# Beneficial Use of Biosolids
# Academic Response to 2018 OIG Report
## W4170 MULTISTATE RESEARCH COMMITTEE
## RESPONSE TO USEPA OIG REPORT NO. 19-P-00021

Nicholas Basta
Professor of Soil and Environmental Science
School of Environment and Natural Resources
Environmental Science Graduate Program, Director
Ohio State University, Columbus, OH

**2021 Plant Operations and Lab Workshop**
**June 2-3, 2021**

# USEPA
# Office of Inspector General
# Report No. 19-P-0002
# Nov 15, 2018

# EPA Unable to Assess the Impact of Hundreds of Unregulated Pollutants in Land-Applied Biosolids on Human Health and the Environment

## OIG Report:

"…[EPA] lacked the data or risk assessment tools needed to make a determination on the safety of 352 pollutants found in biosolids…[including] 61 designated as acutely hazardous, hazardous or priority pollutants in other programs"

# Agency Comments on Draft Report and OIG Evaluation Appendix D of OIG Report

## Response from USEPA Office of Surface Water and Office of Enforcement and Compliance Assurance

**“We are concerned about how the science is presented in the OIG report It is biased and raises alarm ..and is taken out of context”**

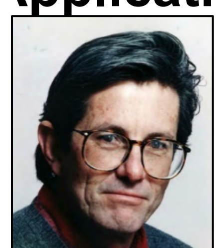
# Biosolids Stakeholders
# Greatly Impacted by OIG Report

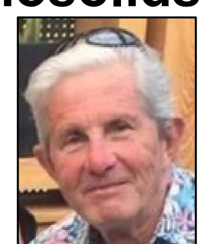
USDA W4170 Multistate Research Committee members decided to Respond to OIG Report

**Groups of 50+ scientists from 30 states with extensive history on biosolids**
**USEPA Office of Water; USEPA ORD; USDA ARS**
**Biosolids Regional Groups (NW, NEBRA, CASA, MWRD, Mid Atlantic**
**Other biosolids stakeholders**

**W170 provided research data and risk assessment support to develop risk based guidelines (Tables 2, 3, 4) in Part 503 1993 rule**

**Cooperative Research on Land Application of Biosolids since 1972**





# Response Document

**On W4170 website:** **https://www.nimss.org/projects/18624**
**underline outline—attachment**
**Direct link:**
nimss.org/system/ProjectAttachment/files/000/000/502/original/W4170%20Response%20to%20OIG%20Report%20July%2023%202020%20final.pdf

- **Response to chemical issues**, Dr. Nick Basta, OSU
- **PFAS**, Dr. Linda Lee, Purdue
- **Response to Antibiotic and pathogens issues**
  Dr. Ian Pepper, Univ. of Arizona
- **Overall review**, Greg Kester CASA

# We reviewed chemicals identified by OIG for further review (including 61 regulated chemicals)

- **Identified 380 chemicals found in biosolids (including 352 in OIG Report)**
    - National sewage sludge surveys (1988,2003,2009)
    - Biennial reviews (2003-2017)
- **Identified 61 regulated chemicals for further review**
    - RCRA P-list (acutely toxic) and U-list (toxic)
    - NIOSH Hazardous Drugs list
    - Priority Pollutant list

# The Evaluation

## Hierarchical approach

Collected following and compared concentration data to…

1. **Residential Soil Screening Limit (TR=1E-06; THQ=1.0);** *if higher, compared with*
2. **Part 503 Recommendations**
   **List of 200, List of 50, Risk-based screening limit.** *If not addressed, compared with*
3. **Other risk-based screening limit (Ohio EPA VAP)** *if higher, compared with*
4. **Persistence (half-life, mobility).** *If half-life >1year, then*

## Remaining chemicals may need further investigation

# 61 Regulated Chemicals identified by OIG

## Organics

2,3,7,8 Tetrachlorodibenzo-P-dioxin
2-Propanone
Benzoic acid
Bis (2-ethylhexyl) phthalate
Carbon tetrachloride
Chloroaniline, 4-
Chloroform
Chloronaphthalene, 2-
Cresol, p-
Cyanide
Dimethyl phthalate
Di-n-octyl phthalate
Di-n-butyl phthalate
Dichlorophenol, -2,4
Ethylbenzene,
Nitrophenol, p-
Methylene Chloride
Tetrachloroethylene
Toluene

## Nitrosamines

N-nitrosodibutylamine (NDBA)
N-nitrosodiethylamine (NDEA)
N-nitrosodimethylamine (NDMA)
N-nitroso-di-n-propylamine (NDPA)
N-nitrosodiphenylamine (NDPhA)
N-nitrosopiperidine (NPIP)
N-nitrosopyrrolidine (NPYR)

## Pesticides

Dichlorobenzene, 1,3-
Dichlorobenzene, 1,4-
Dimethoate
Endosulfan, α
Endosulfan, β
Heptachlor epoxide
Pentachloronitrobenzene

## Metals

Antimony
Beryllium
Silver
Thallium

## Hormones

Estradiol, 17α-
Estradiol, 17β-
Estradiol-3-benzoate, β-
Estriol (estradiol)
Estrone
Ethynyl estradiol, 17α-
Norethindrone (norethisterone)
Norgestimate
Norgestrel (levonorgestrel)
Progesterone
Testosterone

## Polycyclic Aromatic Hydrocarbons (PAHs)

Benz(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Chrysene
Fluoranthene
Naphthalene
Phenanthrene
Pyrene

## Pharmaceuticals

Trichlorophenol, 2,4,5-
Carbamazepine
Cyclophosphamide
Mestranol
Sodium valproate
Warfarin

# 1. All concentrations below the USEPA RSSL (if available) or ND (in red)

### Organics

2,3,7,8 Tetrachlorodibenzo-P-dioxin*
2-Propanone
Benzoic acid*
Bis (2-ethylhexyl) phthalate
Carbon tetrachloride
Chloroaniline, 4-
Chloroform
Chloronaphthalene, 2-
Cresol, p-
Cyanide
Dimethyl phthalate
Di-n-octyl phthalate
Di-n-butyl phthalate
Dichlorophenol, -2,4
Ethylbenzene
Nitrophenol, p-*
Methylene Chloride
Tetrachloroethylene
Toluene

### Nitrosamines

N-nitrosodibutylamine (NDBA)
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N-nitrosodimethylamine (NDMA)
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Estradiol, 17α-*
Estradiol, 17β-*
Estradiol-3-benzoate, β-*
Estriol (estradiol) *
Estrone*
Ethynyl estradiol, 17α-*
Norethindrone (norethisterone)*
Norgestimate*
Norgestrel (levonorgestrel)
Progesterone*
Testosterone*

### Polycyclic Aromatic Hydrocarbons (PAHs)

Benz(a)anthracene*
Benzo(a)pyrene*
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Benzo(k)fluoranthene
Chrysene
Fluoranthene
Naphthalene
Phenanthrene*
Pyrene

### Pharmaceuticals

Trichlorophenol, 2,4,5-
Carbamazepine*
Cyclophosphamide*
Mestranol*
Sodium valproate*
Warfarin

# 2. Deemed low-risk by Part 503a (in red)

### Organics

- 2,3,7,8 Tetrachlorodibenzo-P-dioxin
- 2-Propanone
- Benzoic acid
- Bis (2-ethylhexyl) phthalate
- Carbon tetrachloride
- Chloroaniline, 4-
- Chloroform
- Chloronaphthalene, 2-
- Cresol, p-
- Cyanide
- Dimethyl phthalate
- Di-n-octyl phthalate
- Di-n-butyl phthalate
- Dichlorophenol, -2,4
- Ethylbenzene
- Nitrophenol, p-
- Methylene Chloride
- Tetrachloroethylene
- Toluene

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- Naphthalene
- Phenanthrene
- Pyrene

### Pharmaceuticals

- Trichlorophenol, 2,4,5-
- Carbamazepine
- Cyclophosphamide
- Mestranol
- Sodium valproate
- Warfarin

# 3. Below Ohio EPA Voluntary Action Program (Brownfields) RSSL

## Organics

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2-Propanone
Benzoic acid
Bis (2-ethylhexyl) phthalate
Carbon tetrachloride
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Phenanthrene
Pyrene

## Pharmaceuticals

Trichlorophenol, 2,4,5-
Carbamazepine
Cyclophosphamide
Mestranol
Sodium valproate
Warfarin

# 4. Likely to degrade within 1 year (half-life <3 months)

## Organics

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Benzoic acid
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Carbon tetrachloride
Chloroaniline, 4-
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## Pharmaceuticals

Trichlorophenol, 2,4,5-
Carbamazepine
Cyclophosphamide
Mestranol
Sodium valproate
Warfarin

# Remaining chemicals that may need further investigation

| No SSLs | |
|---|---|
| Carbamazepine<br>Cyclophosphamide<br>Estradiol-3-benzoate, β-<br>Estriol (estradiol)<br>Estrone<br>Mestranol<br>Norethindrone (norethisterone)<br>Norgestrel (levonorgestrel)<br>Progesterone<br>Sodium valproate<br>Testosterone<br>Trichlorophenol, 2,4,5- | Hormones and medications. |

| Above SSLs | |
|---|---|
| Chloroaniline, 4- | 6/84 TNSSS samples above USEPA Cancer RSSL; Child eating 200mg/day* will not exceed CalEPA cancer standard of 1.5ug/day. |
| "2,3,7,8 TETRACHLORODIBENZO-P-DIOXIN" | EPA considered setting a limit of 300ng/kg, but declined to regulate. 4/113 samples exceeded 300ng/kg in 2003 NSSS |

*Part 503a "child eating biosolids" exposure pathways assumes children consume 200mg biosolids/day

# Conclusions

Most of the 61 hazardous chemicals listed in the OIG report have been previously assessed by U.S. EPA

Most chemicals of concern have low concentrations or persistence in biosolids and are low-risk to human health

# What about the 300+ non-listed chemicals?

- Not on the NIOSH, Priority Pollutant, or RCRA P / U lists
- Many non-toxic human nutrients (calcium, sodium)
- Some recognized as toxic but not yet listed (PFAS)

# Evaluation approach for non-listed chemicals

- **Group into chemical category**
  - Organics, pesticides, antibiotics…
- **Biosolids review articles for each chemical category**
  - *"Review of contamination of sewage sludge and amended soils by polybrominated diphenyl ethers based on meta-analysis". Kim et al., 2017*
  - *"Fate, Transport, and Biodegradations in the Environment and Envineered Systems". Khanal et al., 2006.*

# Non-listed chemical

| | |
|---|---|
| Pharmaceuticals | 70 |
| PFASs/ Surfactants | 20 |
| Metals /Inorganics | 23 |
| Brominated flame retardants | 43 |
| Dioxins/ Furans | 28 |
| Organics | 34 |
| Antibiotics and antimicrobials | 64 |
| Pesticides | 10 |
| Hormones/steroids | 19 |

# What about PFAS?

## Section in our Response written by Dr. Linda Lee

# What are PFAS - Per and Polyfluoroalkyl substances?

## Currently > 4,800 PFAS produced

## New estimate: >7000* PFAS (*Johnson et al., 2020)

- All have a perfluoroalkyl chain of varying length
- Numerous su… differentiating…
- Each subclas… different perfl…
- An individual… isomers (line… branching)
    - **Each class either does not degrade or degrades to another subclass**

*OIGP report mentioned PFAS and PFOA once in a single sentence*

**PFAS are the Biggest Current Concern Nationally/Globally and an area of growing data**

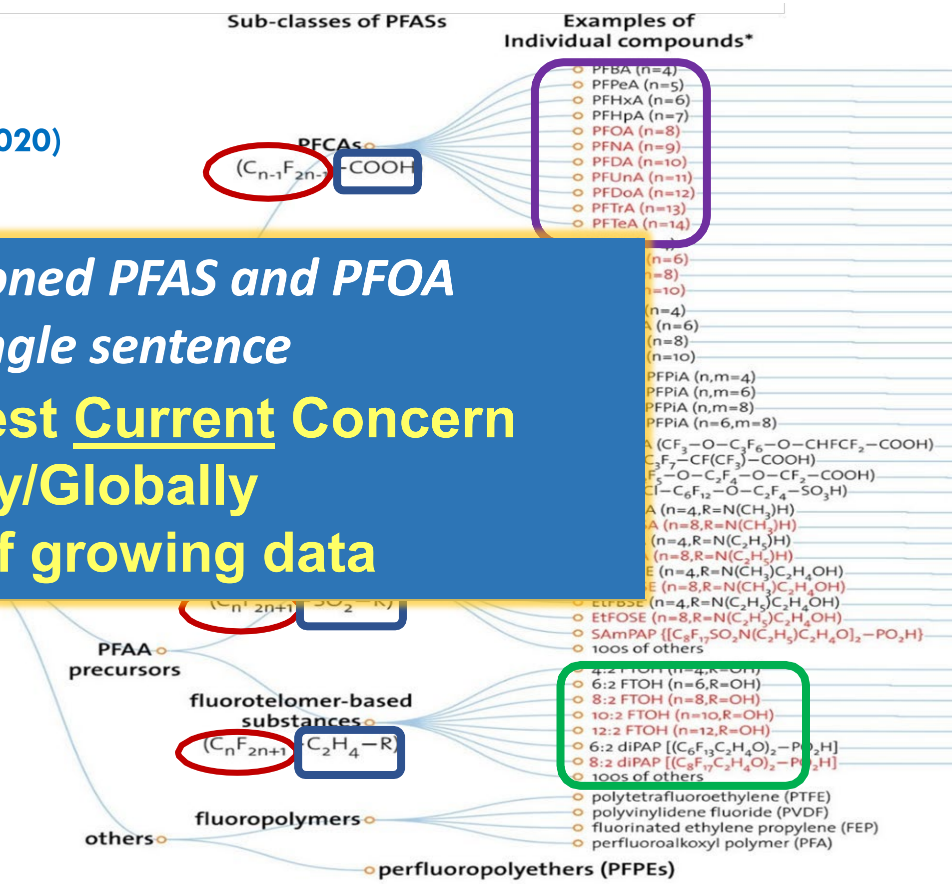



Figure modified from Wang et al., 2017, ES&T, 51:2508-2518

Education & Training Events

RESIDUALS AND BIOSOLIDS: A Virtual Event

# PFAS in Biosolids: Challenges & Management Options

Linda S Lee

PURDUE UNIVERSITY

Agronomy

WEF Residuals & Biosolid Conference

May 11, 2021

# PFAS Content in 2019 Biosolids

| | Biosolids (n=9) µg/kg | Maine Guidelines µg/kg |
|---|---|---|
| Total PFAS | 160-450 | |
| PFOA | 3.3 - 26.6 (9.95)* | 2.5 |
| PFOS | 5.2 – 127 (59.3)* | 5.2 |
| PFBS | 9.9 – 131 (51.2)* | 1900 |

* Average

- Despite regional, size, property, and process differences among the utilities and biosolids, total PFAS concentrations fall within a relatively narrow concentration interval although specific PFAS vary over 1-2 orders of magnitude
- All would fail to meet one or more of Maine's criteria

Education & Training Events

# *Should we just ban PFAS-containing materials from land-application?*

- Banning land application places a **heavy burden on public municipalities**
- Banning could lead to numerous **unintended consequences**
- **Control sources** contributing to PFAA levels in biosolids (e.g., **pretreatment** of influent from industry or landfills with *high* PFAA levels)
- **Focus on regulating nonessential uses** of PFAS & **ban them from use in food packaging, carpets, etc**. This will go a long way to reducing PFAS loads in municipal wastes including biosolids.


+

→
FINISH LINE
WINNER'S
CIRCLE

# PFAS Biosolids Resources

**Excellent resources:**

**North East Biosolids and Residuals Assoc. (NEBRA)**
**https://www.nebiosolids.org/pfas-biosolids**

**Dr. Linda Lee, Purdue University**

**US Composting Council, https://www.compostingcouncil.org**

# Environmental Sources

## PFAS are **Ubiquitous** in the Environment

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere


### A North American and global survey of perfluoroalkyl substances in surface soils: Distribution patterns and mode of occurrence

Keegan Rankin [a, 1], Scott A. Mabury [a], Thomas M. Jenkins [b], John W. Washington [c, *]

[a] *Department of Chemistry, University of Toronto, 80 St. George Street, Toronto, Ontario, M5S 3H6, Canada*
[b] *Senior Environmental Employment Program, United States Environmental Protection Agency, 960 College Station Road, Athens, 30605, Georgia*
[c] *Ecosystems Research Division, National Exposure Research Laboratory, Office of Research and Development, United States Environmental Protection Agency, 960 College Station Road, Athens, 30605, Georgia*

- Quantifiable concentrations of PFASs were detected in all pristine soils sampled from around the world
- PFOA and PFOS were most common

# Wastewater Treatment Plants

ELSEVIER
Available at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/watres
WATER RESEARCH

## Evaluation of the fate of perfluoroalkyl compounds in wastewater treatment plants

*Rui Guo*[a], *Won-Jin Sim*[a], *Eung-Sun Lee*[a], *Ji-Hyun Lee*[a,b], *Jeong-Eun Oh*[a,*]

[a] *Environmental Analysis Laboratory, Department of Civil and Environmental Engineering, Pusan National University, Busan, Republic of Korea*

[b] *Korea Testing & Research Institute, Ulsan, Republic of Korea*

ELSEVIER
Contents lists available at ScienceDirect
Water Research
journal homepage: www.elsevier.com/locate/watres
WATER RESEARCH

## Poly- and perfluoroalkyl substances in wastewater: Significance of unknown precursors, manufacturing shifts, and likely AFFF impacts

CrossMark

Erika F. Houtz[a, b, *], Rebecca Sutton[c], June-Soo Park[a], Margaret Sedlak[c]

[a] *Environmental Chemistry Laboratory, California Department of Toxic Substances Control, Berkeley, CA 94710, USA*

[b] *Sequoia Foundation, La Jolla, CA 92037, USA*

[c] *San Francisco Estuary Institute, Richmond, CA 94804, USA*

# Wastewater Impacted by Aqueous Film Forming Foam (AFFF)

Emergency Response

**Waste Water Management**

Hangars and Buildings

Equipment Maintenance and Testing

# Summary and Conclusions

- Extensive data and risk assessment for many of the chemicals in the OIG report

- Lack of consideration by OIG of low concentration of chemicals of concern in biosolids OIG report. Low concentration of most chemicals causes little exposure and risk. Emphasis on “hazard” designation rather than risk for chemicals of concern by OIG.

- Most chemicals in biosolids were (i) below natural soil levels, (ii) non toxic and pose no risk, (iii) result in minimal exposure and risk, or (iv) will not persist in the environment

# U.S. EPA response to OIG and Ongoing Risk Assessment by U.S. EPA for "Unassessed" Chemicals in OIG Report

https://www.epa.gov/biosolids/office-inspector-general-reports-biosolids-program

**Dr. Elizabeth Resek, Biosolids Lead**
**Health and Ecological Criteria Division**
**Office of Science and Technology**
**EPA/Office of Water**

# OIG Nov 2018 Report

THE OHIO STATE UNIVERSITY

# Climate Change

Climate Change

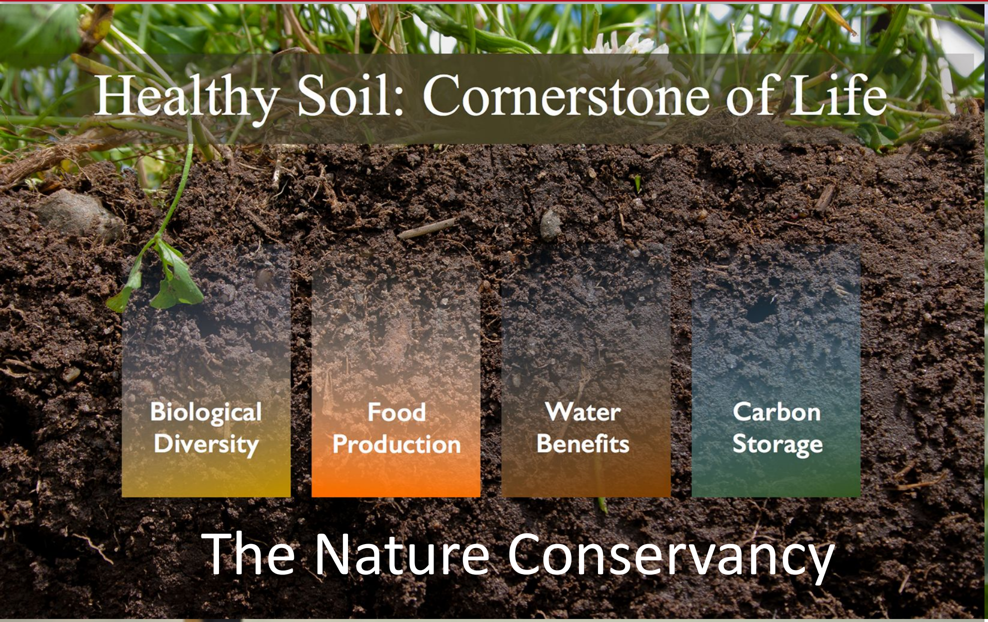
Wildfires in California

# Beneficial Use of Biosolids is a Solution for "The Grand Challenges"

- Food production / security
- Clean water
- Contaminant Remediation
- Climate Regulation (resilience)
- Waste Reuse

The answer is
**biosolids**

"Carnac The Magnificent"



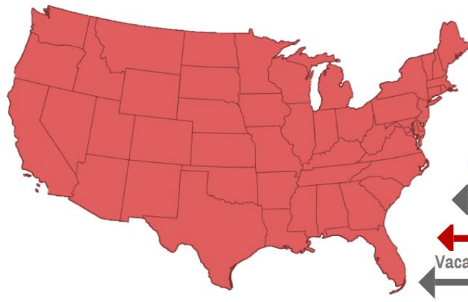

# W4170 and OSU

# Biosolids and Soil Health Research, Teaching and Extension

# Restoring Urban Soils to Restore Communities

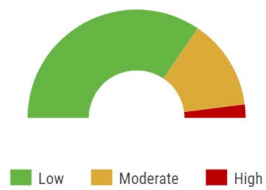
Investing in cities with low-cost soil testing and treatment

## In the U.S

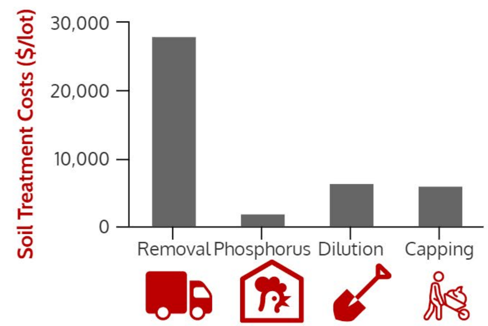


- Vacant land results from population declines in cities
- 21% of land in Midwest cities is vacant
- Reutilizing vacant land reduces problems like crime & food insecurity
- Vacant lots need to be tested and treated for contaminants to protect public health

## Reusing Vacant Land While Protecting Human Health




Lead in Cleveland Community Garden Soils




Although most vacant lots have little or no contamination, public fears can prevent lot reuse. Low-cost testing can increase reuse of sites with little or no contamination. Treatments like phosphorus fertilization, dilution, and capping protect public health on moderately contaminated sites, reuse locally-available materials, and reduce costs of traditional remove and replace remediation.

SUMMARY

**Reusing vacant urban lots for food production, green space, and wildlife habitat brings humans and wildlife into contact with potentially-contaminated soil. Soil testing, inexpensive remediation practices, and education are needed to protect human and ecological health when revitalizing vacant urban lots.**

Soil Environmental Chemistry Group
The Ohio State University

**Soil Testing: SWEL.OSU.EDU**
**Urban Soil Education: DIRT.OSU.EDU**

# Soil Environmental Chemistry Group

**Research**

- Risk-based environmental chemistry of organic and inorganic soil pollutants
- Soil chemical contaminant speciation
- Human and ecological *in vitro* bioaccessibility assays
- Bioavailability-based contaminant remediation
- Beneficial reuse of industrial and municipal byproducts

**Testing Services**

- **Soil, Water, and Environmental Lab (SWEL)** is a service lab in the School of Environment and Natural Resources at The Ohio State University
- Contracts with universities, industry, and government
- Research-quality data produced by professional staff from several labs specializing in water quality and soil health, contaminants, and biology.
- Comprehensive assessment of human and ecological contaminant exposure

https://swel.osu.edu/home

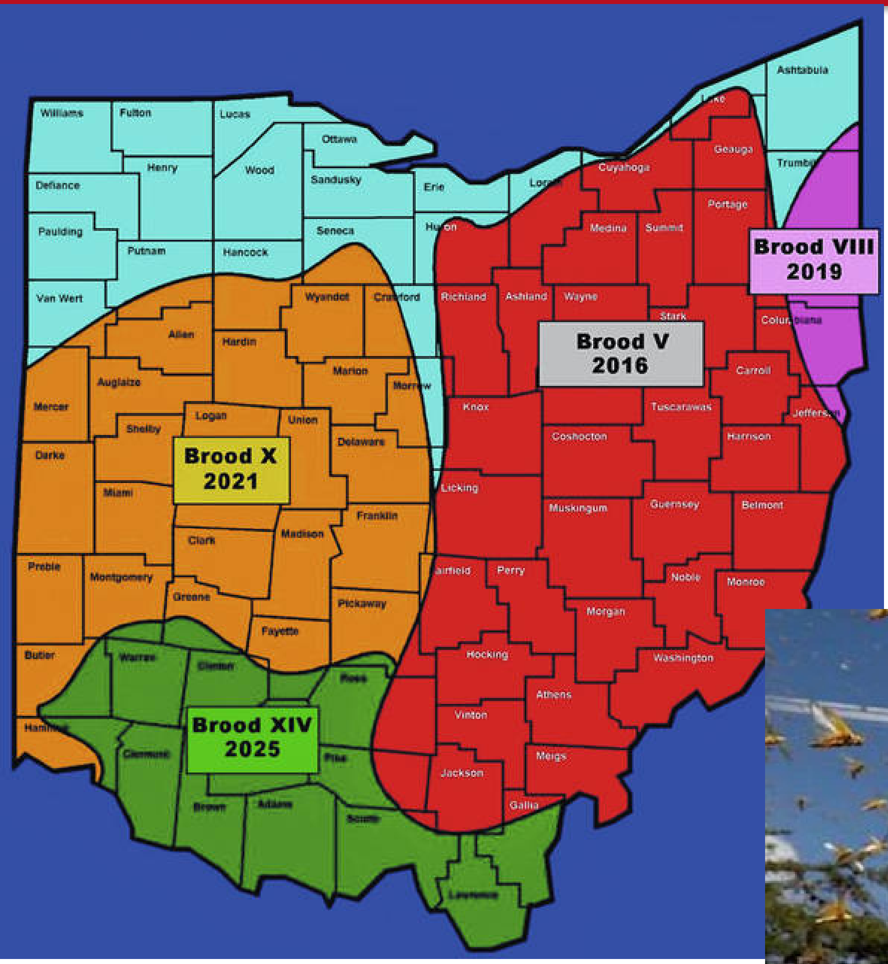
**Outreach**

- **Damaged soil Investigation, Restoration, and Treatment** (DIRT.osu.edu) provides testing information, treatment options, and soil lead education
- Offers low-cost soil heavy metal screening, testing interpretation, and workshops
- Students help assess vacant urban lots for remediation through City of Columbus partnership

https://dirt.osu.edu

Soil Environmental Chemistry Group
The Ohio State University

Soil Testing: SWEL.OSU.EDU
Urban Soil Education: DIRT.OSU.EDU



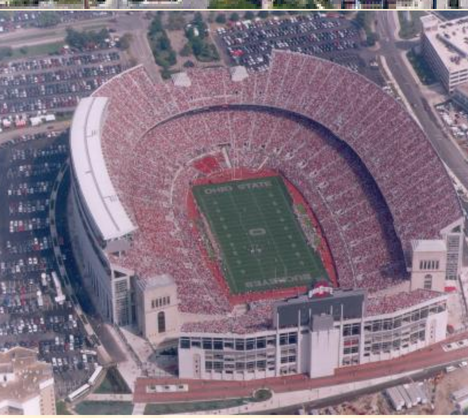

# The next big event in west / central Ohio and east Indiana?

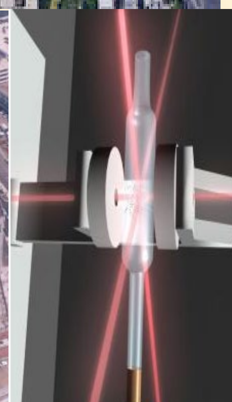
# 17 yr Brood X cicadas

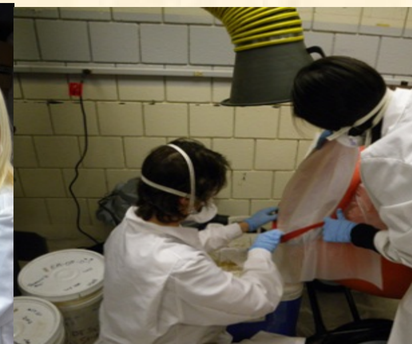
# Thank you for your attention

## More information?

**Nick Basta**
**Soil and Water Environmental Laboratory (SWEL)**
**basta.4@osu.edu**







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