

Why Air Quality Matters to Everyone

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CEET

CENTER OF EXCELLENCE IN ENVIRONMENTAL TOXICOLOGY

Ambient Air Pollution

EPA Criteria Air Pollution

O₃ (ozone)

PM (particulate matter)

SO₂ (sulphur dioxide)

NO_x (nitrogen oxides)

CO (carbon monoxide)

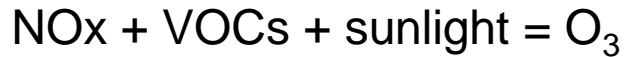
Lead

Dose-Response Relationship

◆ **“The dose makes the poison”**

Photochemical Smog (Summer Smog)

Ozone- in stratosphere occurs naturally, protects us from UV radiation



Nitrogen oxides (NO_x): fuel combustion (motor vehicles, coal power plants)

Volatile Organic Compounds (VOCs): Paints, Pesticides, Gasoline vapors and naturally occurring



Ozone Health Effects

- ◆ **Respiratory symptoms- wheezing, coughing, chest discomfort, bronchoconstriction, decreased lung function**
- ◆ **Mucous membrane irritation- throat, sinus, eye**
- ◆ **Long-term exposure may cause asthma**
- ◆ **Children particularly vulnerable- high respiratory rate**

Geography: Its Effect on Air Pollution

- ◆ **Urban areas surrounded by mountains or in a bowl type geographical depression are most at risk**
- ◆ **Examples: London, Los Angeles, Mexico City, Bogata, Santiago**

Winter Smog: Inversion

Cold air at
high altitude



Warm polluted
air trapped



Cold air at
ground level



Acute Air Pollution Episodes and Attributed Mortality

- ◆ Meuse Valley of Belgium 1930- **60 deaths** during thermal inversion
- ◆ Denora, PA 1948- **20 deaths** during thermal inversion (steel mills, coke ovens, zinc production, sulfuric acid manufacturing)
- ◆ Great Smog of London 1952- **4000 deaths** in 2 weeks



Sulfur Dioxide (SO₂)

- ◆ Created in combustion of fuels containing sulfur (coal, oil)
- ◆ Created when gasoline is extracted from oil; and metals extracted from ore
- ◆ SO₂ reacts in air to form sulfuric acid
- ◆ SO₂ combines with particulates (PM) to forms acidic complexes

Sulfur Dioxide (SO₂) Health Effects

- ◆ Reduced lung function, bronchoconstriction
- ◆ Asthma exacerbation: high levels/ brief periods
- ◆ Cardiovascular- myocardial infarction
- ◆ Exacerbation of respiratory disease
- ◆ Eye, nasal, sinus irritation
- ◆ Adverse pregnancy outcomes
- ◆ Mortality

Nitrogen Oxides (NO_x)

- ◆ Created by fuel combustion in motor vehicles (especially), coal power plants etc
- ◆ Generates ozone with VOCs and sunlight
- ◆ In atmosphere forms reactive nitrogen compounds, nitric acid, nitrates, and acid aerosols

Nitrogen Oxides (NO_x) Health Effects

- ◆ Irritation eyes, nose and throat
- ◆ Short term decreases in lung function
- ◆ Bronchoconstriction
- ◆ Possible increase in respiratory infections in children

Health Effects of Ozone, SO₂ and NO_X are Similar and Additive

Particulate Matter (PM)

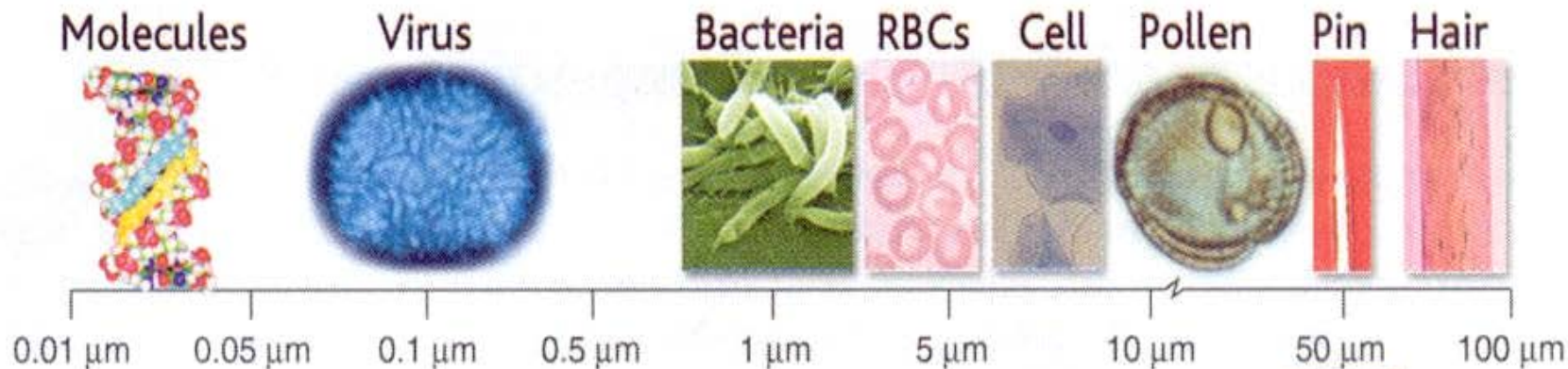
Mixture of solid particles & liquid droplets

PM 10: airborne particles ≤ 10 μm

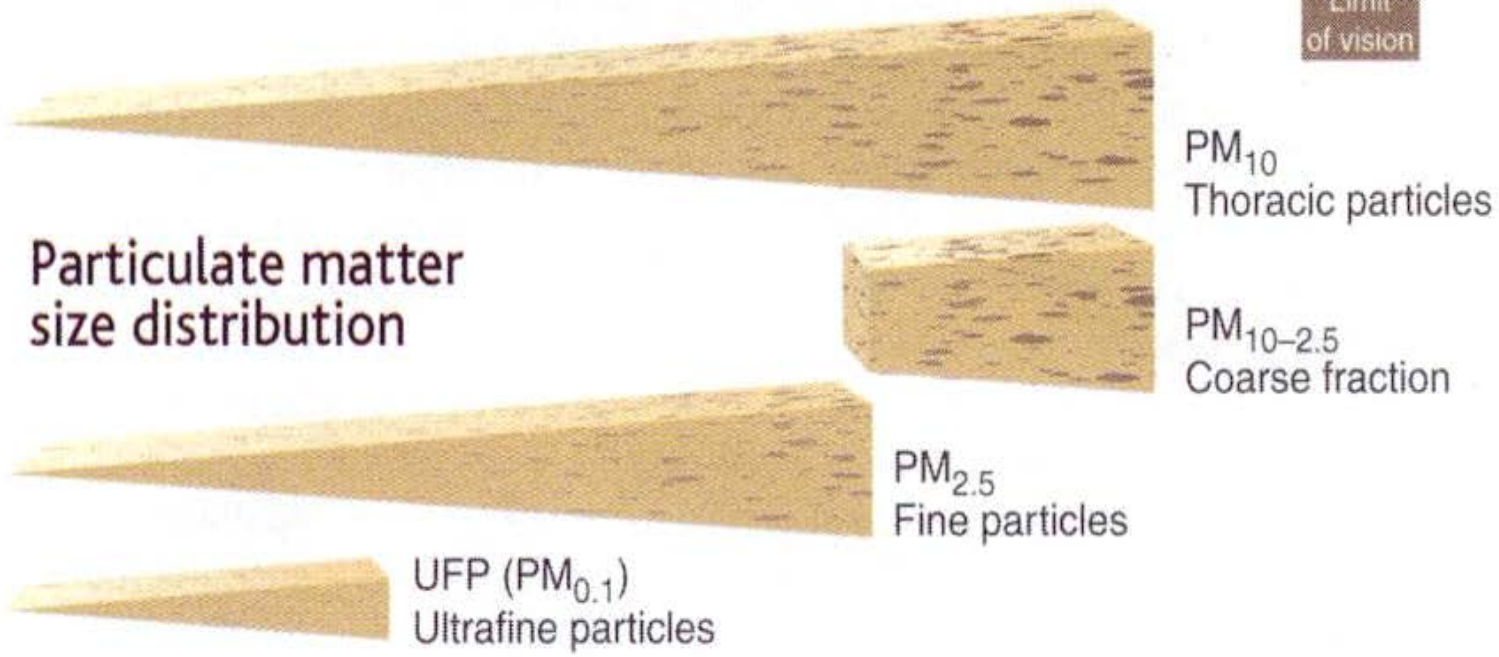
PM 2.5: fine airborne particles that are ≤ 2.5 μm

Ultrafine particles are ≤ 0.1 μm

Main sources: gasoline/diesel engines, power plants, incinerators, wood burning, natural -pollens, fires etc.



Limit of vision



Absorption from Inhalation

Particles	Deposition site
Size	
Large	Upper Tract
Small	Lower Tract

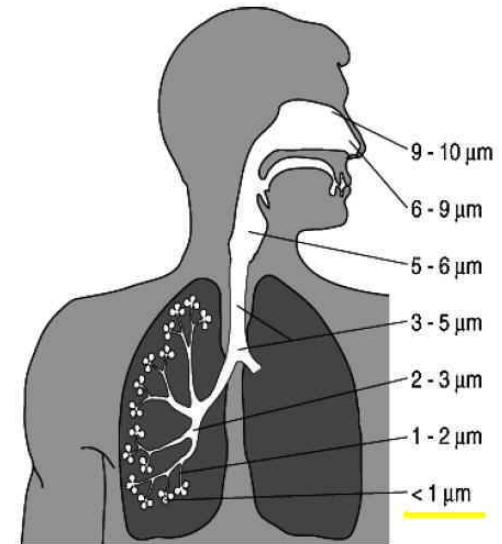
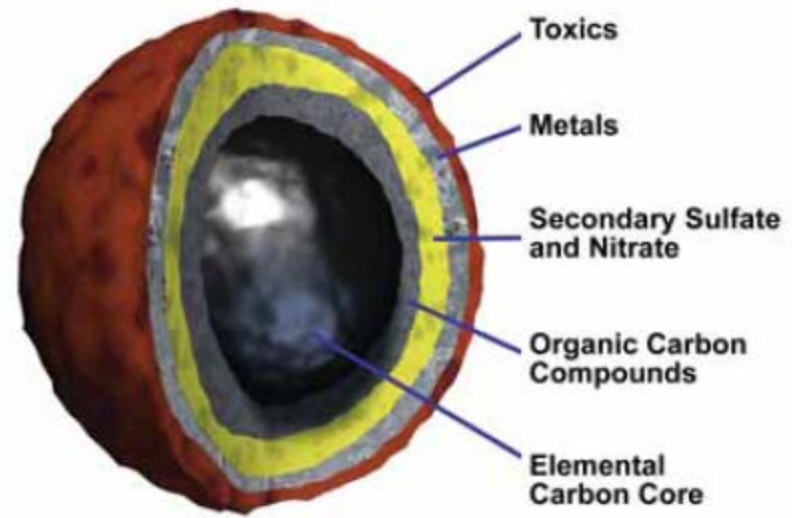


Figure 2 Particle deposition in respiratory system

Composition of Diesel Exhaust



◆ Particulate phase

- Mostly elemental carbon (soot)
 - 20% to 40% adsorbed organic compounds
- Sulfates, nitrates, metals, other trace elements
- The most toxicologically relevant adsorbed **compounds (less than 1% of PM by mass):**
 - PAHs
 - Nitro-PAHs
 - Oxidized PAH
- 92% of mass is in particles smaller than 1 micron

Health Effects of Fine and Ultrafine Particles

- ◆ **Increased mortality from cardiac/ respiratory problems in populations exposed to fine particulates such as in diesel exhaust (Bruske-Holfeld et al, 2005)**
- ◆ **Changes in cardiovascular physiology (arterial diameter and cardiac rhythm)**
- ◆ **Coal miners accumulate ultrafine dust in the liver and the spleen. Accumulation higher in miners exhibiting pulmonary problems
(Donaldson, 2005)**

Epidemiologic Studies

- **Harvard Six Cities (Dockery et al 1993)**
 - PM_{2.5} associated with mortality (1.26 (95%CI: 1.08-1.47))
 - Elevated risks for lung cancer and cardiopulmonary disease
 - Lower risks for other air pollutants, sulfates similar
- **ACS (Pope et al 2002, 2004)**
 - Each 10- $\mu\text{g}/\text{m}^3$ elevation in PM_{2.5} associated with
 - 4% increased risk of all-cause mortality
 - 6% increased risk of cardiopulmonary mortality
 - 8% increased risk of lung cancer mortality

Asthma in Children

- ◆ **Between 1980 and 1995 the prevalence of asthmatic children in the USA increased from 2.3 million to 5.5 million**
- ◆ **Sharpest prevalence increases – urban minority children under 5 years of age**
- ◆ **Atopy (familial allergy to common allergens) with IgE antibody production is the most reliable predictor of asthma development**
- ◆ **Air pollutants potentiate the tendency toward allergy**

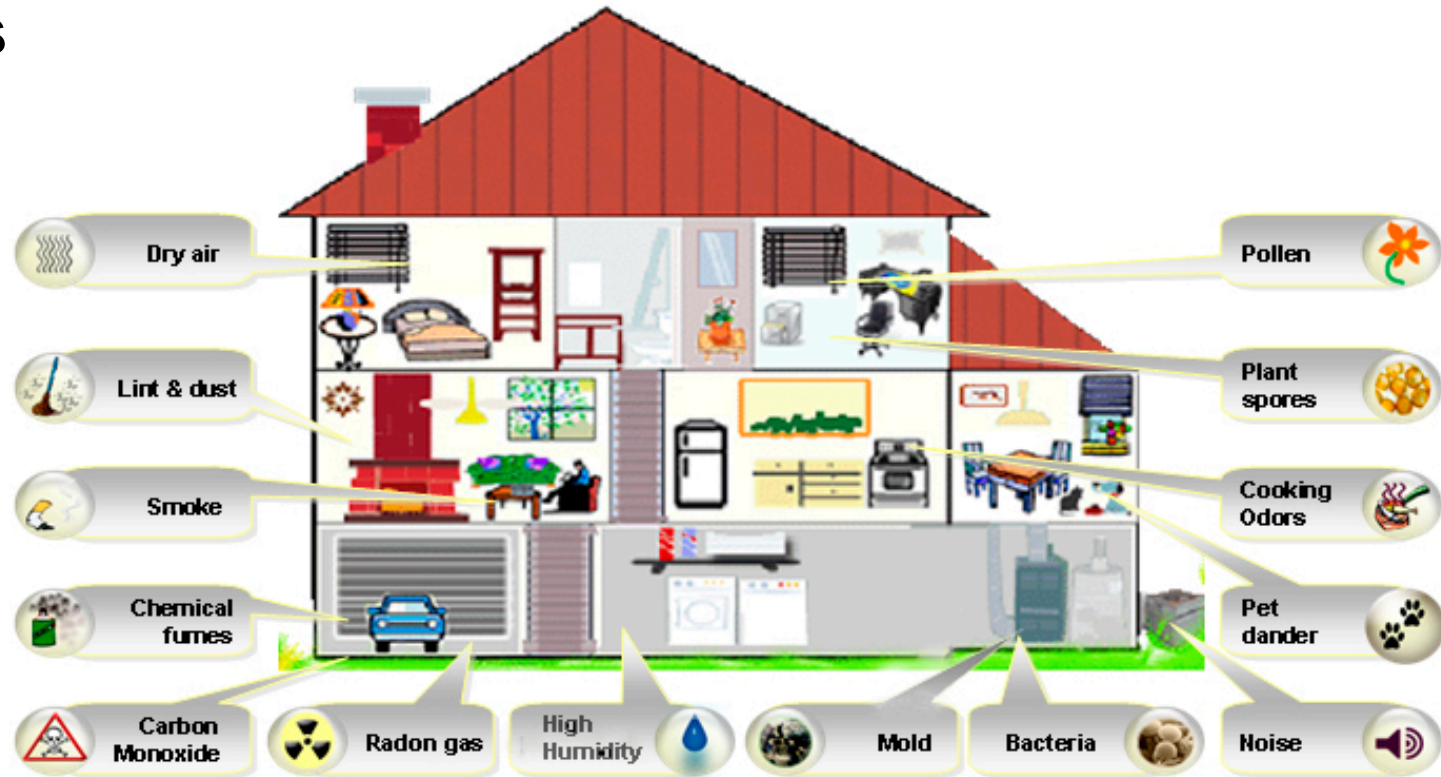
National Ambient Air Quality Standards (NAAQS)

- ◆ **December 14, 2012 EPA revised PM 2.5 standard from 15ug/m³ to 12 ug/m³**

- ◆ **Expected to save thousands of ER visits for exacerbation of cardiac and pulmonary conditions**

Indoor Air Contaminants

- ◆ Biologic Agents
- ◆ Combustion Products
- ◆ Particulates
- ◆ Pesticides
- ◆ Radon
- ◆ VOCs



Health Effects Attributed to Poor IAQ

- ◆ Irritation of mucous membranes
- ◆ Headache
- ◆ Lethargy
- ◆ Sinus congestion
- ◆ Allergy
- ◆ Asthma

Mold and the Illness it Can Cause

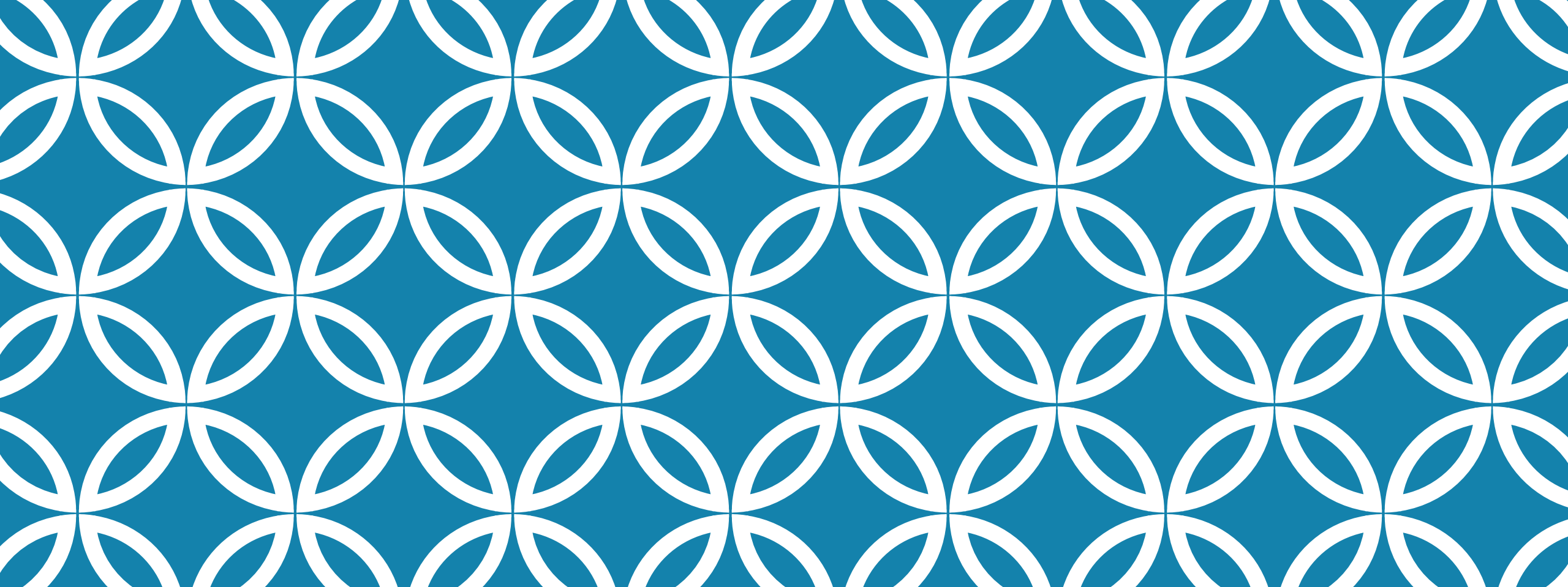
- ◆ **Anyone can become sensitized (allergic to mold proteins) if the exposure is great or long lasting**
- ◆ **Atopic individuals are more likely to become sensitized to mold**
- ◆ **Hypersensitivity pneumonitis occurs with large inhalation exposure only**
- ◆ **Exacerbation of allergy leading to asthma can occur with ongoing exposure**

Mold grows in large amounts only when there is water intrusion and humidity remains >50%



Summary: Why Air Quality Matters

- ◆ **Significant health effects of poor outdoor and indoor air quality**
- ◆ **Vulnerable populations are particularly at risk: children, elderly, those with underlying heart and lung conditions**
- ◆ **Improving air quality saves lives and improves health**



REGIONAL AIR QUALITY, IS THAT WHAT WE REALLY WANT TO KNOW?

A tale of South Philadelphia

Carol Ann Gross-Davis, PhD, MS

EPA Region 3

May 16, 2014

WHAT ARE THE QUESTIONS WE ARE TRYING TO ANSWER AND WHAT DATA DO WE HAVE?

- The National Ambient Air Quality Standards (NAAQS) are a regulatory tool used by federal and state agencies alike AKA the Clean Air Act
- This approach attempts to measure “REGIONAL” air quality, which is basically the overall or background pollution level in a geographic area over time
- Not designed to estimate individual or “community” exposures to chemicals measured in ambient air for select pollutant

SHOULD WE THINK ABOUT SCALE.. AND HOW

- Temporality and duration are key factors, as well as attempting to address the error around each estimate
- Peak pollution levels can be the most biologically relevant if the health effect is triggered by short-term exposures compared to steady (average) state
- Peak concentration of associated with episodic, local emission events resulting in heterogeneous concentrations (Brown et al., 2014)

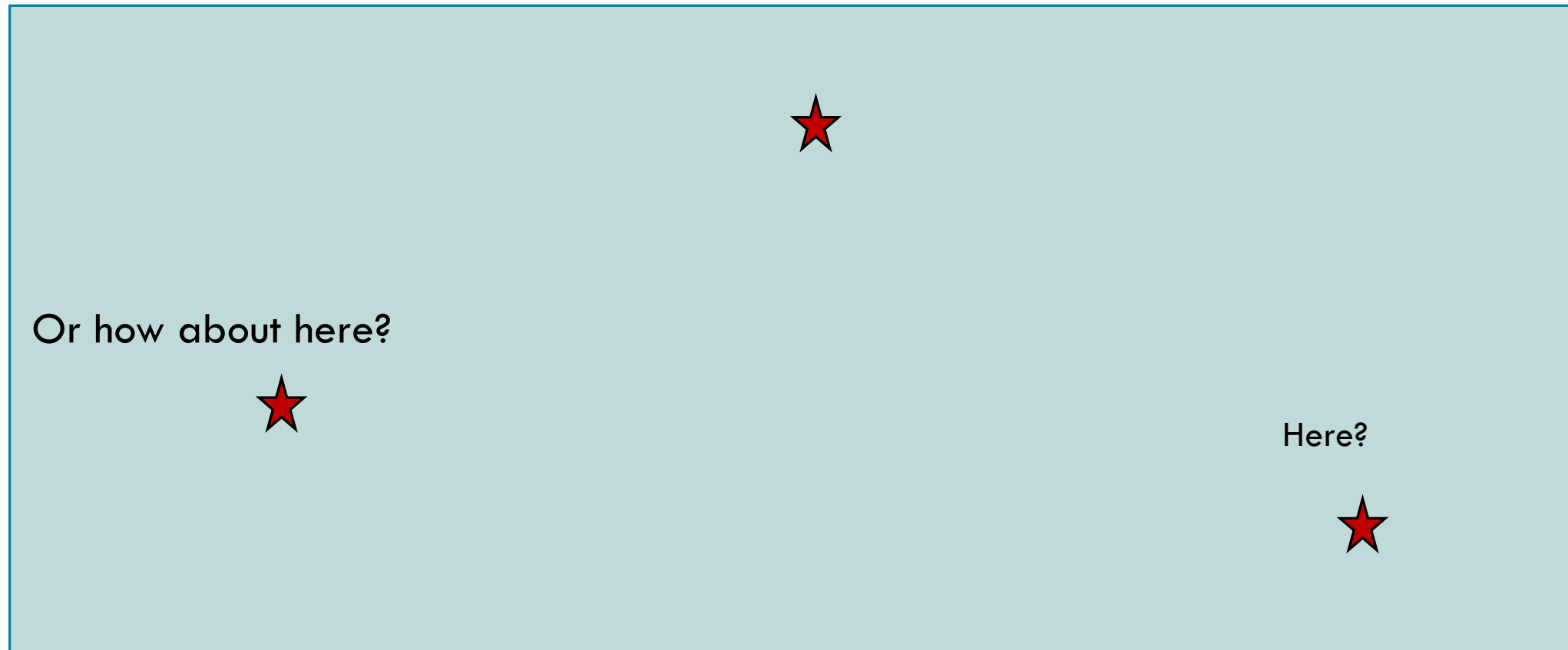
SO WHAT'S THE BIG DEAL

- Data is lost when we are only working with averages, means, or categories of exposure levels etc...
- These peaks, are of the most interest to the community living close to sources with potential for spikes

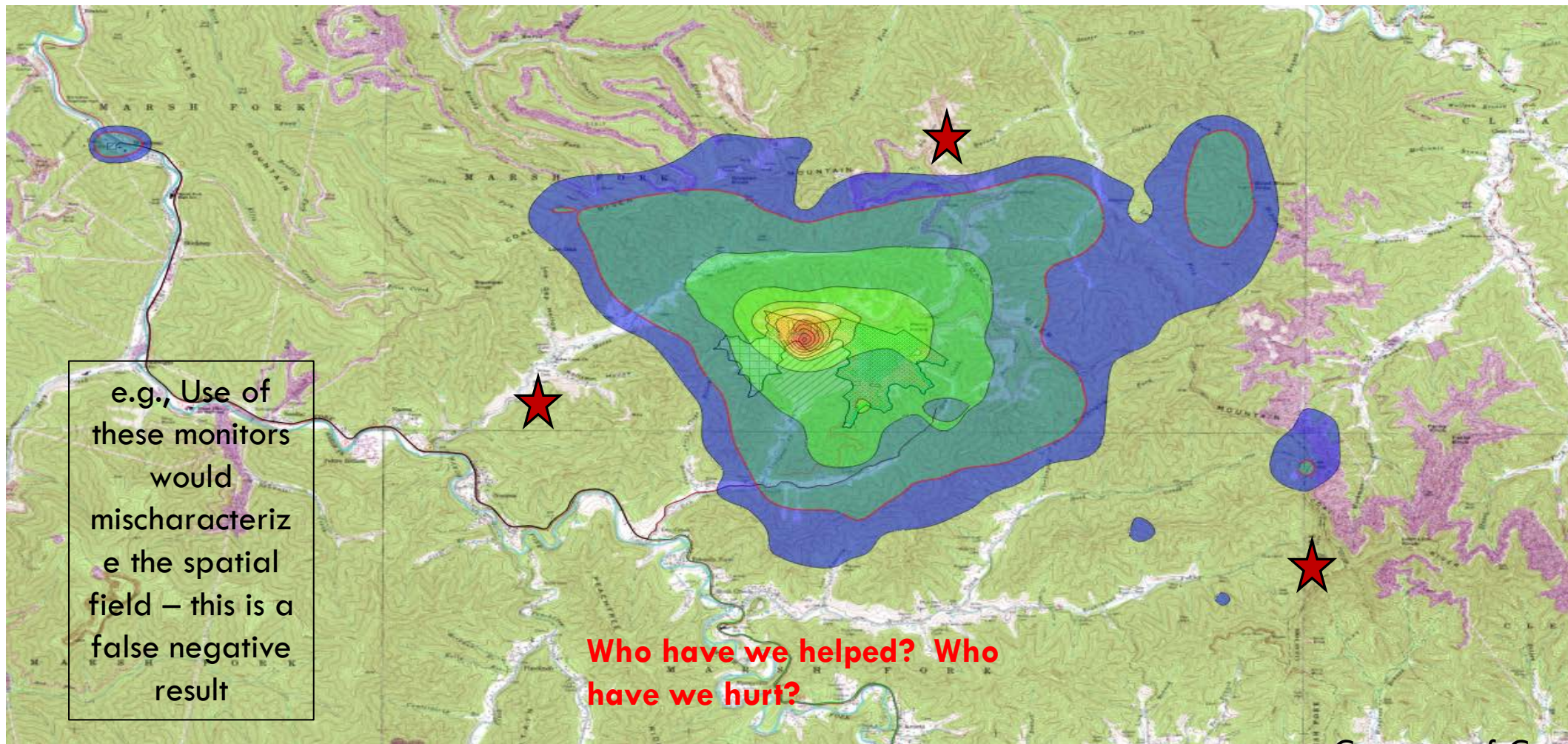
END RESULT: These regulatory tools require averaging of samples

BUT aren't we comfortable we averages, omitting outliers, smoothing the curves.....

WHAT IF YOU WANTED TO KNOW WHAT THE CONCENTRATION IS IN THIS AREA... WHERE WOULD YOU PUT YOUR MONITOR?



CONSIDER A SCENARIO WHERE YOU MONITOR BUT DON'T FIND ANYTHING BUT THE POLLUTANT SPATIAL FIELD REALLY LOOKS LIKE THIS....





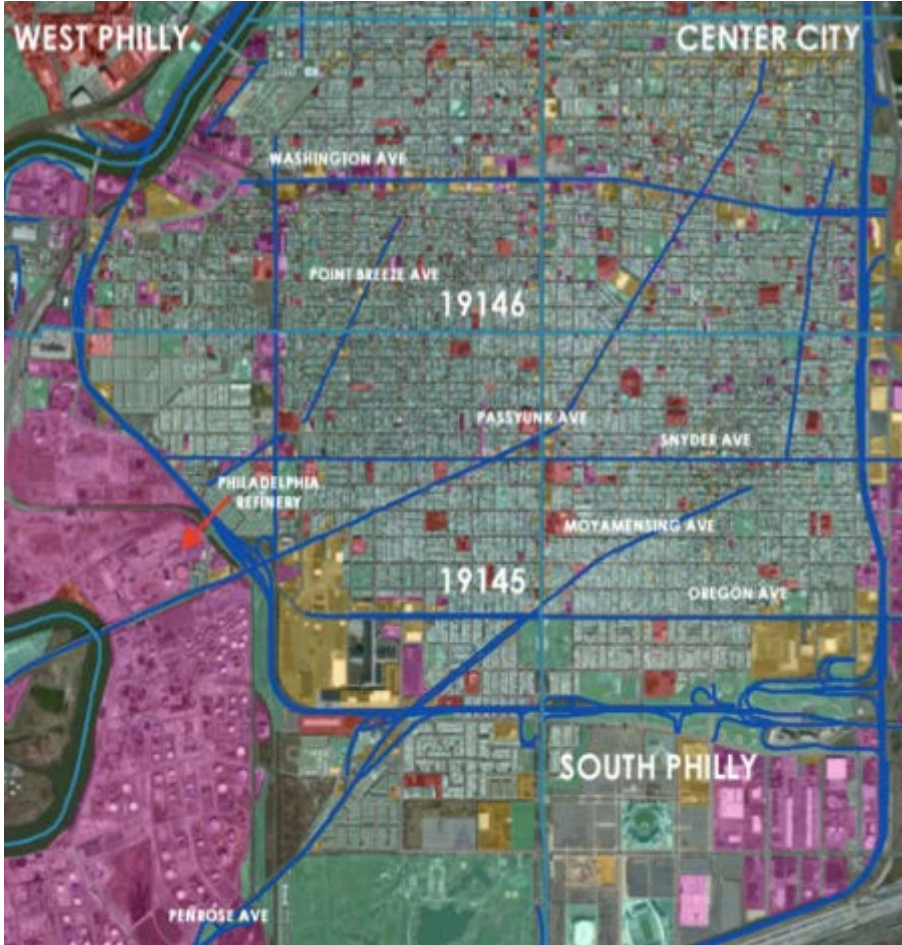
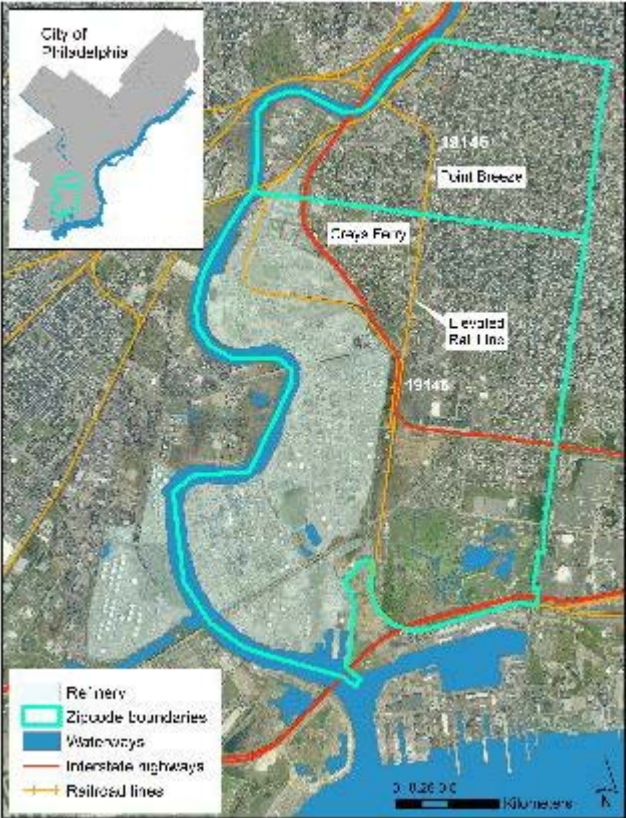
SOUTH PHILADELPHIA WEST, EXAMPLE

South Philadelphia

- Focus on the Philadelphia Energy Solutions (PES) facility, formerly Sunoco refinery and the surrounding Communities
 - Largest source of air pollution in the greater Philadelphia area
 - Communities directly next to the facility (Point Breeze, Greys Ferry)
 - High health risks from NATA
 - Lower income and education
 - Emissions expected to increase



Overview Maps Showing Philadelphia Refinery and the Greys Ferry & Point Breeze Neighborhoods



GREYS FERRY & POINT BREEZE NEIGHBORHOODS

- Point Breeze and Grey's Ferry lie next to an oil refinery along with other industrial sites.
- Residents have been experiencing disproportionate exposure to environmental health hazards for decades.
- Communities in the South Philadelphia West neighborhood have long been concerned about the possible impacts specifically the oil refinery also located in this area.
- 45,000 residents live within 1.6 km from the refinery, 59% were black, 29% white, 8% Asian and 4% Latino. Thirty-two % live below the federal poverty level

AMS Monitor Locations

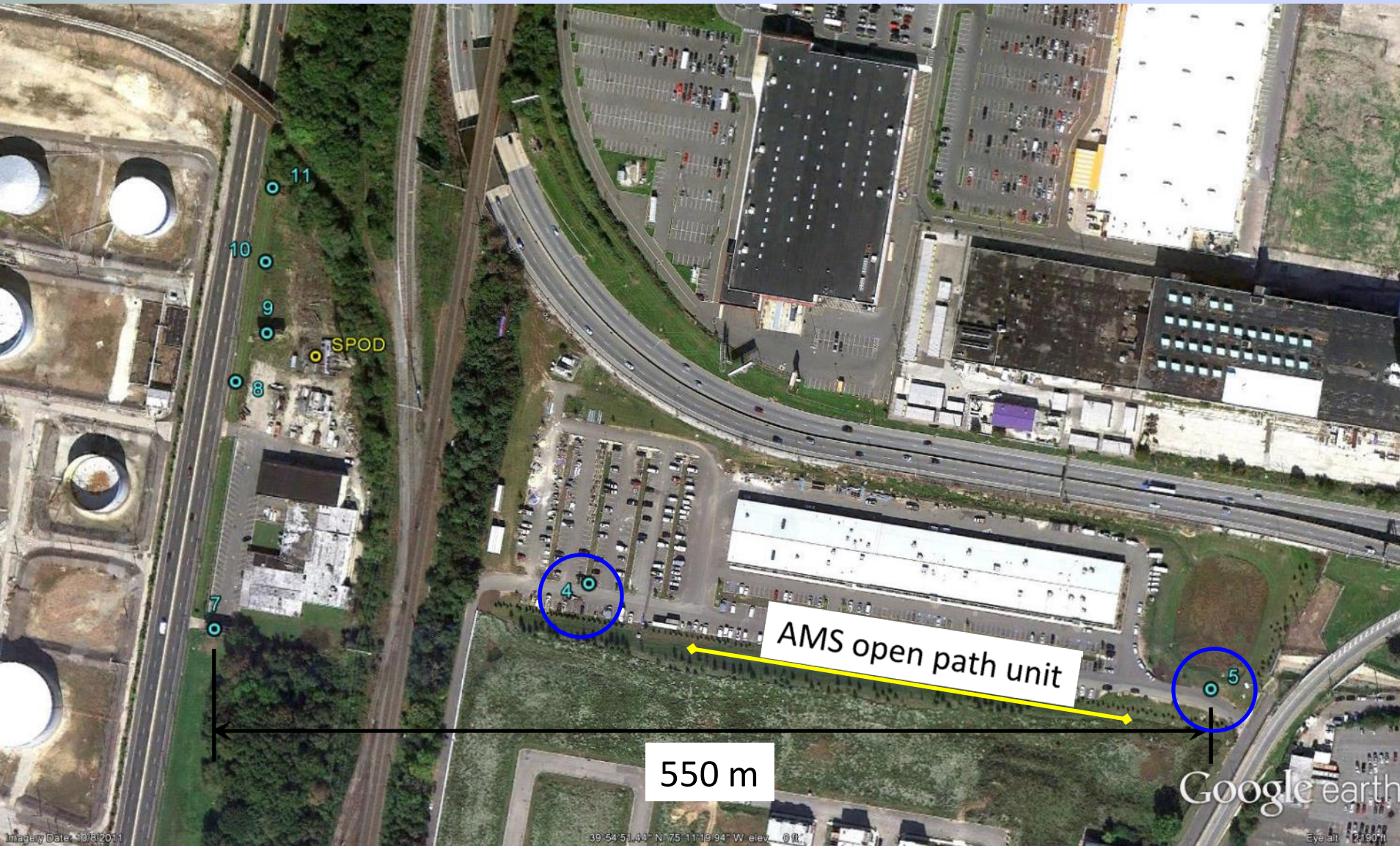


WHO IS ON THE TEAM?

Over the last 2 years, Region 3 has collaborated with

- EPA/Office of Research and Development (ORD)
- EPA/Office of Environmental Information (OEI)
 - toxics Release Inventory (TRI)
- City of Philadelphia
 - Department of Health, Air Management Services (AMS)
 - Parks and recreation Services
 - Philadelphia housing Authority
- University of Pennsylvania and Drexel University

R3, ORD, OAR, City of Phil. AMS and Housing Authority cooperation

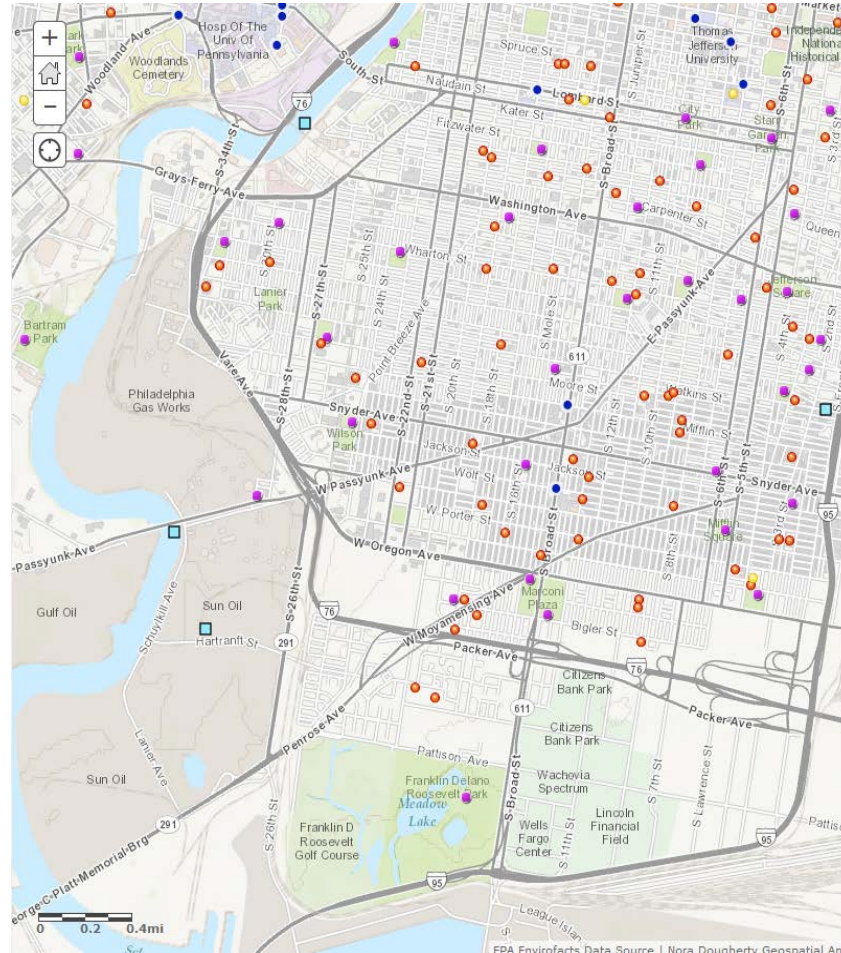


AMS deployed low-cost UV open-path system (OAQPS community scale grant)

**South Philadelphia West, zip codes 19145,
19146, 19147 and 19148**

MAP LEGEND

- Light Blue Squares = 2012 TRI Facilities
- Yellow Circles = Nursing Homes
- Orange Circles = Schools
- Purple Circles = Playgrounds
- Blue Circles = Hospitals



**Web based, non-static map allows users to turn on
and off any layer of interest, and drill down with clicks
to get more information about a particular point of
interest.**

CHALLENGES TO BE ADDRESSED

We need to acknowledge these limitations of the regulatory sampling methodologies

Monitoring sites are widespread and local impacts are not typically captured “yet”

Yet, there is a real potential for significant public health threats

Local air quality impacts have many challenge and they have not been adequately addressed by EPA

Sensor, mobile monitoring devices and small scale modeling are being developed or already exist

We must do a better job at describing ambient air exposures and human health risk for communities close to sources?

THANK YOU

QUESTIONS?

Contact information:

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Indoor Air Quality

Pennsylvania Integrated Pest Management Program
Philadelphia School & Community IPM Partnership

215-471-2200 Ext. 109

Email: pscip@psu.edu

Website: www.paipm.org



Air Pollution – Where is it?



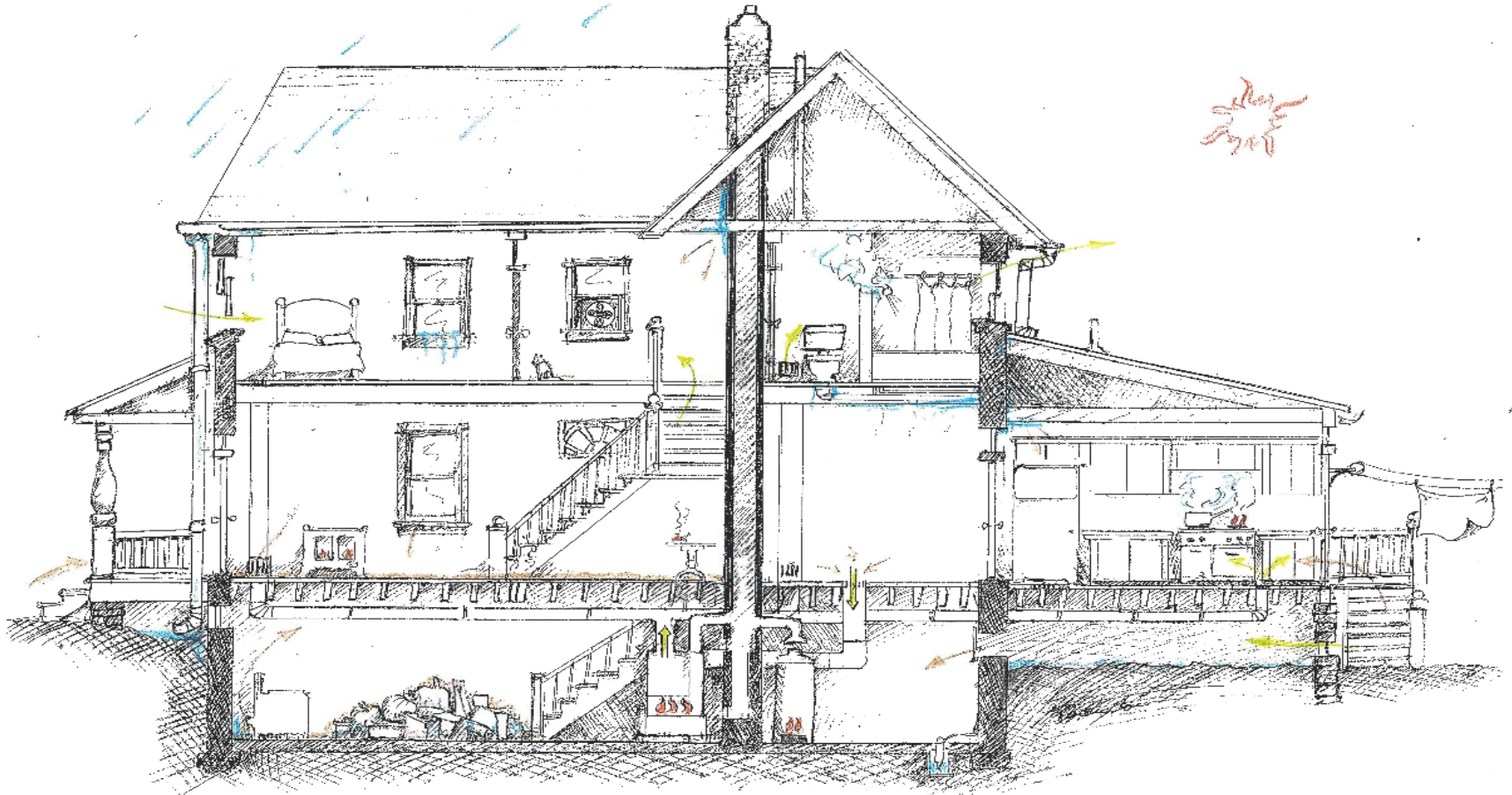
But what about ...



Indoor Air Quality

- Most Americans spend 90% of their time indoors
- Indoor concentrations of pollutants are commonly 3 to 5 times higher than outdoor concentrations
- Indoor air quality is affected by cleaning products and processes, HVAC systems, interior finishes, exterior pollutants, personal-care products, pesticides, and pet dander

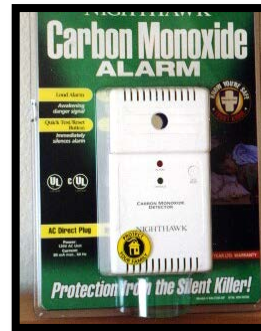
Air is all Connected



If you breathe it, you are taking it into your body = exposure

Health Problems Related to Housing Conditions

- Asthma
- Allergies
- Brain damage
- Behavior problems
- Learning problems
- Developmental delays
- Lung cancer
- Injuries
- Poisonings
- Death



What Allergens and Irritants Trigger Asthma?

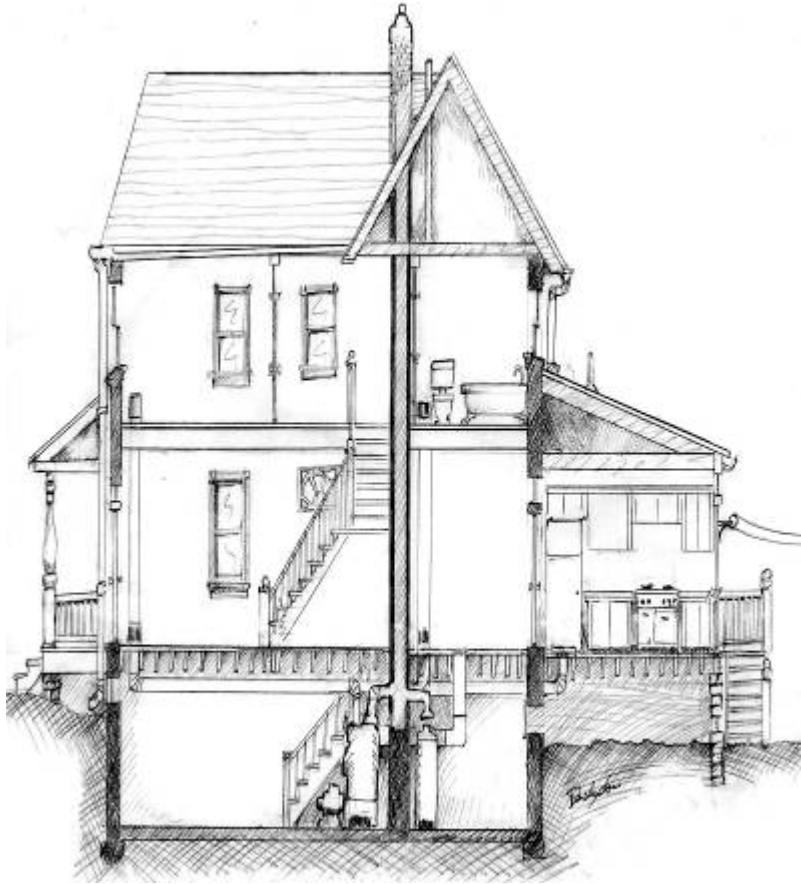
Irritants:

- Secondhand smoke
- Pollutants
- Ozone
- Strong smells or sprays
- Exercise
- Allergies
- Hot or cold air

Allergens:

- Dust mites
- Pets
- Molds
- Cockroaches
- Pollen
- Rats
- Mice
- Birds

7 Principles of a Healthy Home



Keep It:

1. Dry
2. Clean
3. Ventilated
- 4. Pest-Free**
5. Safe
- 6. Contaminant-Free**
7. Maintained

What is a Pest?

Pests may include: mammals, insects, rodents, bacteria, and plants. Pests spread diseases to people, animals and plants, destroy property, and are a nuisance.

Cockroaches

Ants

Deer

Mice

Fleas

Raccoons

Flies

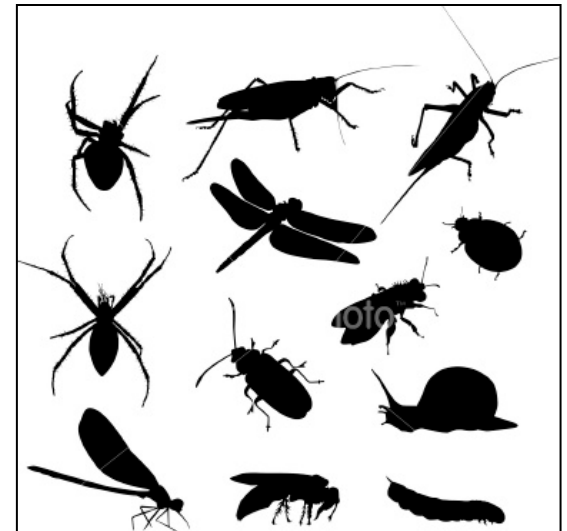
Birds

Spiders

Bed bugs

Head lice

Weeds



Problems Caused by Pests

- People don't like them in their spaces



- Health Problems

- Spread Bacterial Diseases
- Contaminate Food
- Trigger Asthma
- LCMV – spread by mice. Causes meningitis and may harm pregnancies



- Damage Property



What is a Pesticide?

“_____ - cide” means “to kill”

Rodenticide (kills rodents)

Insecticide (kills insects)

Herbicide (kills plants)

Algicide (kills algae)

Plus “Anti-microbials” such as “**Triclosan**”

Problems Caused by Pesticides:

Acute Exposure:

- Asthma Attacks
- Flu-like Symptoms
- Vomiting
- Dizziness
- Unconsciousness

Long-Term Exposure:

- Asthma
- Cancer
- Neurological damage
- Immune system damage
- Permanent chemical sensitivity
- Endocrine disruption

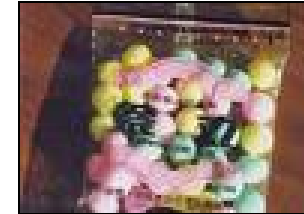
Pesticide Signal Words

Read Labels on Cleaning Products & Pesticides

<u>Signal Word</u>	<u>Toxicity</u>	<u>Oral Lethal Dose</u>
DANGER POISON (Skull & Crossbones)	Deadly	Fatal if swallowed
DANGER	Highly toxic	Few drops to 1 tsp.
WARNING	Moderately toxic	1 tsp. to 1 Tbsp.
CAUTION	Slightly toxic	1 oz. to more than a pint

Illegal and Unmarked Pesticides

Pesticides that look like candy



Insecticide chalk

(a.k.a. Miraculous or Chinese chalk)



“Tres Pasitos”



What is IPM?

Integrated **P**est **M**anagement (IPM) is an approach to controlling pests in **safer, more effective, and longer-lasting ways.**

When you use **IPM**, you

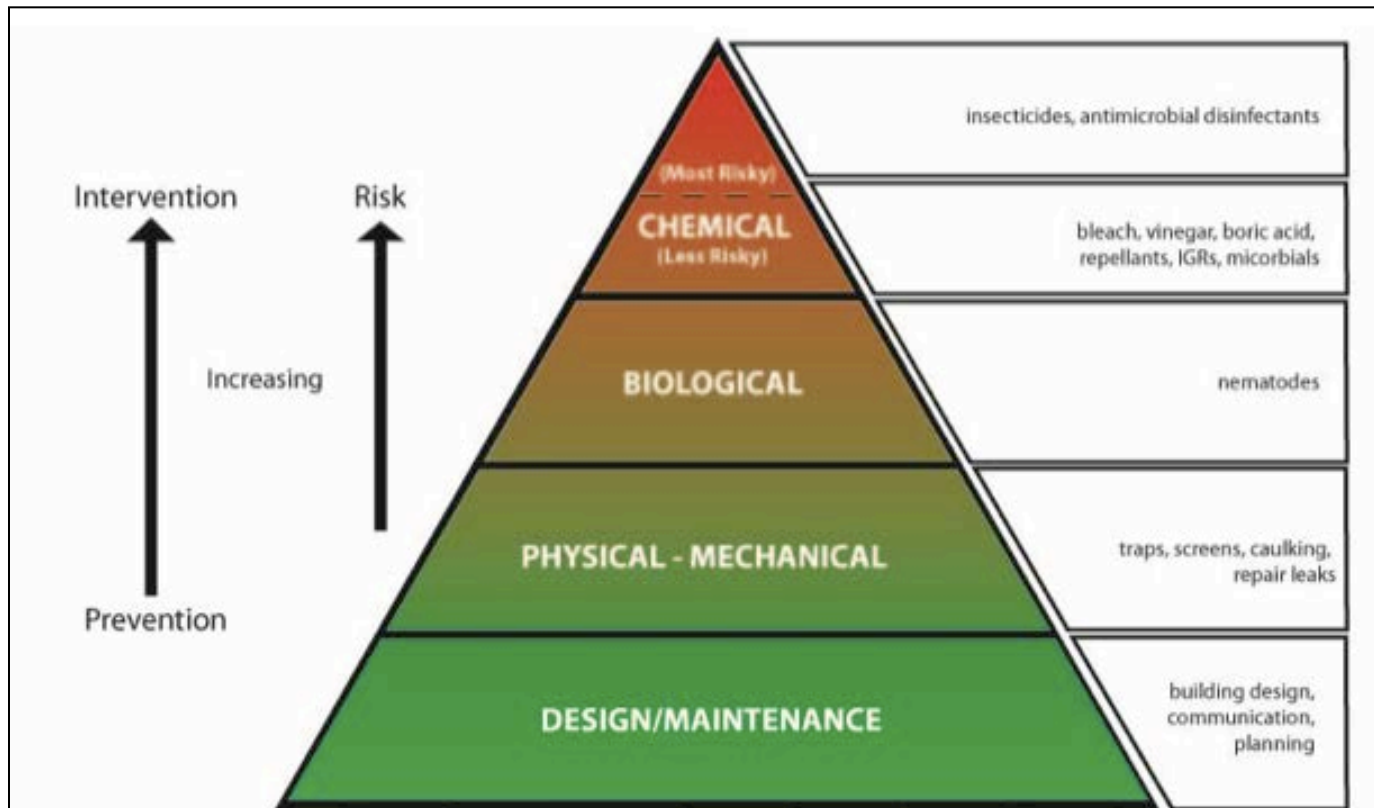
- a. understand a pest's identity and habits so non-toxic, preventative measures can be used first
- b. use a combination of different tactics for better effectiveness
- c. use least-toxic chemicals, if any at all

How do we do Integrated Pest Management?

1. Keep Pests Out
2. Remove Pests' Food & Water
3. Remove Pests' Shelter
4. Monitor for Pests
5. Treat Existing Pest Problems

Routine Monthly Spraying is NOT Part of IPM

IPM Pyramid of Tactics



Pyramid of IPM Tactics Inside Buildings

Start with People

- What good are they?
- What's difficult about people?
- How can you deal with people?



Challenges

- Communication
 - Literacy
 - Language
 - Education
 - Economics
- Cultural and Social Norms
 - If some is good, more is better (WRONG!)
- Human Behavior

What is Risk?

Human perception:

Hazard x Exposure x Vulnerability

Examples:

- Common/familiar = safe
- Under my control = safe
- Associated dread = risky

Resources for more Information

- US Department of Health & Human Services,
Household Products Database
<http://householdproducts.nlm.nih.gov/>
- The National Center for Healthy Housing
<http://www.nchh.org/>
- The Pennsylvania Asthma Partnership
<http://www.paasthma.org/>

Thank you!

Michelle Niedermeier

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