**Air Quality Guidance for Urban Development in the Pittsburgh Area**

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## 1.0 Summary

Cities such as Pittsburgh are on the verge of a significant and exciting growth in population. However, despite several decades of progress through the Clean Air Act, air pollution problems still persist in many areas. This document aims to provide a framework to help advance healthful air quality as a central consideration in Pittsburgh's sustainable development planning.

Urban planning decisions that provide guidance on how to manage air pollution sources and how to mitigate human exposures to air pollution can materially enhance the quality of health and well-being of future development in Pittsburgh. Working to limit exposures to existing pollution sources will in turn benefit all persons, but especially vulnerable populations such as: pregnant women; infants and children; the elderly; and those with chronic medical conditions. There will be short-term and longer-term health benefits to urban populations, as well as contributions to strengthening urban resilience to climate change outcomes. There will also be reductions in adverse effects on populations that experience disproportionate gradients in socioeconomic and equity conditions, which can affect the frequency and intensity of health burdens.

Two core recommendations are offered (starting on p. 7) that reflect a synthesis of readily available practices found in other U.S., Canadian and European cities grounded in well-established principles of environmental protection.

1) Sources of air pollution should be controlled at their point of origin to the greatest extent possible. This serves as a primary means to reduce emissions before they enter the ambient environment.

2) Where source control measures are insufficient, efforts should focus on reducing outdoor pollutant exposure inside buildings. These include specifications on building air intake and setback distances (particularly from major vehicle thoroughfares), for example.

Each recommendation is accompanied by specific implementation strategies and includes examples of where such strategies are being practiced. Examples are drawn from local, national and international settings comprised of voluntary standards and organizational guidance as well as ongoing policy conversations.

The list of examples is not exhaustive, but rather represents an initial inventory of options that reflects the rapidly evolving conversation around cleaner air. They represent both specific criteria as well as models for implementation.

## 2.0 Introduction

Cities throughout the world are facing the increasing realization that the public health impacts of air pollution are serious and extensive. Air pollution has been found to be a leading cause of death, both nationally and globally (GBDS, 2015). Air quality guidance over the past several decades has become progressively stricter reflecting advances in scientific understanding. Health studies now demonstrate that adverse health impacts from air pollutants occur at levels far lower than regualtory standards, even at concentrations approaching background. In effect, this means that there is no demonstratable threshold for defining a safe exposure level. Simply attaining federal air quality standards does not ensure adequate protection of populations, especially those who are vulernable to the insidious effects of air pollution exposure that can have lasting and lifelong consequences (COEC, 2005; WHO, 2003; NYCDOH, 2011; Schwartz, 2013).

The practical importance of this scientific consensus is that air pollution control strategies in advanced cities and countries are moving from the goal of attaining air quality standards towards the goal of achieving optimal risk reduction by lowering exposures to the greatest feasible extent (c.f., the European Communities Thematic Strategy on Air Pollution: EC, 2013). In 2003, for example, the World Health Organization recommended doing away with the so-called “threshold concept” and replacing it “with a more complete exposure risk function.” (WHO, 2003) Such a recommendation emphasizes the need to follow the most protective scientific public health guidance avaiable.

WHO has produced air quality guidelines for ozone, particulate matter, sulfur dioxide and nitrogen dioxide. This document focuses on ozone and particulate matter, as they are of greatest public health concern for the Pittsburgh area. WHO guidance for fine particulate matter ($PM_{2.5}$) is 10 $\mu g/m^3$ (annual average) and 25 $\mu g/m^3$ (24 hour). For ozone ($O_3$), the guidance is 100 $\mu g/m^3$, or 65 parts per billion, averaged over an 8 hour period.[1,2] Combustion sources, including both fossil fuel and biomass burning, are the predominant contributors to particulate and ozone air pollution.

## 3.0 The Pittsburgh Context

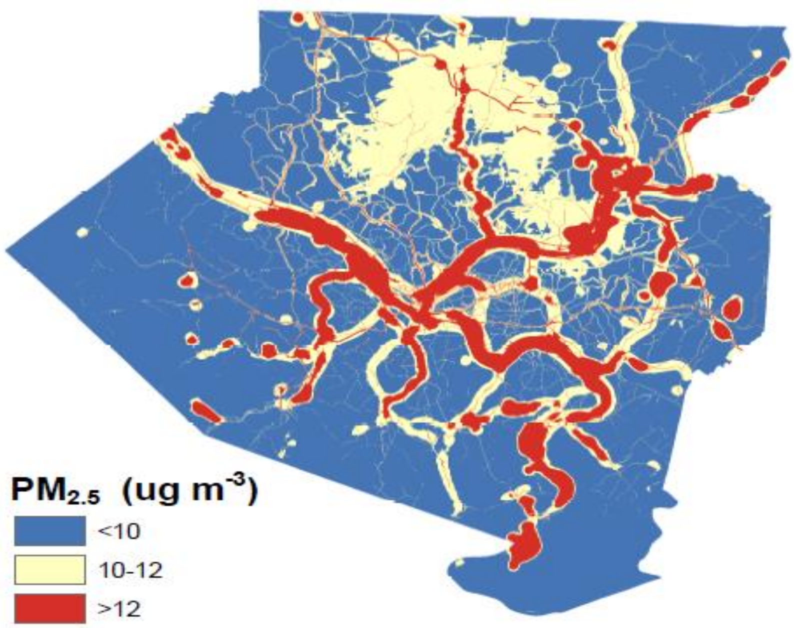
As several recent academic and independent scientific reports have shown, air polllution health risks in the Pittsburgh area are high relative to the rest of the country. Allegheny County remains a non-attainment area for ozone and fine particulate matter. Both ozone and fine particulates are associated with damage to the cardiovascular and respiratory systems. Further, fine particulate matter is increasingly associated with more systemic effects such as low birth weight, diabetes and neurodevelopmental disorders. It is also a recognized human carcinogen by the International Agency for Research on Cancer (IARC, 2015).

Monitored values for ozone immediately downwind of Pittsburgh rank within the worst 10% in the United States. Half of the ozone monitoring locations in the greater Pittsburgh area would fail the new ozone standard of 70 parts per billion (J. Graham, CATF, 2016, personal communication). Further,

[1] Note: The long-term European Union objective for air quality impllies no exceedance of these values (EC, 2013).
[2] There are yet to be standards regarding cumulative cancer risk. Most guidance, however, identifies 1 in a million as a de minimus risk and 100 in a million as an unacceptable risk

Allegheny County is one of only 20 counties in the US that is non-attainment for fine particulates.[3] Averaged over the metro areas, the Pittsburgh region is at the upper 15th percentile for fine particulate matter concentrations (J. Graham, CATF, 2016, personal communication). As much as one-half to two-thirds of the particulate air pollution in the Pittsburgh area may be generated locally, including signficant contributions from industrial sources (CATF, 2011).

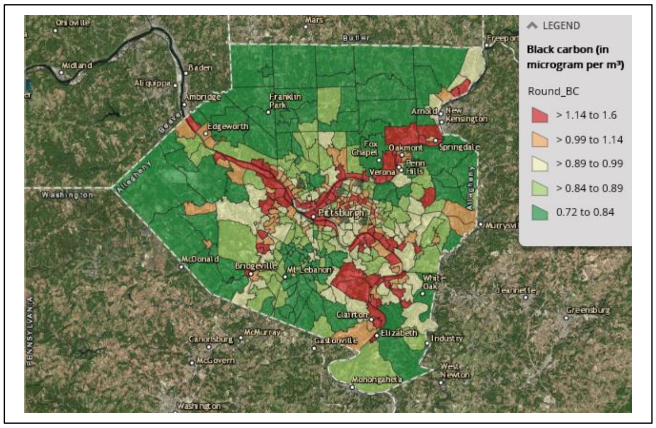
When measured against the World Health Organization $PM_{2.5}$ benchmark of 10 $\mu g/m^3$ (annual average), much of Pittsburgh can be considered unhealthful relative to this metric. A smaller, but still signifcant part of the Allegheny County currently exceeds the National Ambient Air Quality Standard of 12 $\mu g/m^3$ for PM2.5. The map below provides approximations of annual fine particulate concentrations relative to these benchmarks. These approximations are based on land use regression techniques, which recognize the need to understand the spatial variations of pollutant levels within a city (Jerret et al, 2005). While compensating for current air quality monitoring limitations within Pittsburgh, they should not be considered as precise boundaries of pollutant exposure. At the same time, it is evident that these areas of high pollution correspond to the low lying river valleys, where emissions combined with frequent inversion conditions can create periods of elevated pollutant concentrations.

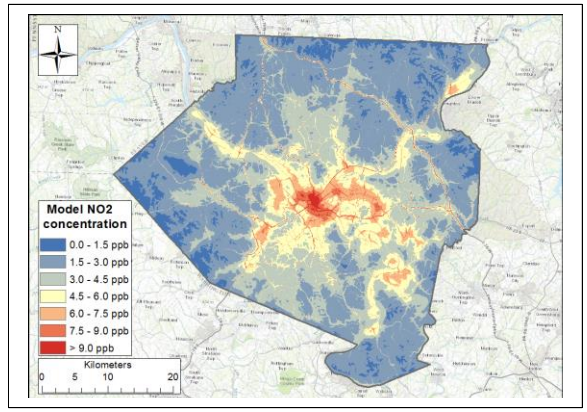



Spatial variations in annual $PM_{2.5}$ Concentrations, Allegheny County
*Source: Presto, Carnegie Mellon University, 2016, personal communication*

It is important to recognize, however, that the PM2.5 measurements reflect a combination of pollution generated locally as well as pollution. In this respect, black carbon and NO2 provides a better representation of pollution generated locally, at least from transportation sources (see below).

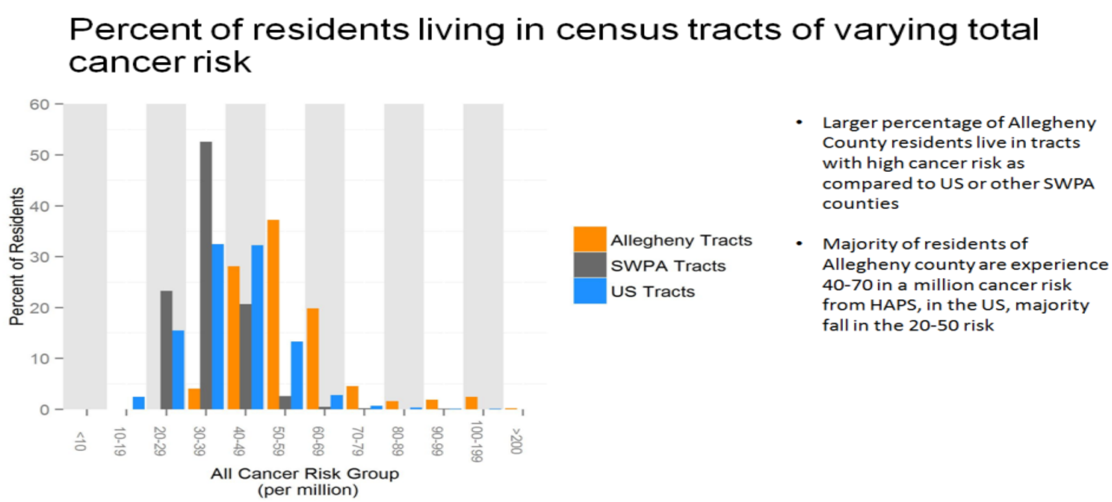
[3] https://www3.epa.gov/airquality/particlepollution/designations/2012standards/index.htm




*Source: Albert Presto, CMU*

Allegheny County also has a high cancer risk attributable to air toxics pollution. In EPA's 2011 National Air Toxics Assessment (NATA) released in December 2015,[4] Allegheny County ranked 21st out of more than 3,200 counties nationwide for cancer risk from air pollution, well within the worst 1% of the US. The contrast between Allegheny County and the rest of country is illustrated in the graph below.[5]




*Source: NATA 2011, Kheirbek, 2016*

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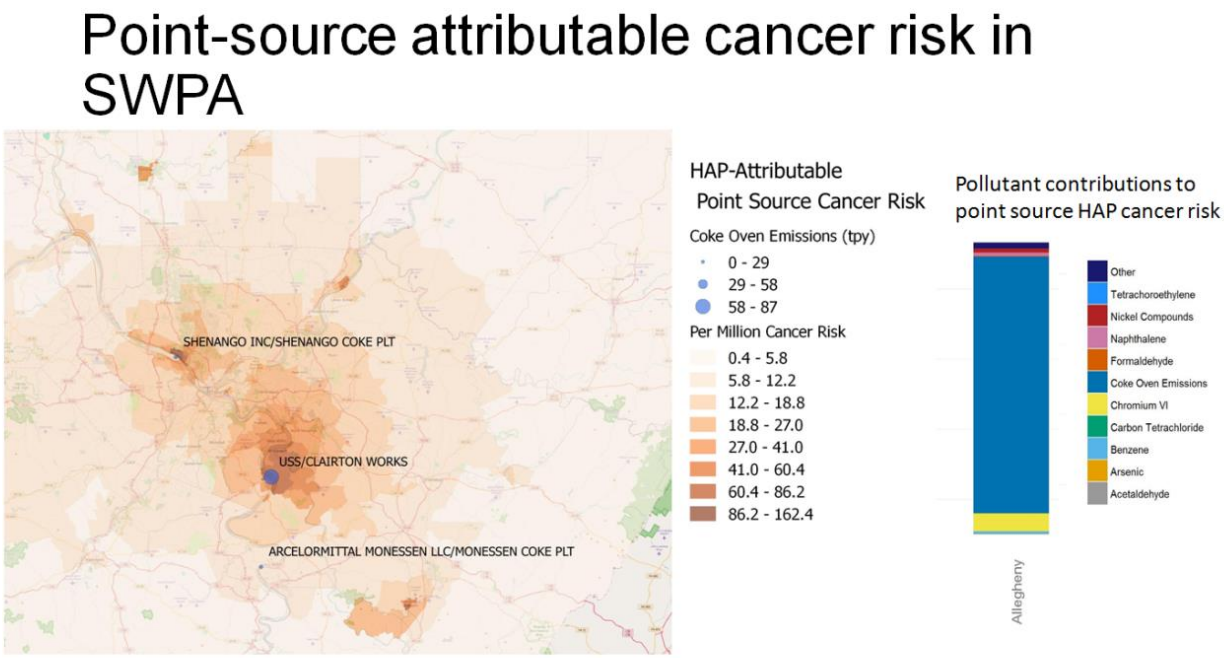
[4] http://www.epa.gov/national-air-toxics-assessment

[5] Note: These estimates are not specific to any types of cancer. A recent analysis by the University of Lowell, however, found elevated rates of certain cancer types commonly associated with environmental exposures (e.g., lung, bladder, and childhood leukemia). Source: Lowell Center for Sustainable Production, Memo to Phil Johnson, Heinz Endowments, A Review of Cancer Incidence Trends – Allegheny County and SW Pennsylvania, January 9, 2014.

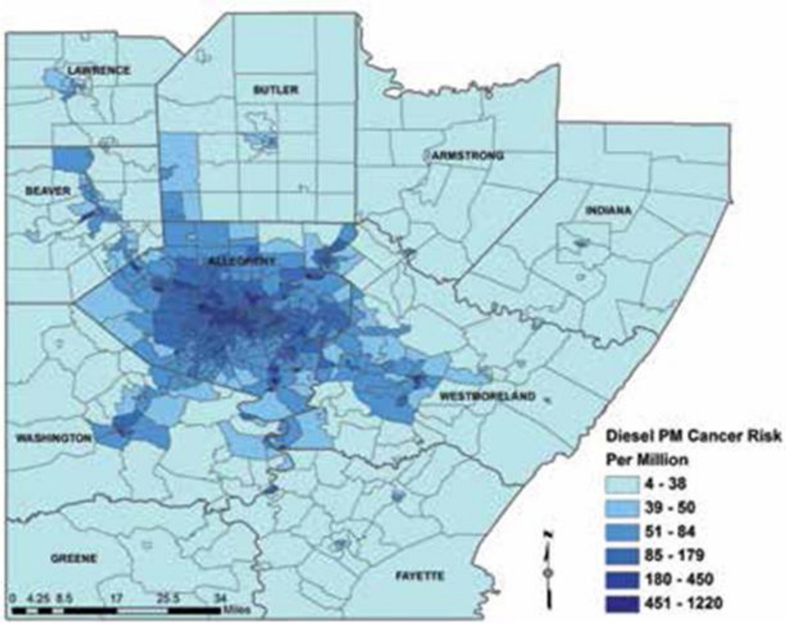
In further contrast to most other areas of the country, the high NATA risks were attributable to industrial point source pollution, predominately from coke oven emissions (see map and source contribution chart below). For this category of pollutants, the overall risk was estimated to be nearly 21 per million persons, ranking the county the third worst in the nation. Moreover, EPA determined cancer risk for more than 73,000 census tracts in the US. Forty percent of the country's tracts with industrial point source risk over 10 persons per million were located in Allegheny County.




*Source: NATA 2011, Kheirbek, 2016*

It is important to note that the NATA risks cited above do not include the cancer risks from diesel particulate matter (DPM). The cancer risk from diesel particulate matter in Allegheny County is 128 persons per million, ranking Allegheny within the top 7% of counties nationally (J. Graham, CATF, 2016, personal communication), with risks in certain areas of Pittsburgh that can be up to ten times higher (see map below).[6]

[6] Note: The Clean Air Task Force is currently re-assessing the cancer risks from diesel particulates in light of the recent requirements for cleaner burning diesel engines.




Spatial distribution of cancer risk attributed to diesel particulate matter (DPM) in the region
*Source: Michanowicz et al. 2013.*

It is also important to consider the impact of air pollution odors. While odors in and of themselves are not well correlated with health effects, they can be indicators of toxic hazard if the emission sources are known. They can also adversely impact liveablity and undermine health promotion intiatives associated with increasing outdoor activities. Although odor impacts currently elude specific regulatory guidance, the potential adverse impacts of odors on health and quality of life should be serious urban planning considerations in the Pittsburgh area, as odors are a frequent source of air quality complaints.[7]

[7] For example, see Molly Born, Stagnant air brings an odor rotten eggs to Pittsburgh suburbs, August 20, 2015, http://www.post-gazette.com/local/east/2015/08/20/Stagnant-weather-encourages-rotten-egg-smell/stories/201508200072

## 4.0 First Recommendation: Reduce emissions from their sources

Reducing emissions through the control of air pollution sources recognizes the first order need to prevent or limit air emissions before they enter the ambient environment. This priority consideration addresses the basic environmental protection principle of limiting exposure in the most efficient and effective way possible. Point sources, non-point sources (e.g., construction practices) and transportation sources should all be given priority consideration.[8]

4.1. Place public health protection at the core of urban planning decisions.

The first category of recommendations emphasizes a a risk reduction strategy and a continuous improvement objective, drawing mainly on the recommendations of the European Union.

1. Risk Reduction Strategy #1. Adhere to an environmental health planning framework analogous to the European Union's Thematic Strategy on Air Pollution, based on the recognition that it is impossible to determine a level of exposure to particulate matter and tropospheric ozone that does not constitute a danger to human beings (CEOC, 2005 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52005DC0446&from=EN ). Basic components of this framework include:

i. A two-part focus directed towards:
   a. improving community environmental legislation and
   b. 2) integrating air quality concerns into related policies (e.g., energy efficiency and greenhouse gas mitigation).

   Example: New York City, 2011 Plan NYC
   http://www.nyc.gov/html/planyc/downloads/pdf/publications/planyc_2011_planyc_full_report.pdf

ii. Benchmarks for reductions in air pollution-attributable morbidity and mortality.
   Example: example, the EU's strategy long term objectives call for a 47% reduction in loss of life expectancy as a result of exposure to particulate matter;10 % reduction in acute mortalities from exposure to ozone, relative to 2000

2. Risk Reduction Strategy #2. Develop Risk-based permitting guidance that considers sensitive receptors and cumulative air pollution impacts, as recommended by the California Environmental Protection Agency (CalEPA, 2003)

Examples:

Eugene, Oregon, Addressing Environmental Justice Through Zoning for Industry (2013)
https://www.**eugene-or**.gov/Archive.aspx?ADID=2853

National City, CA, General Plan – Health and Environmental Justice (2012)
http://www.ci.national-city.ca.us/index.aspx?page=549

San Francisco Health Code ,
http://library.amlegal.com/nxt/gateway.dll/California/health/article38enhancedventilationrequiredforu?f=templates$fn=default.htm$3.0$vid=amlegal:sanfrancisco_ca

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[8] Also, with regard to transportation sources, it is important to note that off-road as well as on-road diesel sources are of concern, as well as non-diesel mobile sources. According to the 2011 NATA (which does not have a category for diesel particulate matter), mobile sources account for 15% of the estimated cancer risk in Allegheny County, mostly due to gasoline cars. The cancer risk from cars ranks the county in the worst 4% of counties nationally.

4.2. Establish Best Available Control Technology (BACT) Construction Practices.

The second category emphasizes the application of Best Available Control Technology (BACT) to signficant air pollution sources. It is not exhaustive. It draws heavily on the LEED construction standards developed by the US Green Building Council, recognizing that other relevant standards may exist, and includes examples from Pittsburgh and elsewhere. The recommendations in this category also focus on making staionary source BACT determinations from the perpective of assuring optimal air quality, using the commercial char broiler laws in New York City as an example (see below).

1. BACT Construction Practice. Adopt LEED Clean construction emission standards and dust suppression measures to minimize the health and climate impacts to local communities associated with construction activities http://www.usgbc.org/credits/sspc75 .

Examples

i. Local Example: Chatham University has adopted

LEED construction standards (USGBC, 2013);

Local grant funding program to assist small contractors working predominately in Allegheny County with retrofitting or replacing older diesel equipment http://dieselmidatlantic.org/allegheny

ii. Other examples:

Northeast Diesel Collaborative's Model Contract Specifications for diesel emissions controls in Construction Projects (Appendix 1)

New York City Department of Environmental Protection oversees dust control and has issued rules to prevent dust emissions from construction related activities. http://www.nyc.gov/html/dep/html/air/construction_dust_debris.shtml

In Delft, Netherlands, CE Delft has recommended financial incentives, voluntary agreements, inclusion of due provisions in construction ordinances/directives and certification schemes to encourage implementation of diesel particulate filters and low-dust construction site equipment, or make it compulsory. http://www.cedelft.eu/publicatie/particulate_emissions_in_the_building_industry_and_its_supply_chain/450

2. BACT Point Source Control: Consider point source BACT determinations from the perspective of optimal risk reduction and adherence to the WHO guidelines.[9]

3. BACT Point Source Control: Establish performance measures such as air filtration requirements, catalytic treatment, or other proven effective control technologies for previously uncontrolled sources of significant air emissions, such as commercial char broilers.[10]

[9] WHO's work on environmental health provides the basis for global standards in environmental quality and an effective investments for public health such as air quality guidelines and drinking-water quality guidelines. These guidelines are especially relevant in the context of this document as they provide a common metric for comparing air quality improvement strategies throughout the world.

[10] A charbroiler (also referred to as a chargrill, char-broiler or simply broiler) is a commonly used cooking device consisting of a series of grates or ribs that can be heated using a variety of means. The heat source is almost always beneath the cooking surface. Most commonly the charbroiler is a series of long evenly spaced metal ribs over a large combustion chamber filled with an array of burners that may have a deflector, briquettes or radiant between the burner and the cooking surface.

Example: New York City (New York City, 2015)

4.3. Reduce transportation-related emissions to the lowest possible extent

The final category focuses on transportation related source control measures, drawing on European examples of fees to reduce congestion and diesel emissions, as well as a growing number of cities nationally and globally that are enacting “car free zone” policies for pollution reduction, economic development and health promotion. Example strategies are listed as follows.

1. *Develop systems based approach to transportation planning*. Optimize opportunities for mitigation of traffic congestion and pollutant emission while promoting sustainable economic development.

Examples:

i. Smart technologies: Traffic 21 (http://traffic21.heinz.cmu.edu/) and Metro 21 (http://metro21.cmu.edu) developed by Carnegie Mellon University.

ii. Health impact assessments for major transportation projects. http://www.pewtrusts.org/en/research-and-analysis/analysis/hip/hip-case-study-massachusetts

2. *Low Emission Zones*. Establish low emission zones (LEZ) to encourage the most polluting heavy diesel vehicles to become cleaner by assessing a charge to all vehicles not meeting LEZ standards whenever they enter this zone.

Example: London http://ec.europa.eu/environment/air/pdf/TNOreport_FinalMinutesPMWorkshop.pdf

3. *Congestion Management Strategies*. Enact congestion taxes to reduce vehicle traffic

Examples: London, http://ec.europa.eu/environment/air/pdf/TNOreport_FinalMinutesPMWorkshop.pdf
Stockholm http://www.transportportal.se/swopec/CTS2014-7.pdf

4. *No Idling Zones*. No idling laws in Pittsburgh for on road diesel https://idlefreepa.wordpress.com/, including the provision that building owners that receive deliveries from diesel trucks or that have at least 15 spaces for vehicles are required to have “No Idling” signage.

5. *Car Free Zones*. Establish car free streets plan to restrict traffic in commercially important center city areas

Examples

i. Pittsburgh has recently enacted an Open Streets program during 3 Sundays during the summer, when cars are not permitted on certain streets in the city -- http://openstreetspgh.org/

j. Philadelphia is considering a car free zones in its Center City area during weekends in the summer. https://nextcity.org/daily/entry/car-free-days-philadelphia-2015

ii. At least one dozen cities throughout the world have established car free zones. http://news.nationalgeographic.com/news/energy/2011/11/pictures/111115-car-free-city-zones/

6. *Non-motorized travel*. Incoporate non-motorized transportation into urban planning projects

Example: Bike Pittsburgh http://bikepgh.org/

5.0 Second Recommendation: Reduce outdoor pollutant exposures inside buildings

If source control measures are insufficient, other means of achieving exposure reduction inside buildings are warranted. As people spend approximately 90% of their time inside buildings, one key exposure reduction measure is to limit the intrusion of air pollution from outdoor spaces (Phillips, 2014). Contrary to a common perception, historically the building envelop itself does not provide adequate protection from outdoor pollutants as most older buildings leak air. A combination of building design strategies should be considered in order to reduce exposures indoors. These include: air filtration of supply air, air sealing of the building thermal enclosure, positioning of air intakes, and limiting street canyon effects.[11]

5.1. Air Filtration.. Effective filtration of outdoor air pollutants should be integrated into mechanical ventilation systems of new or signficantly modified commercial buildings, schools and multi-family units (see chart below).[12]

1. Minimum MERV 8 or MERV 10 four inch deep, long life, pleated type filters in all schools
2. MERV 13 filtration requirements for "sensitive use" buildings (schools and hospitals) where there are elevated levels of air pollutants.
3. Medium efficiency range partial bypass gas-phase air cleaners for schools should be considered in areas where health protective ozone standards and guidelines are being exceeded or where there are significant odor problems, in line with the ASHRAE recommendations
4. New buildings should be properly designed and commissioned so that the HVAC systems can adequately accommodate high performance, energy efficient MERV 13 or better filter system designs.
5. All buildings should have effective maintenance plans to ensure continued high performance of HVAC systems.

Examples:

MA CHPS, 2009;

San Francisco Health Code,
http://library.amlegal.com/nxt/gateway.dll/California/health/article38enhancedventilationrequiredforu?f=templates$fn=default.htm$3.0$vid=amlegal:sanfrancisco_ca

USGBC,, 2016, LEED v4 for Building Design and Construction
http://www.usgbc.org/resources/leed-v4-building-design-and-construction-current-version

ASHRAE, 2009, Indoor Air Quality Guide https://www.ashrae.org/resources--publications/bookstore/indoor-air-quality-guide

[11] Physical barriers, sound walls and vegetation barriers (mostly trees and hedges), were considered, and may be helpful under certain situations. There was not enough evidence of their effectiveness, however, to warrant a specific recommendation (cf, CARB, 2012, Phillips, 2014).

[12] Air filters are currently catagorized by a MERV rating. The higher the number the better the air filter. MERV 20 being hospital operating rooms. (See ASHRAE table at end) also note: higher rated fiters require more electrical energy to move air through them, unless more surface area is designed for the filtration, or a filter with high performance is selected, which has low pressure drop.

5.2. Outdoor air intake positioning. Position air intakes to avoid local sources of air pollution (Brauer et al, 2012 (Appendix 2), Phillips, 2014. http://rocis.org/sites/default/files/user-files/ROCIS_CommercialFINAL1120.pdf ).

1. Building outdoor air intakes should not be located near loading docks, where delivery vehicles may be idling, or on the side of a building facing a busy traffic corridor
2. Place air intakes as high above the ground as possible while considering street canyon effects
   Example: New York City (Phillips, 2014).

3. To prevent legionellosis (Legionnaire's Disease), building air intakes should be located far enough away from cooling towers so that cooling tower drift or splash out is not fed into the building air supply system (Phillips, 2014)

5.3. Building Air Sealing. Building air sealing should provide effective air barriers that limit pollutant exposure in the following locations:

1) the building to outside;
2) the building and crawl space to the soil;
3) the building to an attached garage and other attached spaces;
4) between firewall isolation areas, pollutants generated within multi-use buildings. (Phillips, 2014; PlanNYC, 2011).
http://www.nyc.gov/html/planyc/downloads/pdf/publications/planyc_2011_planyc_full_report.pdf

5.4. Building Setback Planning. The following setback recommendations should be followed (Brauer et al, 2012 (Appendix 2); CARB, 2012, http://www.arb.ca.gov/research/health/traff-eff/research%20status%20-reducing%20exposure%20to%20traffic%20pollution.pdf )

1) 500 feet from busy roads (>15,000 vehicles/day, annual average), especially for buildings such as day care facilities, schools, hospitals, long-term care facilities, and residences
2) 1000 feet from busy distribution centers and rail yards
3) Avoid building development within 2,250 feet of truck routes or truck distribution centers
4) Avoid locating buildings that house susceptible populations near major intersections.

5.5. Plan for Minimizing Street Canyon Effects. Minimiize street canyon effects around tall buildings (Brauer et al., 2012 (Appendix 2))

1) Buildings that are perpendicular to the predominant wind direction should be staggered.
2) High rise buildings should be developed on only one side of the street when perpendicular to the predominant wind direction.

5.6 Healthy Homes Principles. . Design and operate buildings that adhere to the Seven Principles of Healthy Homes: Dry, Clean, Pest Free, Safe, Contaminant-Free, Ventilated, Maintained (National Center for Healthy Housing, http://www.nchh.org/WhatWeDo/HealthyHomesPrinciples.aspx)

Examples:

EPA, Indoor airPlus Construction Standards, https://www.epa.gov/sites/production/files/2015-10/documents/construction_specification_rev_3_508.pdf

California Range Hood Standards: http://www.energy.ca.gov/2015publications/CEC-400-2015-037/CEC-400-2015-037-CMF.pdf; http://www.energy.ca.gov/2015publications/CEC-400-2015-032/chapters/chapter_4-Building_HVAC_Requirements.pdf; https://resaveguide.lbl.gov/step-2-kitchen-and-bath-ventilation

**ASHRAE Minimum Efficiency Reporting Values (MERV) ratings and approximate effectiveness for various particle sizes**

| MERV Rating | Average Particle Size Efficiency (PSE) (Microns and % Removal) | | | Typical Controlled Contaminant or Material Sources | Typical Building Applications |
|---|---|---|---|---|---|
| | 0.3-1.0 | 1.0-3.0 | 3.0-10.0 | | |
| 1-4 | | | <20% | **>10 Microns** Textile Fibers, Dust Mites, Dust, Pollen | Window AC Units Common Residential Minimal Filtration |
| 5 | | | 20-35 | **3.0 to 10.0 Microns** Cement Dust, Mold Spores, Dusting Aids | Industrial Workplace Better Residential Commercial |
| 8 | | | >70 | | |
| 9 | | <50 | >85 | **1.0 to 3.0 Microns** Legionella, Some Auto Emissions, Humidifier Dust | Hospital Laboratories Better Commercial Superior Residential |
| 12 | | >80 | >90 | | |
| 13 | <75 | >90 | >90 | **0.3 to 1.0 Microns** Bacteria, Droplet Nuclei (sneeze), Most Tobacco Smoke, Insecticide Dust | Superior Commercial Smoking Lounge Hospital Care General Surgery |
| 16 | >95 | >95 | >90 | | |
| 17** | ≥99.97 | | | **<0.3 Microns (HEPA/ULPA filters)** Viruses, Carbon Dust, Fine Combustion Smoke | Clean Rooms Carcinogenic & Radioactive Matls. Orthopedic Surgery |
| 18** | ≥99.99 | | | | |
| 19, 20** | ≥99.999 | | | | |

Source: Phillips, 2014

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