect were calculated, heterogeneity was quantified, meta-regression was conducted and publication bias was examined. **Sixty-two studies met the inclusion criteria. The majority of studies reported reduced birth weight and increased odds of low birth weight in relation to exposure to carbon monoxide (CO), nitrogen dioxide (NO₂) and particulate matter less than 10 and 2.5 microns (PM₁₀ and PM_{2.5}).** Effect estimates based on entire pregnancy exposure were generally largest. Pooled estimates of decrease in birth weight ranged from 11.4 g (95% confidence interval - 6.9-29.7) per 1 ppm CO to 28.1g (11.5-44.8) per 20 ppb NO₂, and pooled odds ratios for low birth weight ranged from 1.05 (0.99-1.12) per 10 µg/m³ PM_{2.5} to 1.10 (1.05-1.15) per 20 µg/m³ PM₁₀ based on entire pregnancy exposure. Fewer effect estimates were available for preterm birth and results were mixed. Pooled odds ratios based on 3rd trimester exposures were generally most precise, ranging from 1.04 (1.02-1.06) per 1 ppm CO to 1.06 (1.03-1.11) per 20 µg/m³ PM₁₀. Results were less consistent for ozone and sulfur dioxide for all outcomes. Heterogeneity between studies varied widely between pollutants and outcomes, and meta-regression suggested that heterogeneity could be partially explained by methodological differences between studies. While there is a large evidence base which is indicative of associations between CO, NO₂, PM and pregnancy outcome, variation in effects by exposure period and sources of heterogeneity between studies should be further explored.

Autism – 2013

- 3 recent epidemiological studies all show association with Ozone and PM2.5
- 12-15% in relative risk, per increase in O₃, PM2.5

- [Environ Health Perspect.](#) 2013 Mar;121(3):380-6. doi: 10.1289/ehp.1205827. Epub 2012 Dec 17.
- **Ambient air pollution and autism in Los Angeles county, California.**
- [Becerra TA, Wilhelm M, Olsen J, Cockburn M, Ritz B.](#)
- Department of Epidemiology, Fielding School of Public Health, University of California, Los Angeles, Los Angeles, California 90095-1772,

BACKGROUND:

- The prevalence of autistic disorder (AD), a serious developmental condition, has risen dramatically over the past two decades, but high-quality population-based research addressing etiology is limited.

OBJECTIVES:

- We studied the influence of exposures to traffic-related air pollution during pregnancy on the development of autism using data from air monitoring stations and a land use regression (LUR) model to estimate exposures.

METHODS:

- Children of mothers who gave birth in Los Angeles, California, who were diagnosed with a primary AD diagnosis at 3-5 years of age during 1998-2009 were identified through the California Department of Developmental Services and linked to 1995-2006 California birth certificates. For 7,603 children with autism and 10 controls per case matched by sex, birth year, and minimum gestational age, birth addresses were mapped and linked to the nearest air monitoring station and a LUR model. We used conditional logistic regression, adjusting for maternal and perinatal characteristics including indicators of SES.

RESULTS:

- Per interquartile range (IQR) increase, we estimated a **12-15% relative increase** in odds of autism for ozone [odds ratio (OR) = 1.12, 95% CI: 1.06, 1.19; per 11.54-ppb increase] and particulate matter $\leq 2.5 \mu\text{m}$ (OR = 1.15; 95% CI: 1.06, 1.24; per 4.68- $\mu\text{g}/\text{m}^3$ increase) when mutually adjusting for both pollutants. Furthermore, we estimated 3-9% relative increases in odds per IQR increase for LUR-based nitric oxide and nitrogen dioxide exposure estimates. LUR-based associations were strongest for children of mothers with less than a high school education.

CONCLUSION:

- Measured and estimated exposures from ambient pollutant monitors and LUR model suggest **associations between autism and prenatal air pollution exposure, mostly related to traffic sources.**

Epidemiological review: 25 of 29 studies showed adverse health effects w/proximity to residential traffic

- J Environ Health. 2008 Apr;70(8):33-41, 55-6.
- **Potential health effects associated with residential proximity to freeways and primary roads: review of scientific literature, 1999-2006.**
- Boothe VL, Shendell DG.
- **Abstract** This review presents epidemiologic evidence of adverse health effects associated with residential proximity to traffic. Of the 29 peer-reviewed studies that met the authors' defined criteria, **25 reported statistically significant associations with at least one adverse health effect** across a broad range of exposure metrics and diverse geographical locations. Specific pollutants contributing to the associated health effects could not, however, be identified, and uncertainties existed because of the lack of individual exposure assessments that could rule out confounding by other factors. Improved exposure assessments and future studies should be considered for better identification of contributing pollutants and mechanisms of action. In the meantime, additional policies, additional regulations, and improved land use and urban planning can better protect the public and limit exposure, especially for vulnerable populations such as pregnant women, children, and the elderly.
- PMID: 18468221

<http://www.healtheffects.org/>

The Health Effects Institute (HEI)

- HEI is a nonprofit corporation chartered in 1980 as an independent research organization to provide high-quality, impartial, and relevant science on the health effects of air pollution. Typically, HEI receives half of its core funds from the US Environmental Protection Agency and half from the worldwide motor vehicle industry (see [HEI Sponsors](#)). Other public and private organizations periodically support special projects or certain research.

Their EXCELLENT review: Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects

<http://pubs.healtheffects.org/getfile.php?u=552>

And here, for the accompanying Table of Studies; w/references:

<http://pubs.healtheffects.org/getfile.php?u=559>

From: <http://www.arb.ca.gov/research/health/traff-eff/research%20status%20-reducing%20exposure%20to%20traffic%20pollution.pdf>

HEI - 2008 review (presented Jan 2010)

- This is what supplied the preponderance of health outcomes on initial slides.
- In a major 2008 review of the scientific literature by the Health Effects Institute (HEI), **proximity to busy roadways was found to be associated with a variety of adverse health impacts**, the strongest association being exacerbation of **asthma**, with others including **asthma onset** in children, **impaired lung function**, and **increased heart disease** (HEI, 2010). More recent studies have added to the list of effects and heightened concern regarding exposure to traffic emissions. Respiratory and cardiovascular effects seen in these studies include an increased risk of **new - onset chronic obstructive pulmonary disease COPD** (Andersen et al., 2010), **a faster progression of atherosclerosis** in those living within 100 m of highways (Künzli et al., 2010), **increased risk of premature death from circulatory disease** (Jerrett et al., 2009), and **increased incidence of new heart disease** (Kan et al., 2008). Other effects include increased risk of **low birth weight** (Brauer et al., 2008; Llop et al., 2010) and increased risk of **pre-term delivery** (Wilhelm and Ritz, 2003; Wilhelm et al., 2011) for mothers living very near heavy traffic, **lower immune function** in post - menopausal women living within 150 m of arterial roads (Williams et al., 2009), and **increased risk of Type 2 diabetes** in post- menopausal women (Krämer et al., 2010).
- THESE PEOPLE APPLY THE STRICTEST OF CONDITIONS and METHODOLOGICAL RIGOR; based on the Surgeon General's 2004 recommendations post fight/bout with Smoking and Lung Cancer issues.

California Prop: PRC 21151.8

- Mandates set-back requirement for schools of at least 500 feet.
- Air Quality Resource Board - siting for housing and other sensitive uses of **no less than 500ft from major roadways** and **1000ft** from busy distribution centers and rail yards (CARB, 2500a).
- Other Mills Creek developments around country seem to abide by this law, why not Greendale Mews???
- Concord Mews, Concord, MA = **1.06** Miles from Mass Pike
- Watertown Mews, Watertown, MA = **0.9** miles to I-280
- Mission Piers, San Francisco, CA = **0.86** miles I-287
- Latitude Apartments, Morristown, NJ = **0.55** miles to I-405
- The Kelvin Apartments, Irvine, CA. = **0.54** miles from I-475
- Modera Wetshore, Tampa, FL = **0.48** miles from I-95/495
- Landmark Gateway, Alexandria, VA = **0.48** miles from 128/I-95
- Charles River Landing, Needham Heights, MA(NOT MCRT) = **0.34** miles from I- 5
- Crown Valley, Laguna Niguel, CA = **0.28** miles from I-175
- **Proposed Glendale Mews – Needhama, MA = < 0.10 miles from I-95/128**

Is a MA law of 500 ft in the works?

- Is it in the works?
- Should we push it?
- Insight on why (/not); from my colleagues
 - Defining the line in the sand
 - What if 505 feet?
 - Currently leaves room for adjustments based on other variables, and common sense solutions w/intelligent empirical evidence.
 - Provided there exists a respectable level of moral and ethical standards.

For next ZBA meeting:

Noise pollution

- Effect as a confounding variable for air pollution, and direct effects:
- [Noise Health](#). 2006 Jan-Mar;8(30):1-29.
- **Transportation noise and cardiovascular risk: updated review and synthesis of epidemiological studies indicate that the evidence has increased.**
- [Babisch W.](#)

Abstract

- The review provides an overview of epidemiological studies that were carried out in the field of community noise and cardiovascular risk. The studies and their characteristics are listed in the tables. Risk estimates derived from the individual studies are given for 5 dB(A) categories of the average A-weighted sound pressure level during the day. The noise sources considered in the studies are road and aircraft noise. The health endpoints are mean blood pressure, hypertension and ischaemic heart disease, including myocardial infarction. Study subjects are children and adults. The evidence of an association between transportation noise and cardiovascular risk has increased since the previous review published in Noise and Health in the year 2000.
- PMID 17513892 Free full text