

Adverse Health Impacts from Air Pollution Exposure 3/27/2014

This handout provides an overview of recent international, state and regional research findings about the adverse human health impacts caused by outdoor air pollution.

I. IARC: Outdoor air pollution a leading environmental cause of cancer deaths

Source: *IARC Press Release No. 221, October 17, 2013*; http://www.iarc.fr/en/media-centre/iarcnews/pdf/pr221_E.pdf

In October 2013, the International Agency for Research on Cancer (IARC) Working Group for IARC Monographs Volume 109 classified outdoor air pollution as carcinogenic to humans (Group 1), recognizing that outdoor air pollution is a leading environmental cause of cancer deaths:

After thoroughly reviewing the latest available scientific literature, the world's leading experts convened by the IARC Monographs Programme concluded that there is sufficient evidence that exposure to outdoor air pollution causes lung cancer (Group 1). They also noted a positive association with an increased risk of bladder cancer.

Particulate matter, a major component of outdoor air pollution, was evaluated separately and was also classified as carcinogenic to humans (Group 1).

The IARC evaluation showed an increasing risk of lung cancer with increasing levels of exposure to particulate matter and air pollution. Although the composition of air pollution and levels of exposure can vary dramatically between locations, the conclusions of the Working Group apply to all regions of the world.

Volume 109 of the IARC Monographs is based on the independent review of more than 1000 scientific papers from studies on five continents. The reviewed studies analyze the carcinogenicity of various pollutants present in outdoor air pollution, especially particulate matter and transportation-related pollution. The evaluation is driven by findings from a large volume of epidemiologic studies that included millions of people living in Europe, North and South America, and Asia.

II. ARB: Multiple adverse health impacts from traffic-related pollution exposure

Source: *Status of Research on Potential Mitigation Concepts to Reduce Exposure to Nearby Traffic Pollution, August 23, 2012*; <http://www.arb.ca.gov/research/health/traff-eff/traff-eff.htm>

In August 2012, the California Environmental Protection Air Resources Board (ARB) summarized the status of research on traffic exposures and health impacts, as well as research conducted to evaluate mitigation concepts to reduce traffic pollution exposures to those living near busy roadways. ARB recommends siting housing and other sensitive uses 500 feet from major roadways and 1000 feet from busy distribution centers and rail yards. Key research reviewed is discussed below:

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.¹

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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,² a faster progression of atherosclerosis in those living within 100 meters of highways in Los Angeles,³ increased risk of premature death from circulatory disease,⁴ and increased incidence of new heart disease.⁵

Other effects include increased risk of low birth weight^{6,7} and increased risk of pre-term delivery^{8,9} for mothers living very near heavy traffic, lower immune function in post-menopausal women living within 150 m of arterial roads,¹⁰ and increased risk of Type 2 diabetes in post-menopausal women.¹¹

Children appear to be particularly vulnerable to the adverse effects of traffic emissions. Epidemiological studies have found significant associations of children living near high traffic areas with decreased lung function,^{12,13} increased medical visits and hospital admissions for childhood asthma,^{14,15} increased wheezing,¹⁶ and increased childhood asthma and bronchitis,^{17,18,19} including development of new asthma cases.^{20,21}

III. BAAQMD: Premature mortality from Bay Area air pollution exposures

Source: *Draft Bay Area 2010 Clean Air Plan*, March 2010; <http://www.baaqmd.gov/Divisions/Planning-and-Research/Plans/Clean-Air-Plans.aspx>

In September 2010, the Bay Area Air Quality Management District (BAAQMD) adopted its updated Clean Air Plan (CAP). Table 1-1 provides an overview of the key characteristics and impacts of air pollutants addressed in the 2010 CAP. The Plan summarizes how Bay Area air quality has improved significantly in recent decades, due to a comprehensive program to reduce emissions from both stationary and mobile sources of air pollutants. However, despite this progress, a variety of health effects are still associated with exposure to air pollution in the Bay Area today, and these health effects result in direct and indirect economic impacts to the region that are valued in billions of dollars per year. The health and cost impacts include asthma emergency room visits, respiratory hospital admissions, cardiovascular hospital admissions, chronic bronchitis, non-fatal heart attacks, cancer onset, and premature mortality.

The Air District's air pollution modeling has led to their estimate of approximately 2,800 premature deaths in the Bay Area per year related to current air pollution levels, and that the vast majority of these deaths - more than 90% - are related to exposure to fine particulate matter (designated as PM_{2.5}, meaning particles less than or equal to 2 microns in diameter). Further distinction was made for health impacts from the portion of PM_{2.5} that comes from diesel combustion emissions:

Although research is still on-going to determine the precise biological mechanisms through which PM_{2.5} is associated with increased mortality, it appears that cardiovascular problems, such as heart attacks, are the leading cause (EPA 2009). Although diesel PM is the leading air toxic in the Bay Area, it should be noted that perhaps only 10-20% of these PM-related deaths are linked to diesel exhaust. Other sources of PM, such as wood smoke, cooking, and secondary formation of PM from precursors such as NO_x, SO₂, and ammonia, collectively account for most of the ambient PM, and PM-related mortality, in the Bay Area. To the extent that diesel PM does contribute to premature mortality, it appears to be primarily due to the mechanisms mentioned above. Cancer accounts for a smaller

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number of total deaths relate to air pollution. The total annual number of cancer deaths, including lung cancer, related to exposure to diesel PM in the Bay Area, is approximately 80-90 per year. Thus, mortality related to exposure to fine PM (including diesel particles) appears to be associated much more with cardiovascular problems than with cancer.

IV. Children's respiratory health impacts from traffic-related pollution exposure

Source: *Key Research Findings*, website of Southern California Children's Environmental Health Center at the USC Keck School of Medicine; http://hydra.usc.edu/cehc/research_findings.html

1. Current levels of air pollution have chronic, adverse effects on lung development in children from the age of 10 to 18 years, leading to clinically significant deficits in attained forced expiratory volume (FEV1), the maximal amount of air you can forcefully exhale in one second, as children reach adulthood.¹ FEV1 is a marker for the degree of obstruction caused by asthma.
2. Respiratory health in children is adversely affected by local exposures to outdoor NO₂ or other freeway-related pollutants.²
3. Residential traffic exposure is associated with deficits in lung function growth.³
4. Residential traffic exposure is associated with prevalent asthma, lifetime asthma and wheezy phenotype.^{4, 5}
5. New onset asthma in primary school children is independently associated with local traffic-related pollution near homes and near schools.^{6, 7}
6. Markers of traffic-related air pollution are associated with the onset of asthma, providing further evidence that air pollution exposure contributes to new cases of asthma.^{8, 9}
7. On-road commuting exposure to air pollution increases the risk of asthma.¹⁰

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Enhanced Ventilation Energy Use and Costs Article 38 of the San Francisco Health Code

Studies are consistent in demonstrating that the energy use and cost of enhanced ventilation is not substantially increased compared to standard ventilation specifications.

The table below summarizes select findings of reliable research on the energy use and potential costs of installing enhanced ventilation in buildings. Enhanced ventilation system designs are known to protect against the adverse public health impacts from outdoor air quality with high concentrations of pollutants, which is why Article 38 of the San Francisco Health Code requires that enhanced ventilation be provided to all units in a building located in the Air Pollutant Exposure Zone.

These studies show that installation of an appropriately designed enhanced ventilation system does not necessitate substantial additional expenditure for operation or installation.

Selected Reliable Research on Energy Use and Potential Costs of Enhanced Ventilation Systems

Research Information	Selected Results	Source
10 central forced air systems monitored for one year Permanent Split Capacitor (PSC) Brushless Permanent Magnet (BPM) MERV 6 to MERV 16	Measurements were recorded every ten seconds for blower power, filter pressure drop, supply and return plenum pressures together with plenum and indoor temperatures. The field test results were used to simulate additional performance and climate scenarios. The results indicated that <i>for MERV 10-13 filters the effects on energy use are small (<1%)</i> over a wide range of performance conditions and climates. Higher efficiency MERV 16 filters have the potential for increased energy use (>5%) and usability.	Walker et al., 2013
17 forced air HVAC systems monitored for one year occupied residential light commercial + 2 test systems MERV 2 to MERV 11-12	Measurements were recorded monthly for system airflow, fan power draw, power draw of the outdoor compressor-condenser unit, cooling capacity, pressure drops across filters and coils, and duct leakage. <i>Higher-efficiency (MERV 11-12) filters had a generally decreased median energy consequence compared to low-efficiency filters;</i> the authors hypothesized that these small savings came from fan energy reductions.	Stephens et al., 2010
The marginal and annualized cost estimates individual air exchange design whole building design multi-unit buildings (>10 units)	Annualized cost ranged from \$58 - \$727 per unit per year, including material, operating and maintenance costs and accounting for the space to accommodate the system. <i>Whole building ventilation is lower cost; single unit ventilation designs implemented in buildings with more than 10 units have more expensive per unit costs.</i>	San Francisco Office of Economic Analysis

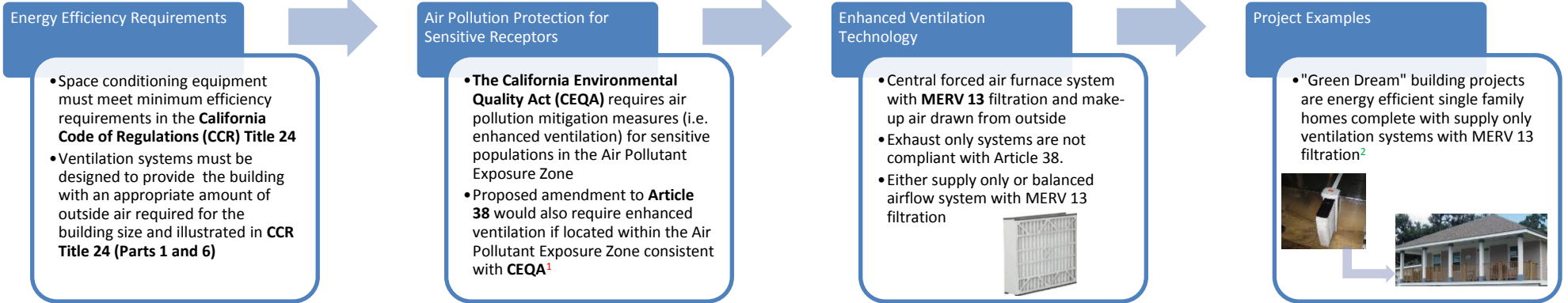
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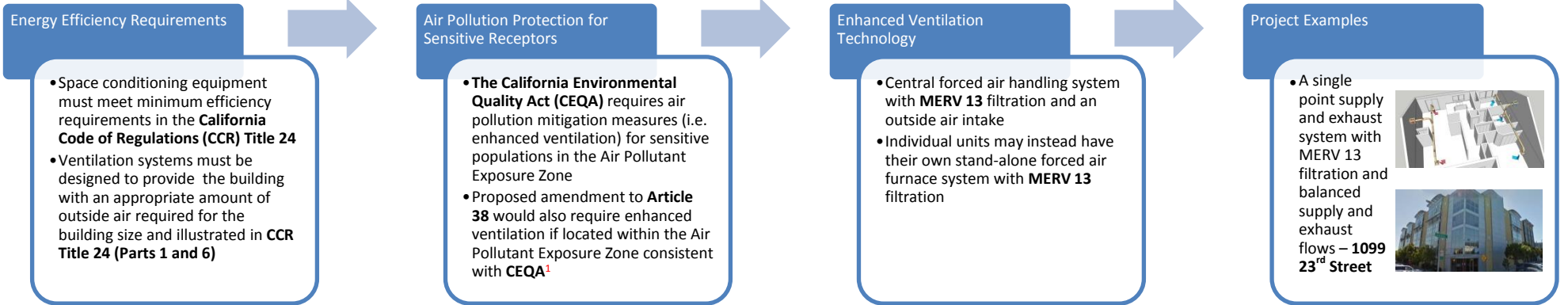
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Ernest Orlando Lawrence Berkeley National Laboratory Environmental, Energy Technologies Division. Submitted for presentation at ASHRAE Annual Conference, June 2013. <http://eetd.lbl.gov/sites/all/files/lbnl-6144e.pdf>

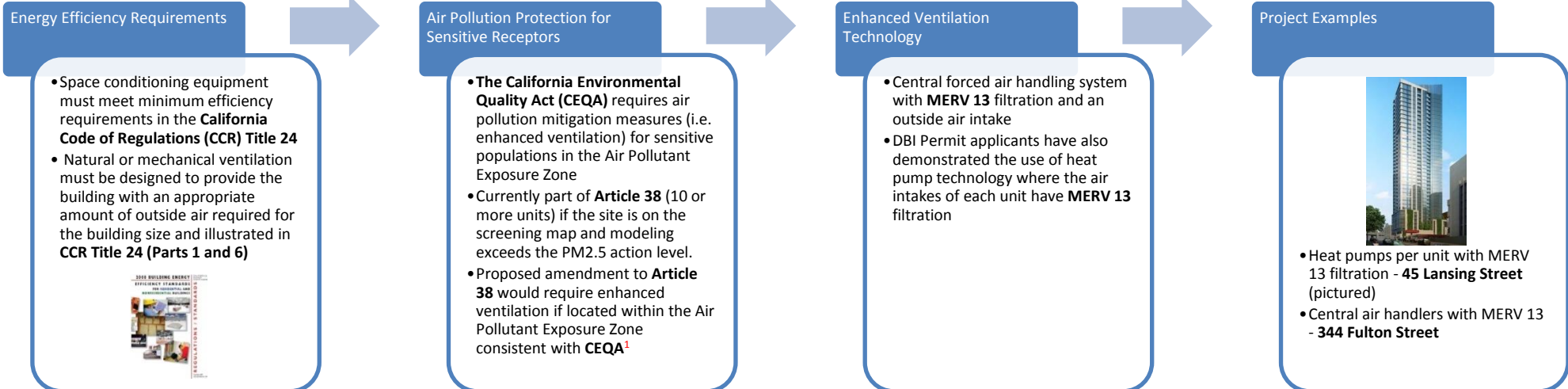
Single Family Homes



Low Rise Residential (Multi-Family, 3 Stories or Less³)



High Rise Residential (Multi-Family, 4 or More Stories³)



¹ By achieving consistency with CEQA, compliance with Article 38 will help a project obtain a categorical exemption, thereby allowing developers to avoid costs and time associated with CEQA (assuming no other significant environmental effects).

² Collaboration project between the US Department of Energy's Building America Program and the Building Science Corporation in New Orleans, LA. http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/new_orleans_green_dream_II.pdf

³ Low rise and high rise residential buildings do not include hotels/motels. For specific Occupancy Groups covered see CCR Title 24 Part 6.



SAN FRANCISCO PLANNING DEPARTMENT

Building and Health Code Amendment

The proposed Ordinance would amend Article 38 of the Health Code to require an enhanced ventilation system for sensitive receptor projects within the Air Pollutant Exposure Zone, as mapped by Article 38 of the Health Code; amend the Building Code to reflect changes in Article 38 of the Health Code; and make environmental findings.

GOAL OF THE ORDINANCE

The goal of the proposed Ordinance is to protect public health in locations of the City burdened with poor air quality (Air Pollutant Exposure Zone). The proposed Ordinance requires new sensitive receptor construction to include a ventilation system that requires the removal of fine particulate matter (PM_{2.5}) equivalent to that associated with MERV 13 filtration.

THE WAY IT IS NOW:

- The Department of Public Health (DPH) maintains a map that identifies *potential* roadways with PM_{2.5} concentrations greater than 0.2 µg/m³ (Potential Roadway Exposure Zone). During the building permit review process, any newly constructed building containing 10 or more residential units within the Potential Roadway Exposure Zone requires that an Air Quality model be generated to assess the impact of roadways within 150 meters to determine if building users would be exposed to PM_{2.5} concentrations greater than 0.2 µg/m³. If the project site exceeds this criterion, the project sponsor must install and properly maintain a ventilation system that will achieve the removal of at least 80 percent of ambient PM_{2.5} concentrations.
- Currently, Article 38 does not apply to projects of fewer than 10 residential units; nor does it apply to schools, day care facilities, and other sensitive receptors, within the Potential Roadway Exposure Zone, although such projects may be required to install the above-mentioned ventilation system through California Environmental Quality Act (CEQA) mitigation measures and conditions of project approval.

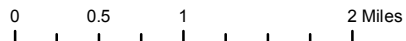
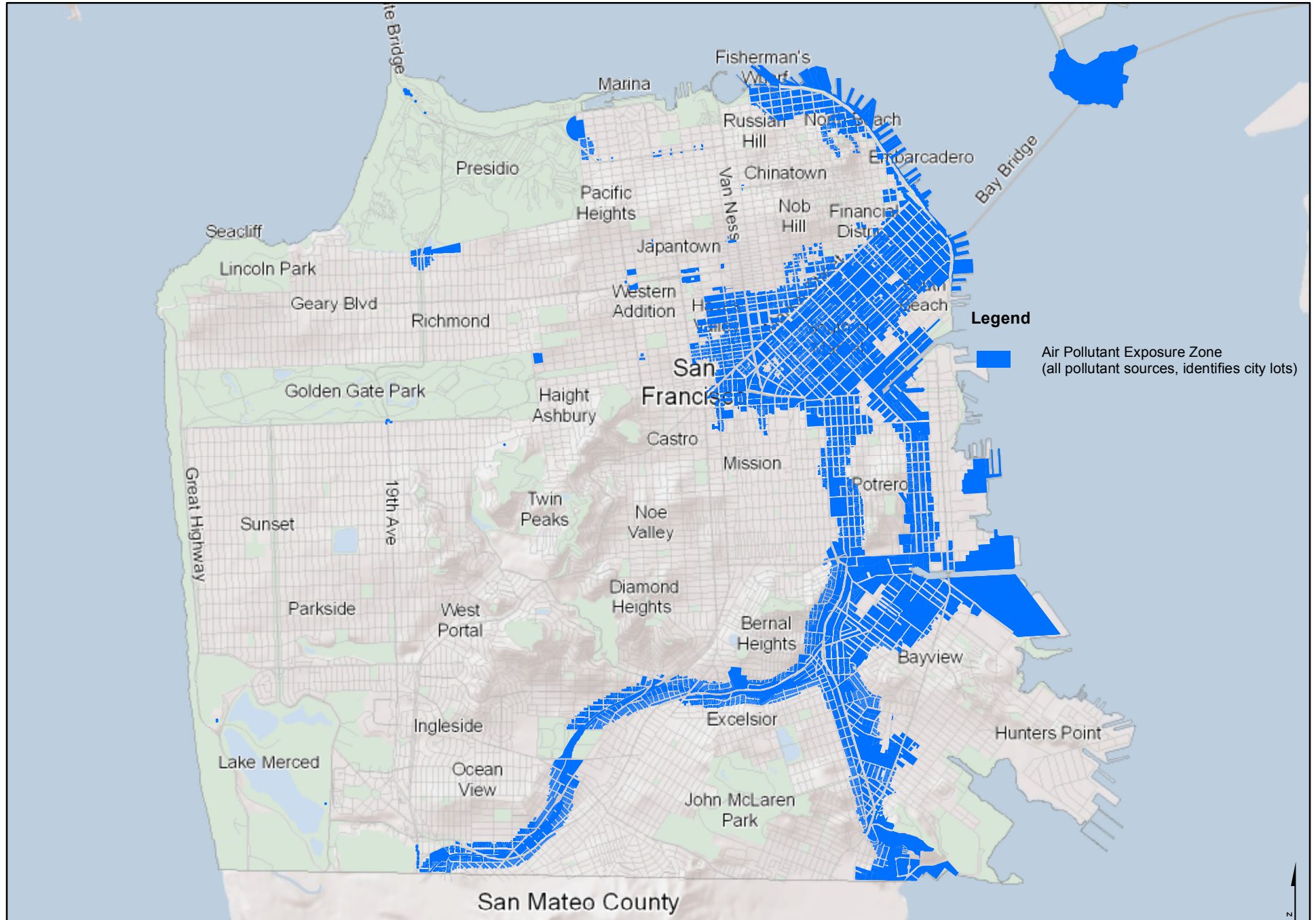
THE WAY IT WOULD BE:

- Since adoption of Article 38 of the Health Code in 2008 scientific methods for understanding the impact of known sources of air pollution (e.g., area, mobile, stationary) have improved dramatically. DPH, the Planning Department, and the Bay Area Air Quality Management District have worked together to utilize third-party-verified modeling to identify locations in the City that exceed two health-based criteria: 1) an excess cancer risk from all modeled sources; and 2) PM_{2.5} concentrations from all modeled sources (including ambient) that exceed defined health-protective limits. These locations are referred to as the Air Pollutant Exposure Zone. In addition, the City has identified parcels within 500 feet of elevated freeways as part of the Air Pollutant Exposure Zone, consistent with guidance from the California Air Resources Board.
- DPH would replace the Potential Roadway Exposure Zone map with the more comprehensive Air Pollutant Exposure Zone map. All sensitive receptor projects *within* the Air Pollutant Exposure Zone must install and properly maintain a ventilation system that will achieve the protection from PM_{2.5} equivalent to that associated with MERV 13 filtration and include a disclosure to buyers or renters that the building is located within the Air Pollutant Exposure Zone. Through CEQA, a ventilation system mitigation measure would not be required as this would be required through adopted legislation. No further analysis would be required for projects *outside* of the Air Pollutant Exposure Zone.

Draft Article 38 - Air Pollutant Exposure Zone



SAN FRANCISCO
PLANNING DEPARTMENT



Effects of Common Air Pollutants

RESPIRATORY EFFECTS



Symptoms:

- Cough
- Phlegm
- Chest tightness
- Wheezing
- Shortness of breath

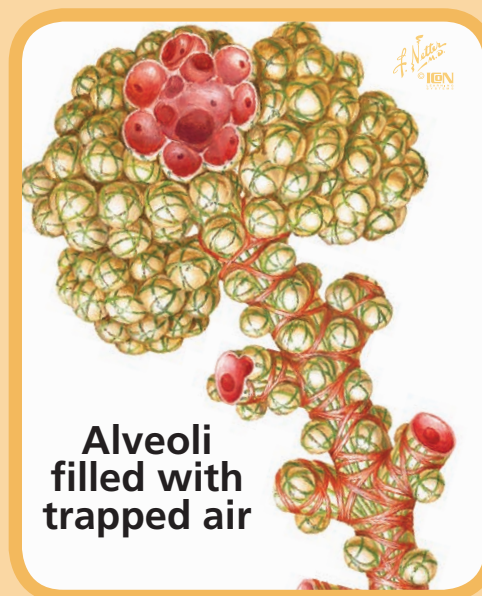
Increased sickness and premature death from:

- Asthma
- Bronchitis (acute or chronic)
- Emphysema
- Pneumonia

Development of new disease

- Chronic bronchitis
- Premature aging of the lungs

How Pollutants Cause Symptoms

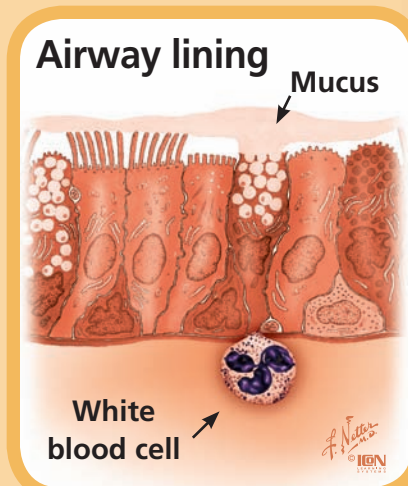


Effects on Lung Function

- Narrowing of airways (bronchoconstriction)
- Decreased air flow

Airway Inflammation

- Influx of white blood cells
- Abnormal mucus production
- Fluid accumulation and swelling (edema)
- Death and shedding of cells that line airways



Increased Susceptibility to Respiratory Infection

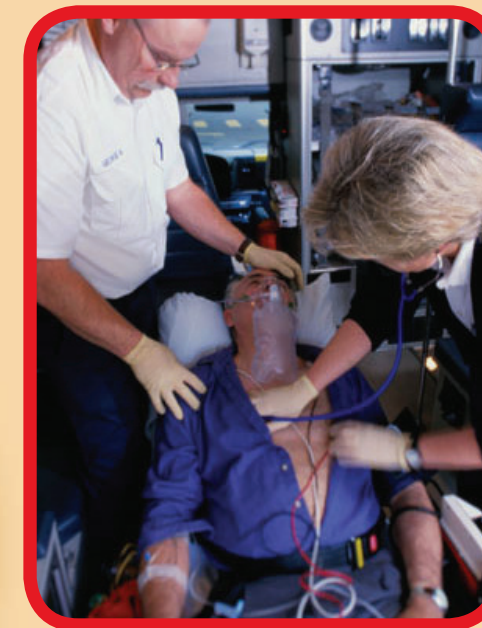


Normal



Lung with respiratory infection

CARDIOVASCULAR EFFECTS



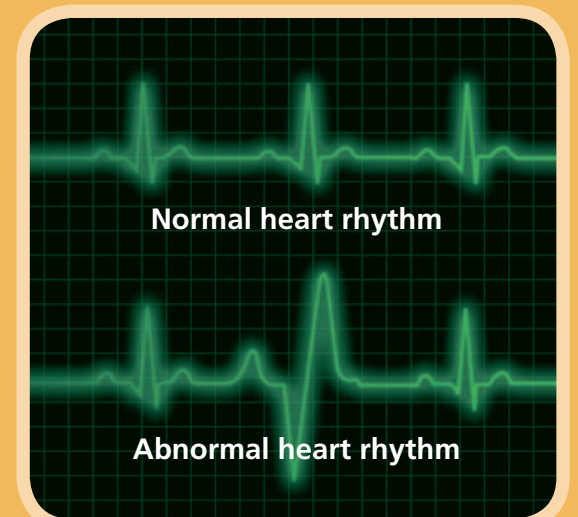
Symptoms:

- Chest tightness
- Chest pain (angina)
- Palpitations
- Shortness of breath
- Unusual fatigue

Increased sickness and premature death from:

- Coronary artery disease
- Abnormal heart rhythms
- Congestive heart failure
- Stroke

How Pollutants Cause Symptoms

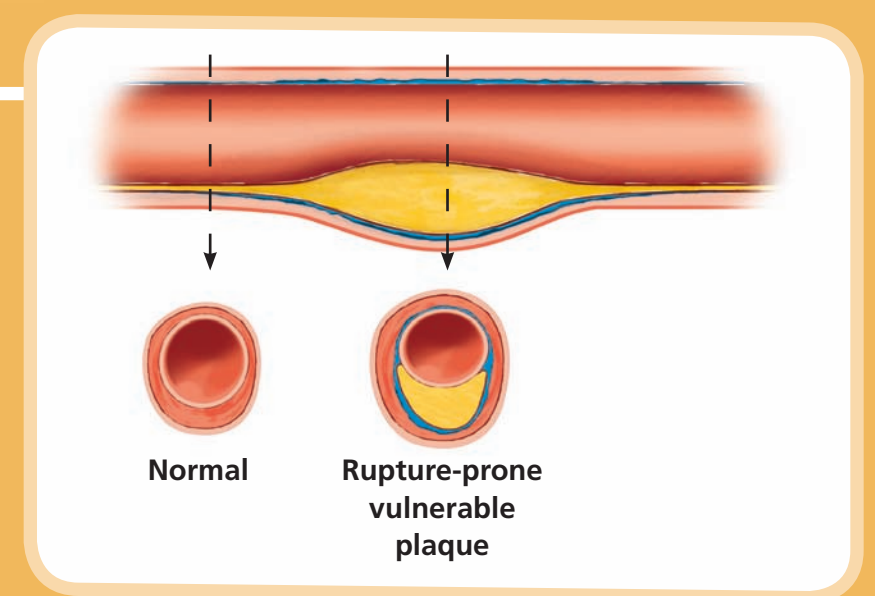


Effects on Cardiovascular Function

- Low oxygenation of red blood cells
- Abnormal heart rhythms
- Altered autonomic nervous system control of the heart

Vascular Inflammation

- Increased risk of blood clot formation
- Narrowing of vessels (vasoconstriction)
- Increased risk of atherosclerotic plaque rupture



Reduce your risk by using the Air Quality Index (AQI) to plan outdoor activities – www.airnow.gov

AQI Levels of Health Concern	AQI Values	What Action Should People Take?
Good	0-50	Enjoy Activities
Moderate	51-100	People unusually sensitive to air pollution: Plan strenuous outside activities when air quality is better
Unhealthy for Sensitive Groups	101-150	Sensitive Groups: Cut back or reschedule strenuous outside activities Ozone: People with lung disease, children and older adults and people who are active outdoors Particle Pollution: People with heart or lung disease (including diabetics), older adults and children Carbon Monoxide: People with heart disease and possibly infants and fetuses Nitrogen Dioxide: People with lung disease, children and older adults Sulfur Dioxide: Active children and adults with asthma
Unhealthy	151-200	Everyone: Cut back or reschedule strenuous outside activities Sensitive groups: Avoid strenuous outside activities
Very Unhealthy	201-300	Everyone: Significantly cut back on outside physical activities Sensitive groups: Avoid all outside physical activities