Welcome to *The Current*, the North Central Region Water Network's Speed Networking Webinar Series

Emerging Contaminants: 2PM CT

1. Submit your questions for presenters via the chat box. The chat box is accessible via the purple collaborate panel in the lower right corner of the webinar screen.
2. There will be a dedicated Q & A session following the last presentation.
3. A phone-in option can be accessed by opening the Session menu in the upper left area of the webinar screen and selecting "Use your phone for audio".

This session will be recorded and available at northcentralwater.org and learn.extension.org.

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Today's Presenters:

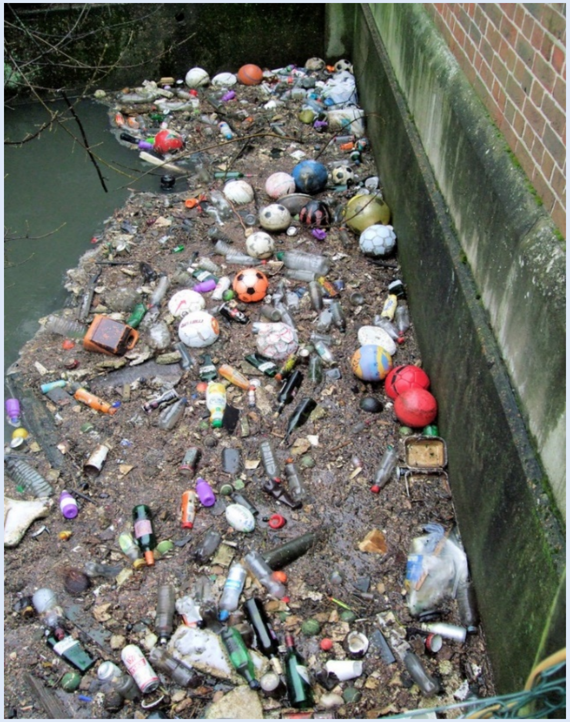
- **John Scott**, Senior Analytical Chemist, Illinois Sustainable Technology Center
- **Ganga Hettiarachchi**, Professor of Soil and Environmental Chemistry, Kansas State University
- **Steve Sliver**, Executive Director, Michigan PFAS Action Response Team, Michigan Department of Environment, Great Lakes and Energy

Follow @northcentralh2o and #TheCurrent on Twitter for live tweets!

John Scott

John Scott is a senior chemist at the Illinois Sustainable Technology Center at the University of Illinois. His research interests include emerging contaminants, waste to energy, biomass utilization and natural products. He has been involved in microplastics research for the past 6 years and participates in regional and international projects addressing microplastics in freshwater systems.

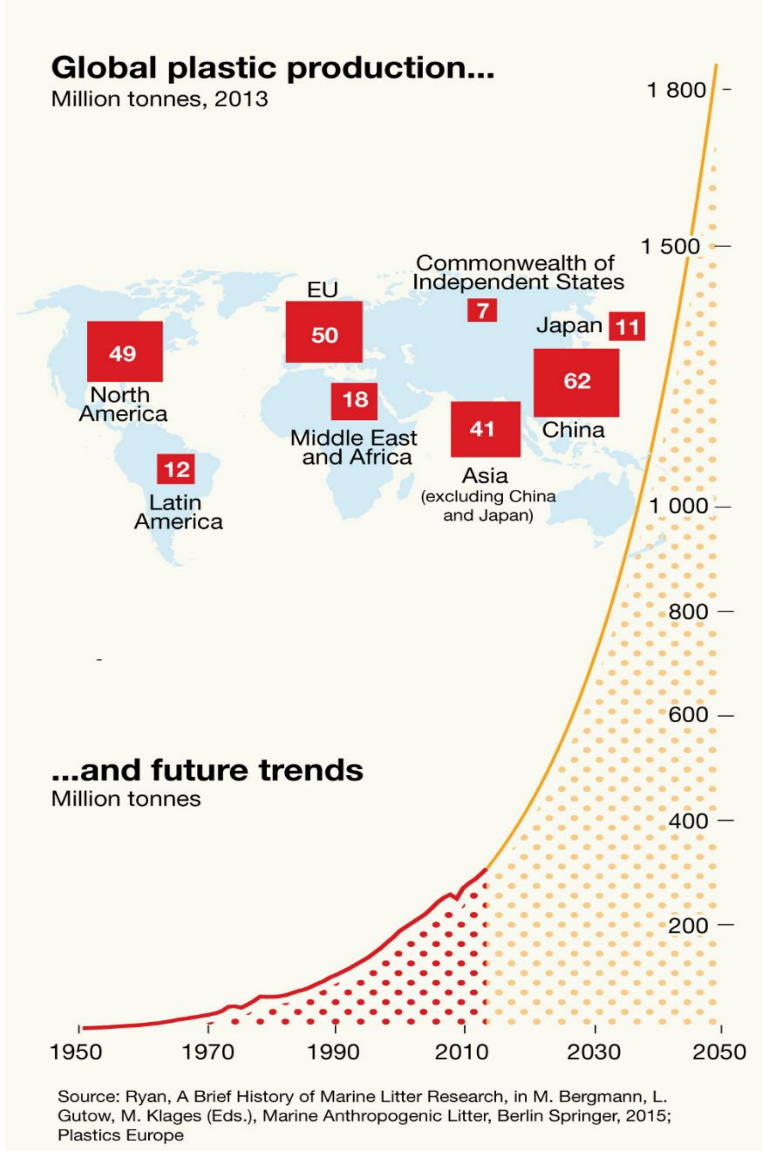
Plastic in the Environment



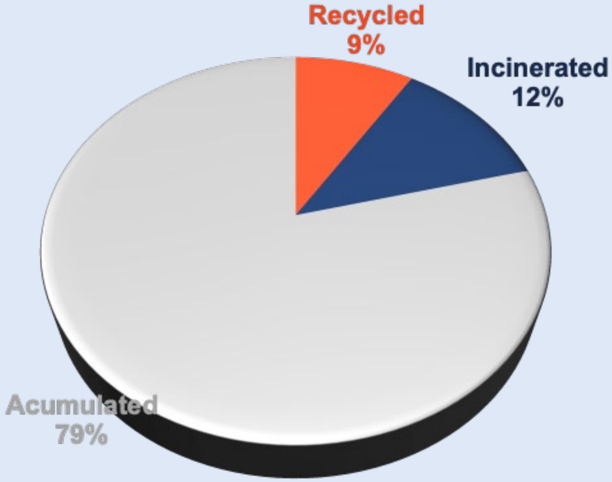
Karst Sample Microplastic

Presented by John Scott
University of Wisconsin-Madison Extension
May 13, 2020

Living in the Age of Plastics



- Estimated that 8.3 billion metric tons of plastic produced to date.
- Cumulative plastic waste generated is 6.3 billion metric tons.



Source- Geyer, Roland, Jenna R. Jambeck, and Kara Lavender Law. "Production, use, and fate of all plastics ever made." Science advances 3, no. 7 (2017): e1700782.

Creator Credit: Maphoto/Riccardo Pravettoni
http://www.grida.no/resources/6923

Microplastics - Definitions

Microplastic: Material less than 5 millimeter in diameter.

Composition is variable and often very complex.

<u>Primary microplastics</u>

Intentionally made
- Microbeads
- Nurdles
- Abrasives

<u>Secondary microplastics</u>

Breakdown of macroplastics
- Wear & abrasion
- Ultraviolet radiation
- Biodegradation

Where are we Finding Microplastics ?

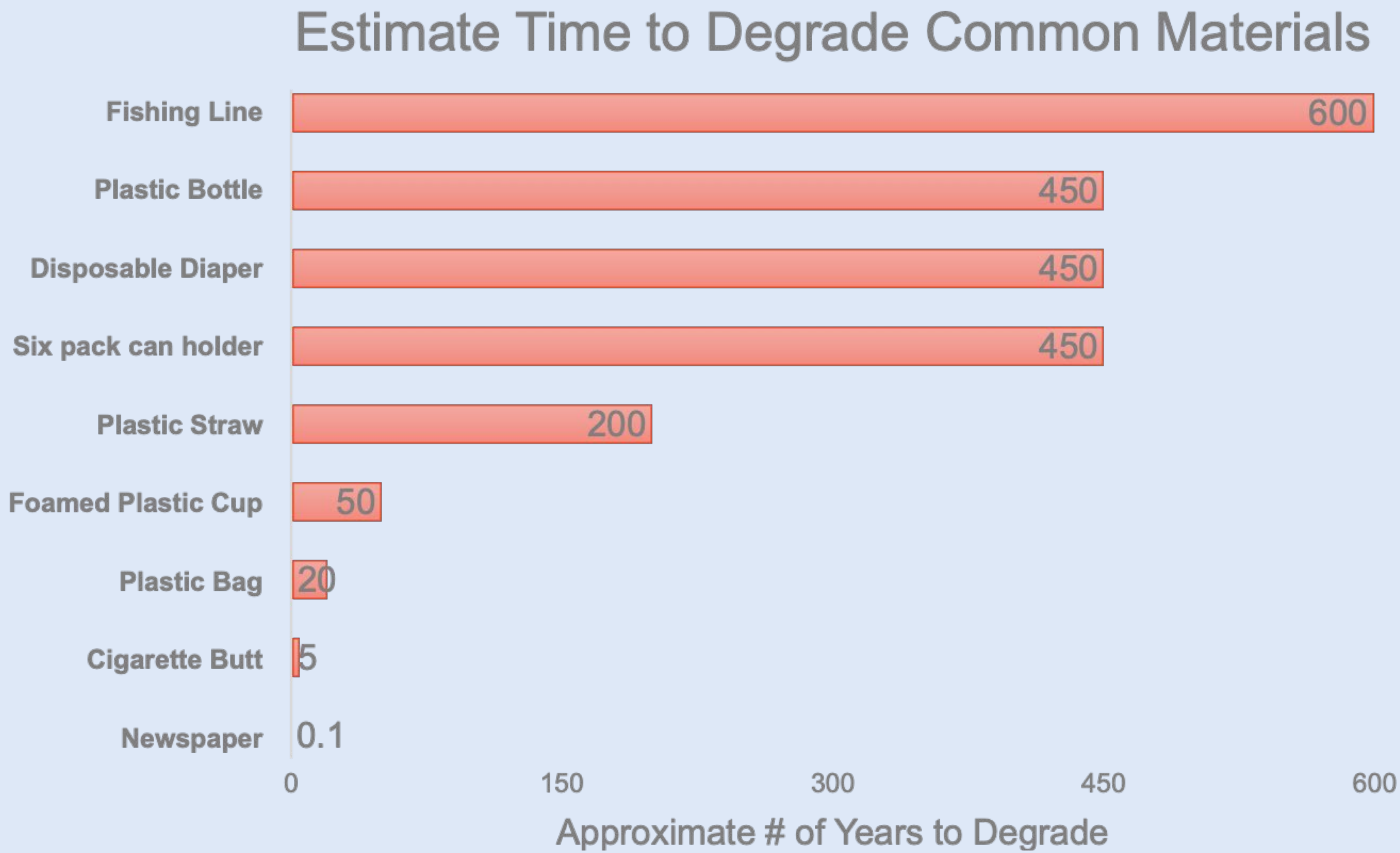
- Surface water
- Sediments and soil
- Air and dust
- Food and beverages
- Cosmetics
- Wastewater
- Wildlife
- Karst groundwater

- And everywhere else we look

Our team first to discover microplastics in karst groundwater

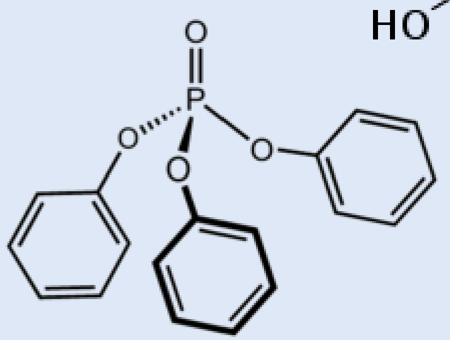
Project Partners
- Illinois State Water Survey
- Loyola University Chicago

The Problem of Persistence

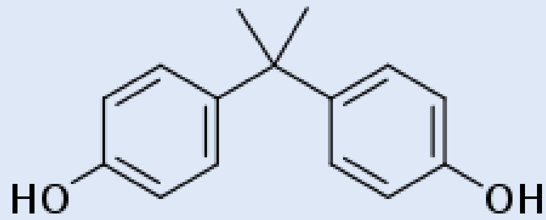


Sources: NOAA/WOODS HOLE SEA Grant & http://environment.about.com/

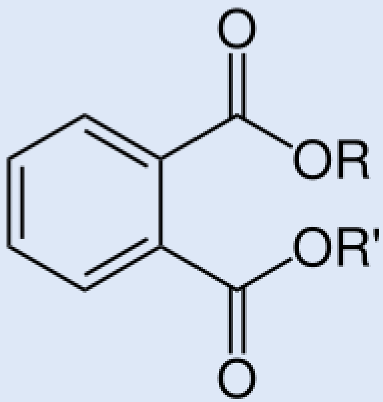
Additives Contained in Plastics



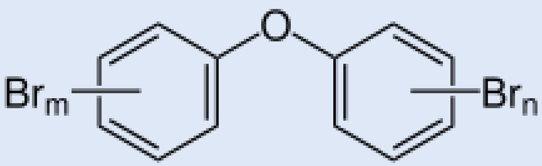
Triphenyl phosphate



Bisphenol A



Phthalates

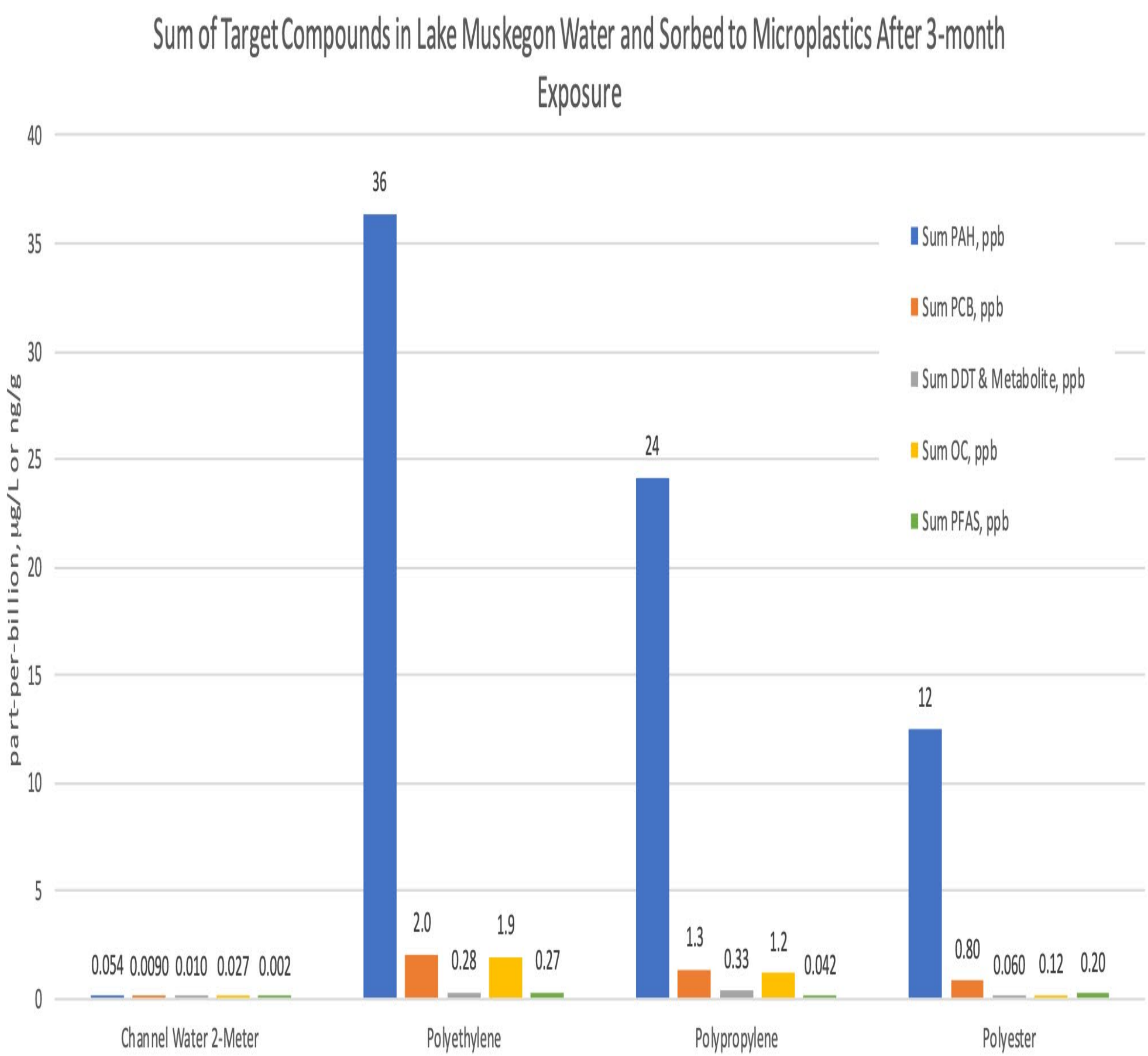


Brominated diphenyl ethers (PBDEs)

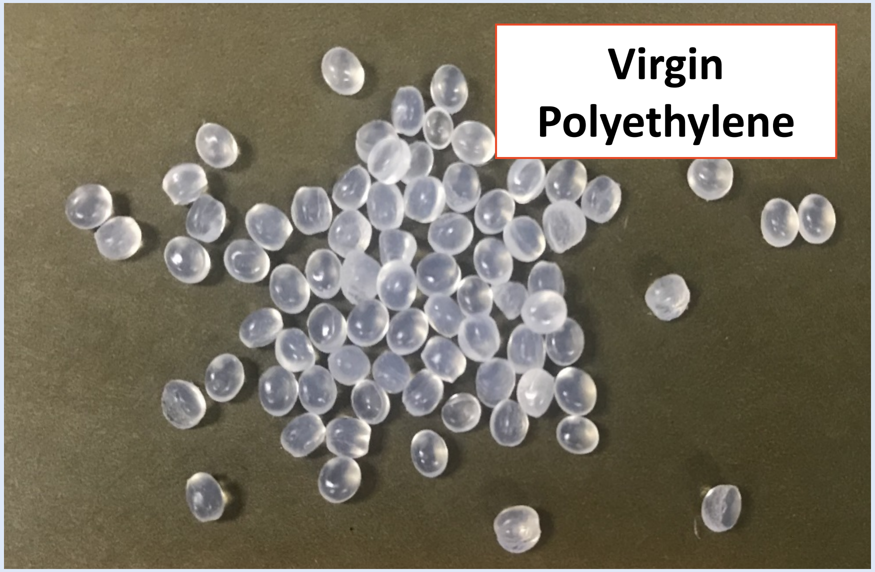
Numerous Potential Organic Additives. Many known to be persistent and bio-accumulative. Some highly suspected to endocrine disrupting

Plastics Sorb Environmental Pollutants

Approximate Deployment Sites



Plastics Sorb Biological Materials



- The biodiversity of microbes on plastics distinctively different.

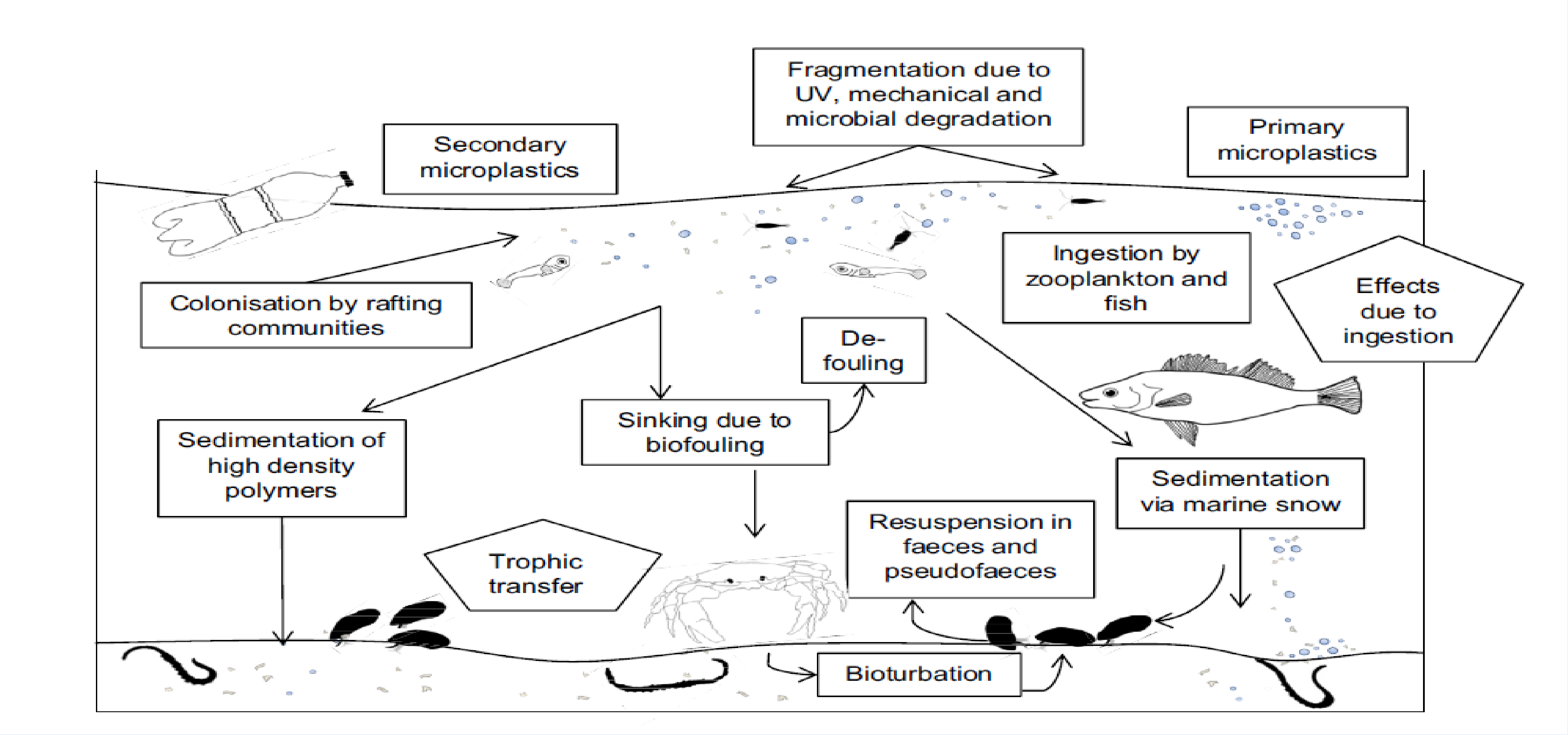
- Carriers of pathogens such as *Vibrio*?

- Carriers of other harmful biological materials – viruses?

Impact of Microplastics on Wildlife?

- Adverse effects on wildlife currently under investigation. Some studies show neutral effects, others show negative effects.

Foley, Carolyn J., Zachary S. Feiner, Timothy D. Malinich, and Tomas O. Höök. "A meta-analysis of the effects of exposure to microplastics on fish and aquatic invertebrates." *Science of the Total Environment* 631 (2018): 550-559.

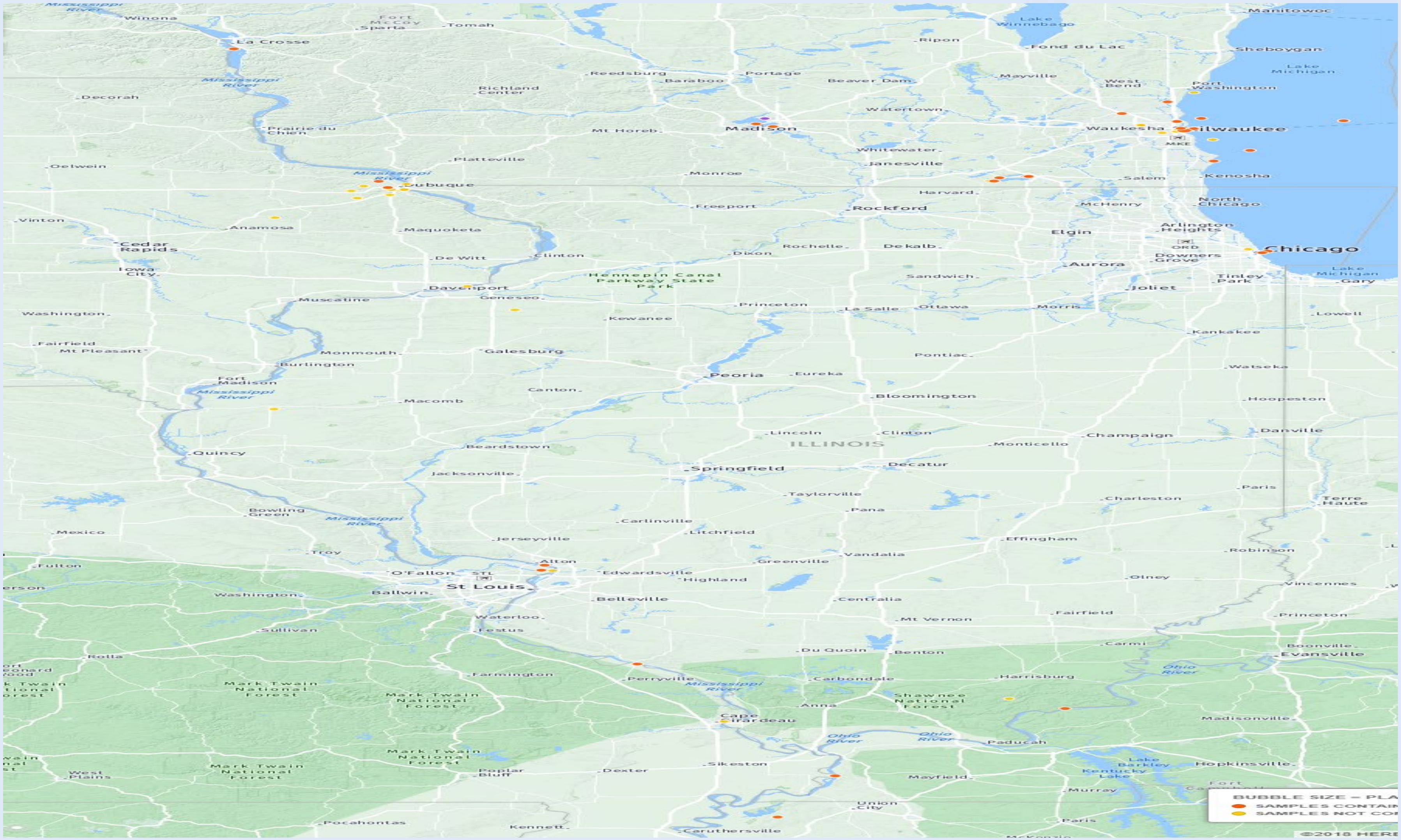


Wright, S. L., R. C. Thompson, and T. S. Galloway. 2013. The physical impacts of microplastics on marine organisms: A review. Environmental Pollution 178:483–492.

The Occurrence of Microplastics (US)

Source: Adventure Scientists. https://www.adventurescientists.org/microplastics.html

The Occurrence of Microplastics (IL)



Source: Adventure Scientists. https://www.adventurescientists.org/microplastics.html

Analysis of Microplastics

> 0.3 mm fraction

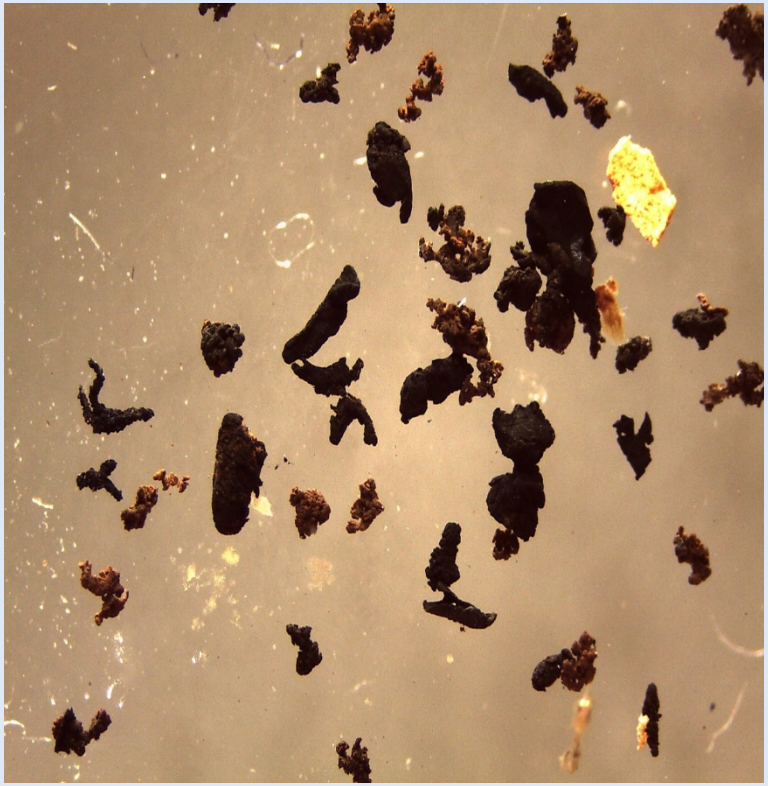
Wet sieve

> 5 mm fraction

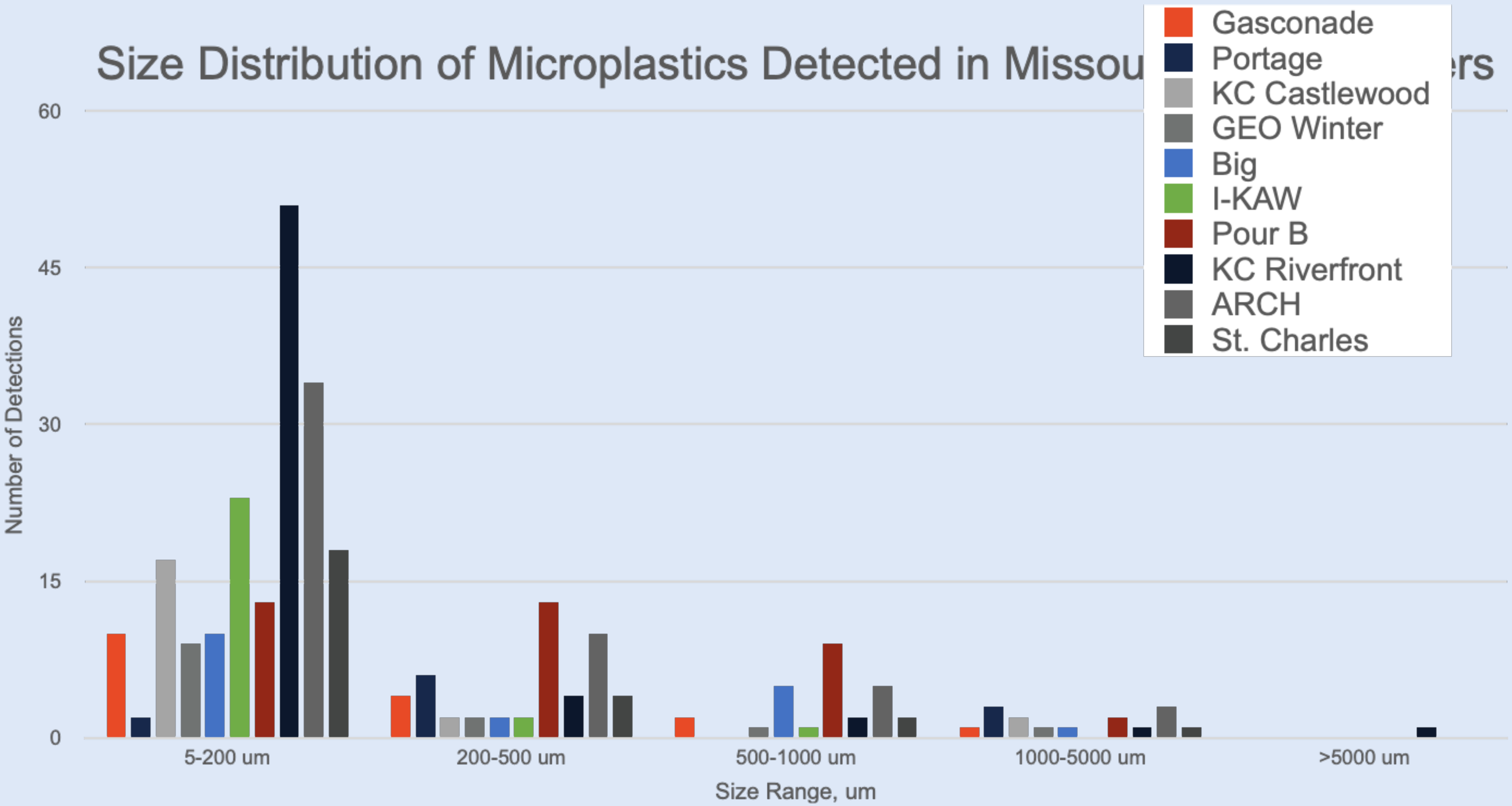
Wet Peroxide Oxidation — To Remove Organic Material

Density Separation — To Separate Inorganic Material from Microplastics

Microscope Examination



Size Matters

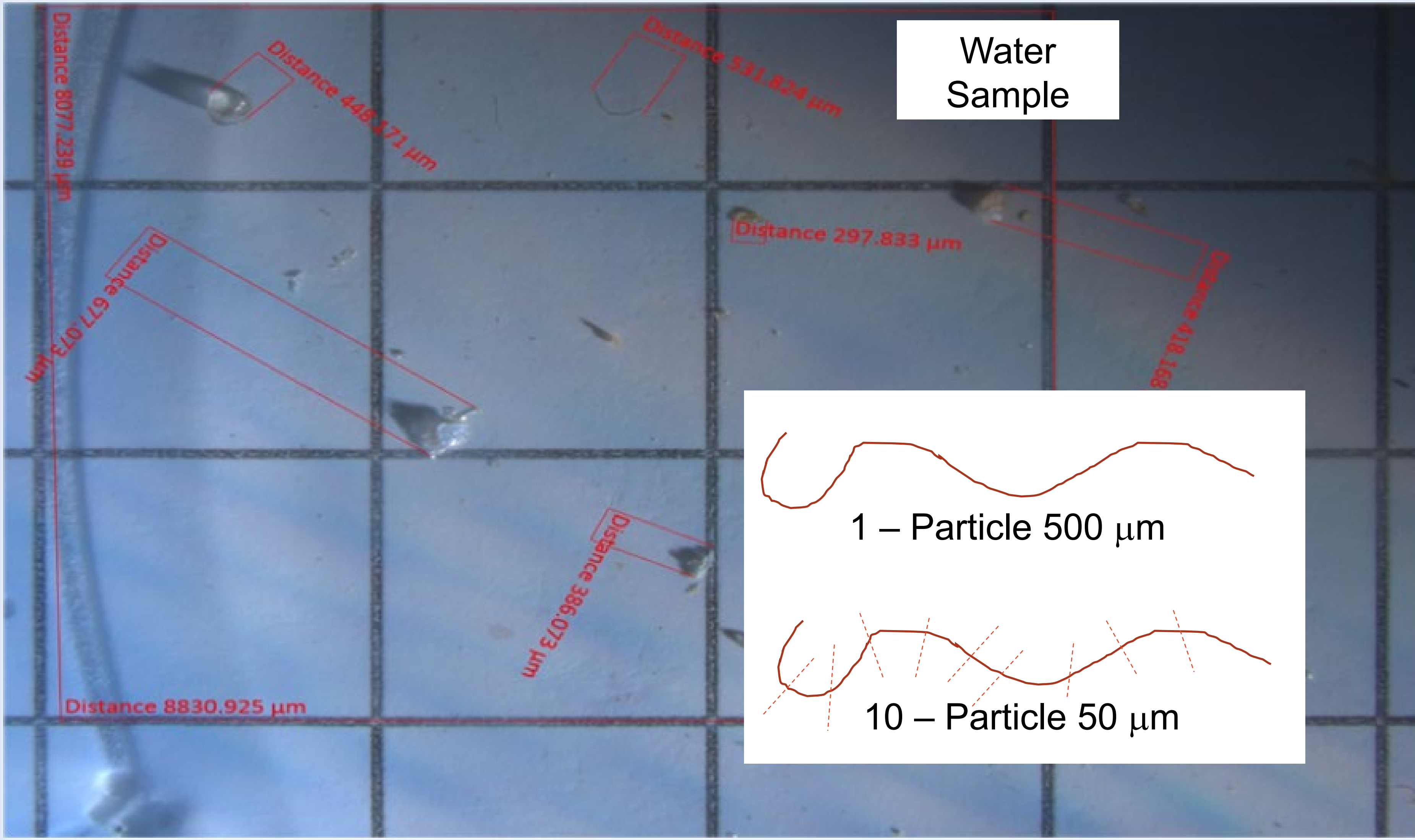


Density Matters

Density of Some Common Salt Solutions	g/L
Sodium Chloride (26%)	1.2
Zinc Chloride (150%)	1.5
Lithium Metatungstate (80%)	1.6
Potassium Iodine (60%)	1.7
ISTC Proprietary Salt Solution	2.3

Density of Some Common Plastics	g/cm^3
Polypropylene	0.90 to 0.91
Polyethylene	0.91 to 0.96
Polystyrene	1.05
Polyvinylchloride	1.16 to 1.55
Polyesters (PET & PBT)	1.30 to 1.45
Polyurethane	1.10 to 1.70
Polytetrafluoroethylene (Teflon)	2.13 to 2.23

Reporting of Microplastics



Thank you!

John W Scott, ISTC Senior Analytical Chemist
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Ganga Hettiarachchi

Dr. Hettiarachchi has been involved in a multitude of research projects within the field of soil chemistry. Primarily, her interests have focused on better understanding the mechanisms and interactions involved in soil chemical reactions enhancing soil quality to improve crop production and/or protection of human health. Main research areas include: the fate and transport of trace elements along with the steps that may be taken to remediate contaminated sites including urban brownfields and abandoned mines; determining reaction pathways of macro- and micronutrient fertilizer sources in soils to understand their relationship to potential availability and plant uptake; and the role soil mineralogy/chemistry play to enhance aggregation and soil C sequestration in agroecosystems.

Soil-based wastewater remediation

Ganga Hettiarachchi

Department of Agronomy

KANSAS STATE UNIVERSITY

The Current Webinar Series, 05/13/2020

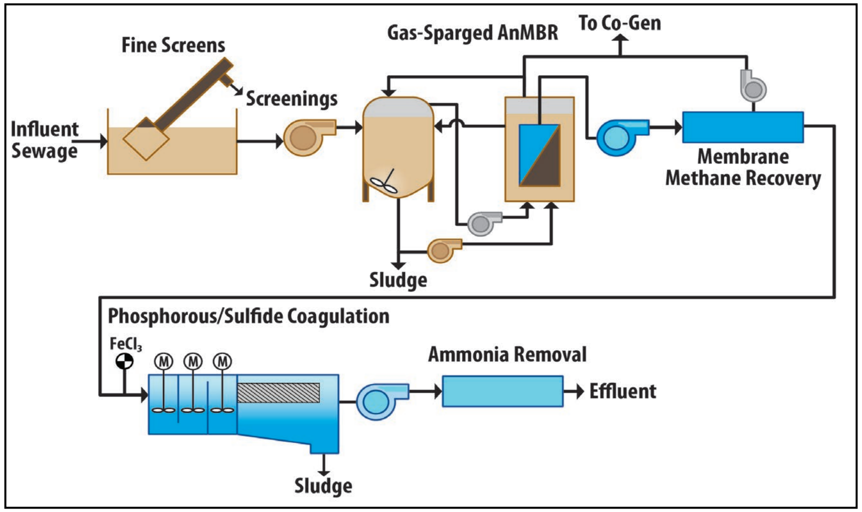
Wastewater

- Can contain variety of contaminants and pathogens
  - Oxygen consuming compounds, particulate solids, nitrogen, phosphorus, heavy metals, bacteria and viruses
  - Emerging constituents of concern include an array of trace organic compounds (consumer products, pharmaceuticals, volatile organics)

Wastewater Treatments

- ↑Regulations of effluent water quality →

Great need for more economical wastewater treatment systems



Picture courtesy: KSU Civil Eng.

Kansas State University

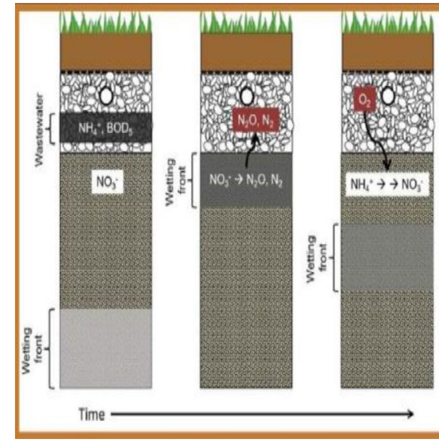
Why soil?

- Soils can be a sink, or interacting medium for many potential contaminants and pollutants
  - Nutrients
  - Trace elements
  - Trace organic compounds
  - Pathogens

Soil-based water treatments

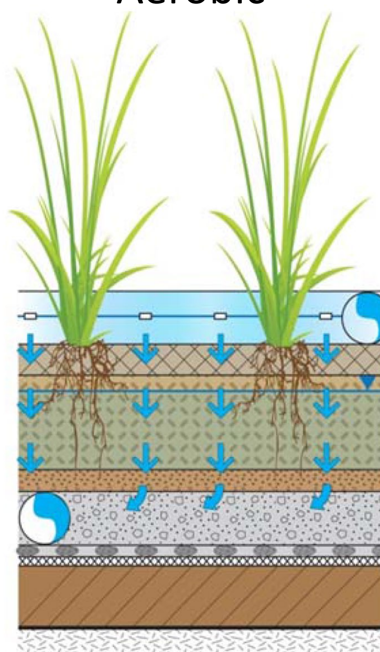
Physical, chemical and biological processes:

- BOD removal- biodegradation
- Suspended solids- physical filtration and absorption- biodegradation
- Ammonium-nitrification; nitrate-denitrification
- Phosphorus- sorption
- Pathogens- filtered out and die-off (parasites, bacteria); adsorbed to grain surfaces (viruses)
- Trace organic compounds-sorption and biodegradation
- Trace inorganics- sorption



Source: Amador and Loomis, 2020

Aerobic

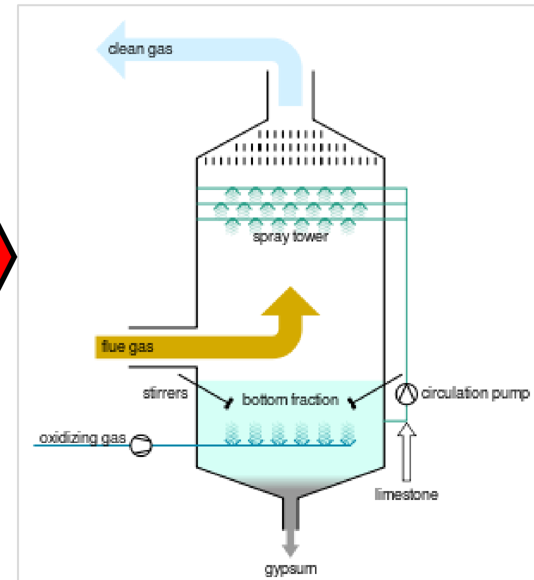


Anaerobic

Example: Flue gas desulfurization (FGD) wastewater

FGD treatment: Remove sulfur dioxide from exhaust flue gases of coal-fired power plants or any other sulfur dioxide emission processes

Coal-fired power plants



FGD system

FGD wastewater

Air pollution → Water pollution

Kansas State University

FGD wastewater: Concerns

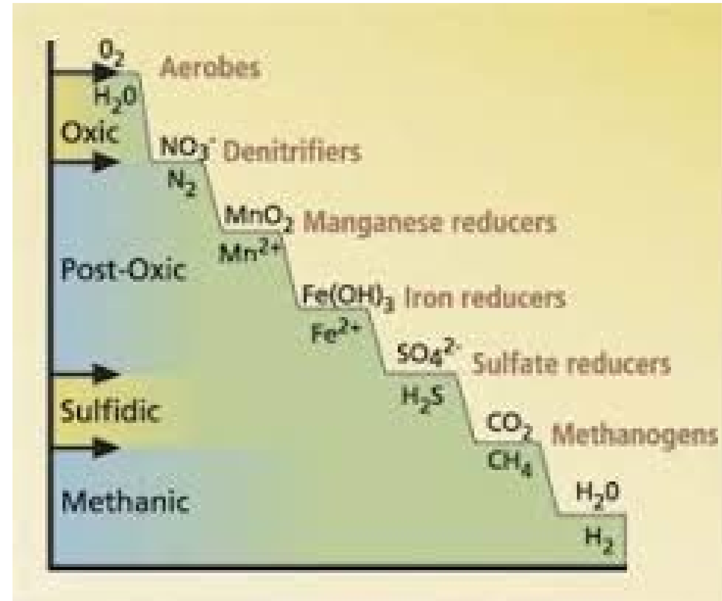
- High salinity
- Presence of trace elements of concern
  - ❖selenium, boron etc.
- Other major and minor constituents
  - ❖ sulfur, calcium, sodium, chloride, bromide, etc.
- Chemical composition varies from site to site

Contaminant removal: Redox-based solutions

Redox –

Oxidation/reduction status of a system Influences biological activity

Microorganisms: Influence on redox - All use an electron acceptor as part of their metabolism – O_2, NO_3^-, Fe^{3+}, Mn^{4+}, SO_4^{2-}, CO_2



Constructed wetland treatment systems (CWTS)

Courtesy: Westar Energy

- Feasible approach to treating wastewater economically and environmentally
- Remove contaminants by physical, chemical, and biological treatment mechanisms
- CWTS efficiently remove selenium and mercury in FGD wastewater

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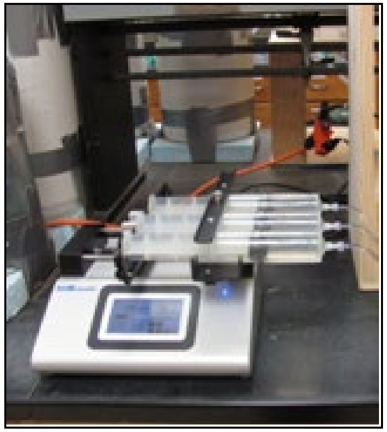
Comparison:

Saturated soil columns



A pilot-scale CWTS

Jeffrey Energy Center, St. Mary's, Kansas

Pilot-scale CWTS to treat FGD wastewater

Galkaduwa et al., 2017. J. Environ. Qual. 46: 384-393

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Comparison of % removal of constituents by pilot-scale CWTS vs soil columns

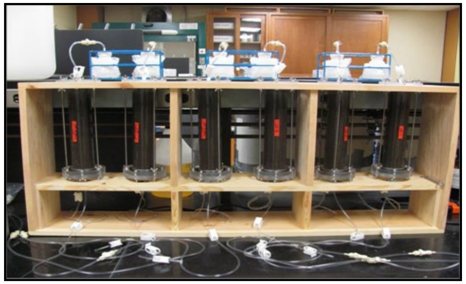
- By CWTS

Selenium %	Boron %	Fluoride %	Chloride %	Sulfate %
80	17	72	-3	-17

- By soil columns

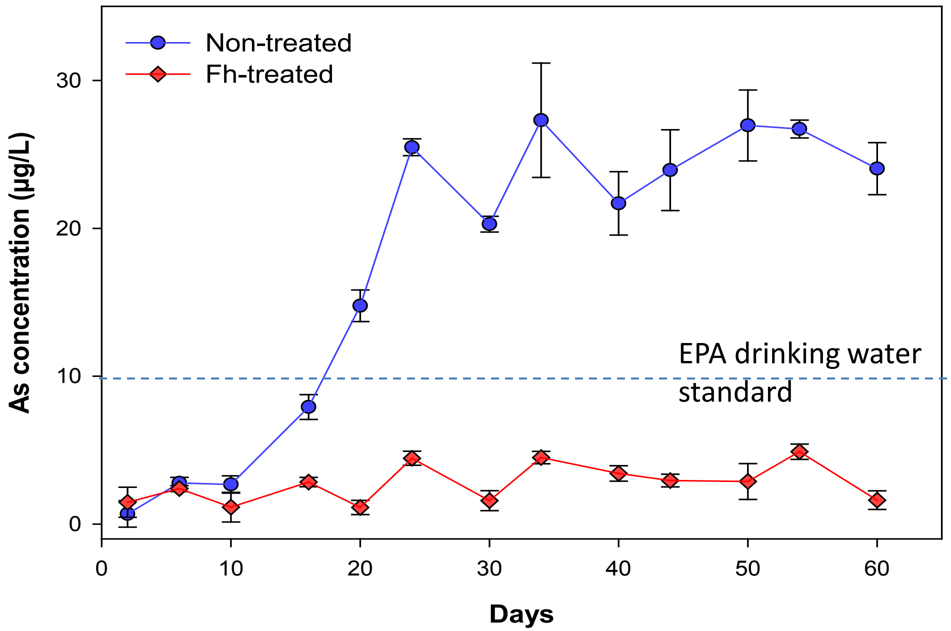
Soil type	Selenium %	Boron %	Fluoride %	Chloride %	Sulfate %
Top soil *	100	19	78	-11	~3
Engineered soil *	100	15	67	-14	-11

- % removal of after 100 days of flushing with river water.
- X-ray absorption spectroscopy revealed that selenium was mainly retained as reduced selenium



Challenges

Native soil arsenic mobilization due to long-term saturation.



Fh= ferrihydrite (iron oxide)

Galkaduwa et al., 2018.
J. Environ. Qual. 47: 873-883

Variable performance of CWTS.

High salinity?

Paredez et al., 2017
Journal of Water Science and Technology

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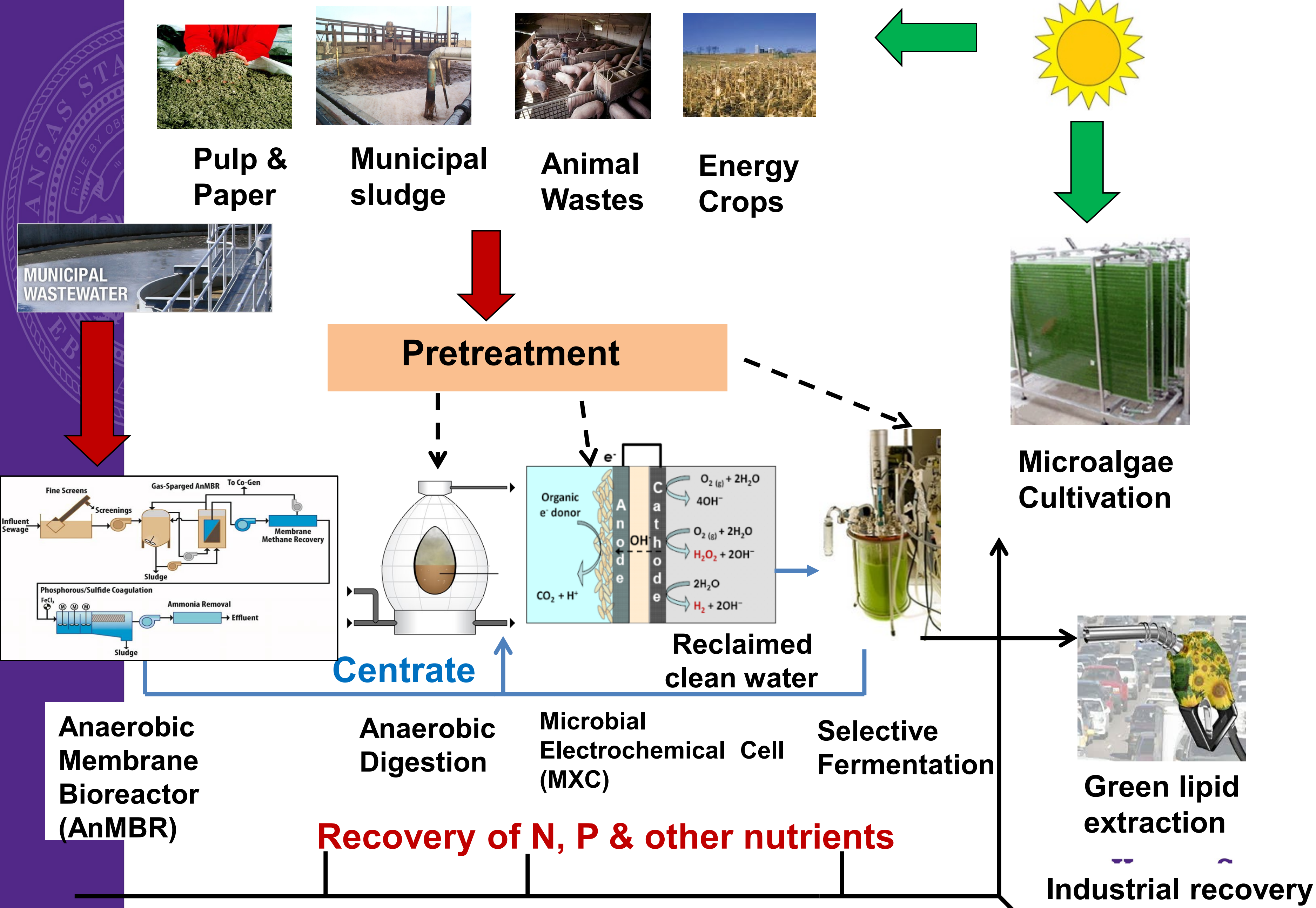
Innovations in wastewater treatments



Parameswaran, Hettiarachchi and Hutchinson, KSU

Thank you

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Steve Sliver

Steve Sliver was named Executive Director of the Michigan PFAS Action Response Team (MPART) in February 2019. He is responsible for coordinating Michigan's unique, multi-agency approach to address per- and polyfluoroalkyl substances contamination across the state. A 33-year veteran of state government, he is the former assistant director of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Materials Management Division, responsible for promoting recycling and waste utilization, pollution prevention, ensuring the proper management of materials under the hazardous waste and liquid industrial by-products, solid waste, scrap tire, medical waste, and e-waste programs, and protecting the public and environment from the hazards associated with radioactive materials. Steve obtained his bachelor's degree in environmental engineering from Michigan Technological University in 1985.

Michigan Taking Action on PFAS

The Current Webinar Series
Emerging Contaminants
May 13, 2020

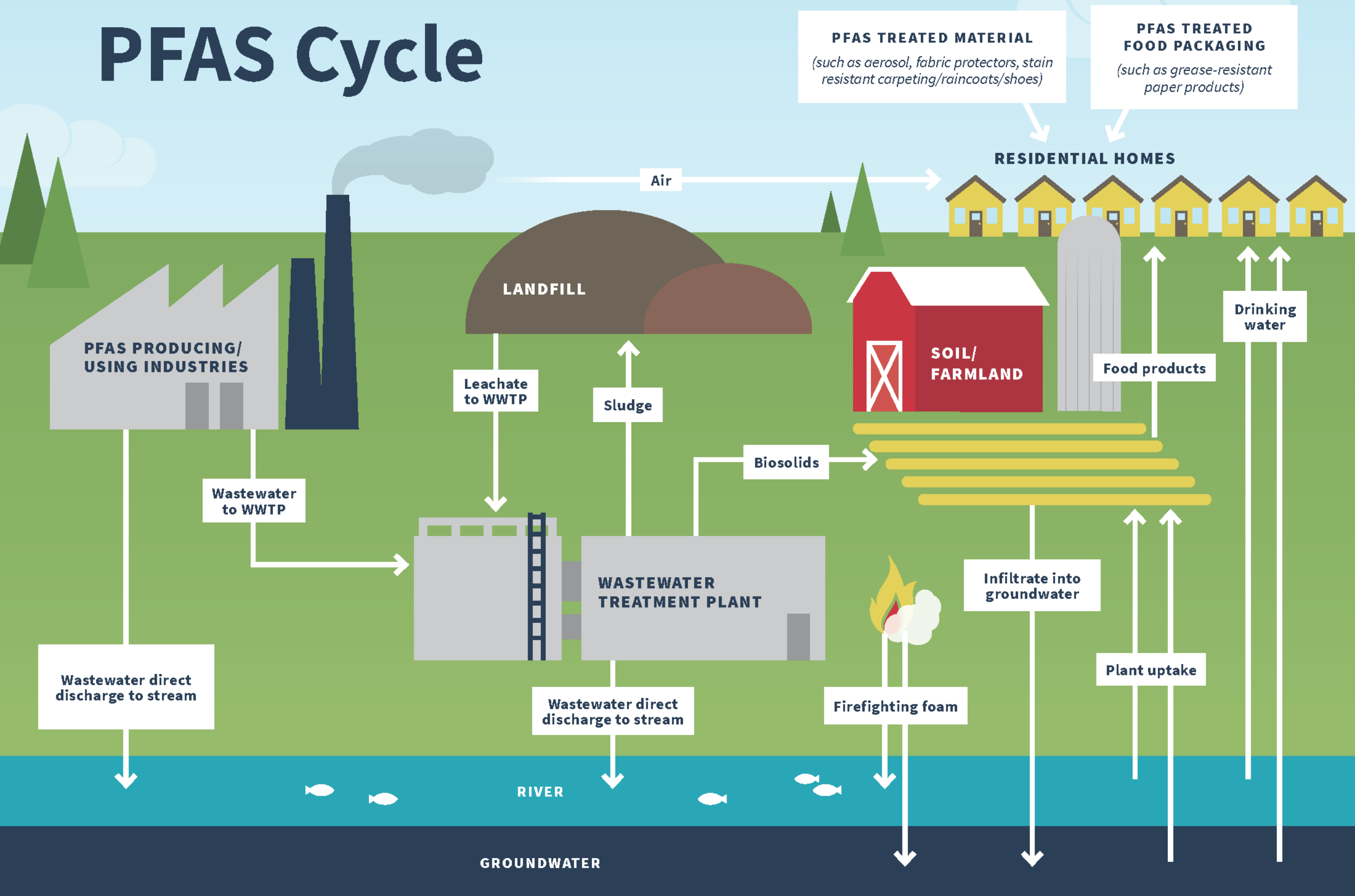
Steve Sliver, Executive Director
Michigan PFAS Action Response Team
517-290-2943 | SliverS@Michigan.gov

EGLE

Michigan PFAS Action Response Team (MPART)

- Executive Order 2019-03
- Unique multi-agency approach
- Leads coordination and cooperation among all levels of government
- Enables a proactive, comprehensive approach to identify and reduce exposures to PFAS contamination

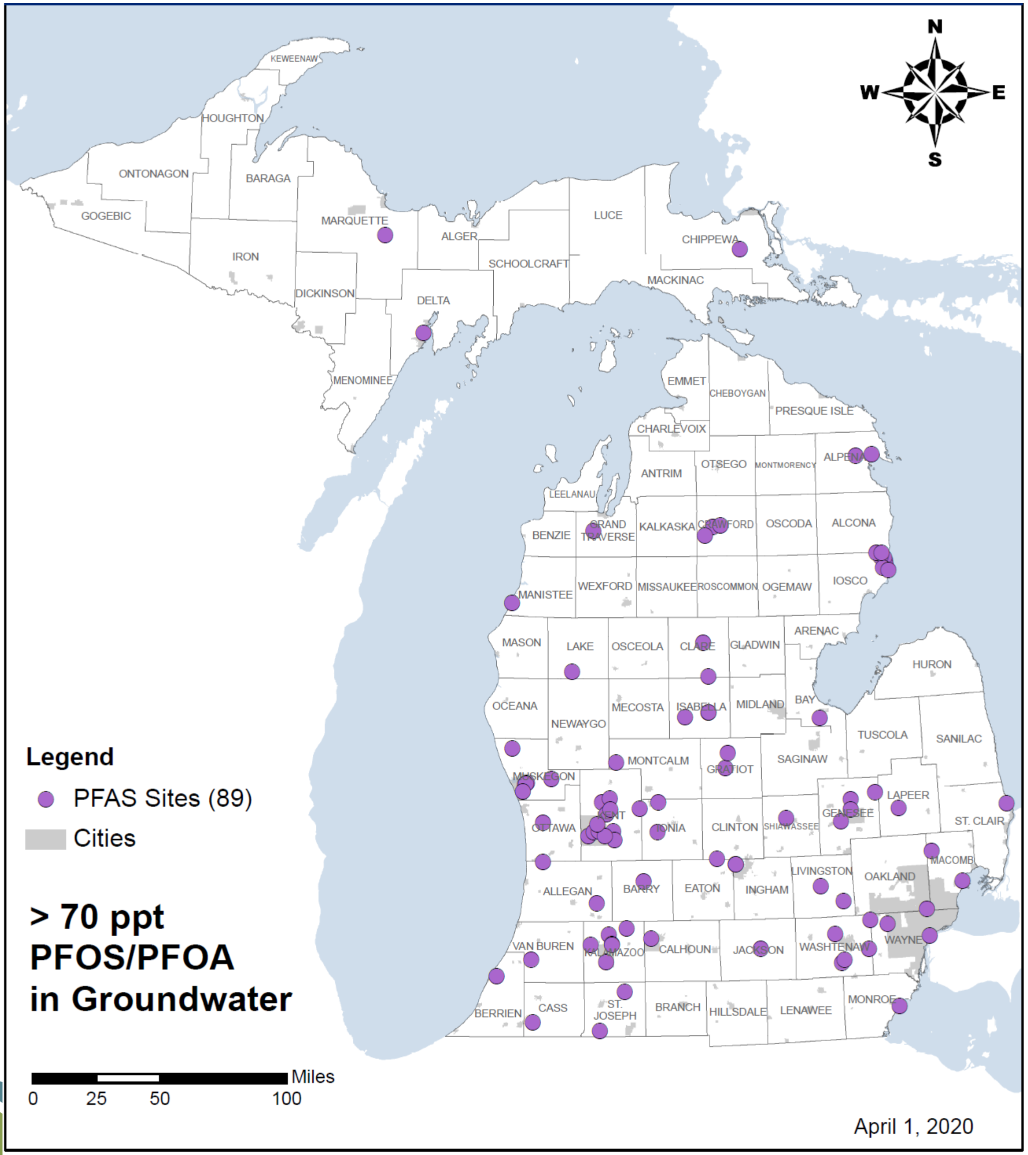
PFAS Cycle



EGLE MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

800-662-9278 | *Michigan.gov/PFASresponse*

7/2019



Groundwater Investigations

- Prioritized based on known or suspected sources, potential for exposure
- Protect drinking water pathway
- Multiple other investigations underway

EGLE




Surface Water Investigations

- Survey of surface water and fish
- Foam
- Wastewater

MI Public Water Supply Testing

- Phase I - 2018
  - All community water supplies (1,114)
  - All NTNCWS schools and day cares (619)
  - All Tribal systems (17)
- Phase II - 2019
  - Non-community water supplies (750 total)
    - 237 children's camps
    - 162 medical care facilities
- Monitoring
  - All 65 surface water systems
  - 61 systems > 10 ppt Total Phase I
- Phase III – 2020

EGLE

Phase 1 & 2 - PWS Sampling Results

Non-Detect	Total PFAS < 10ppt	Total PFAS > 10ppt	PFOS+PFOA > 70ppt

Phase 1 = 1,740 Supplies

89.7% (1,561)	6.6% (115)	3.6% (62)	0.1% (2)

Phase 2 = 482 out of 632 Supplies

91% (439)	5% (24)	3.8% (18)	0.2 % (1)

EGLE

MI Standards

Surface water quality
- ✓ 11/12 ppt PFOS
- ✓ 420/12,000 ppt PFOA

Groundwater cleanup
- ✓ 70 ppt PFOA/PFOS
- ✓ GSI per surface water quality standards

Drinking water
- ✓ 70 ppt PFOA/PFOS lifetime health advisory recommendation
- ❑ MCLs

Establishing Drinking Water Standards

- No federal standards on the horizon
- Science Advisory Panel Report, December 2018
  - **70 ppt standard for PFOA/PFAS could be too high**
  - **Other PFAS should be considered as well**
- Michigan's two-step approach
  - **Science Advisory Workgroup recommendations on June 27, 2019**
  - **Rulemaking underway**

EGLE

Proposed Drinking Water Standards

Specific PFAS	Parts Per Trillion (ppt)
PFOA	8
PFOS	16
PFHxS	51
PFNA	6
PFBS	420
GenX	370
PFHxA	400,000

- Versus 70 ppt PFOA+PFOS
  - Evolving science
  - Differences among PFAS
- 2,700 water systems
- Implications for groundwater cleanup standards

Environmental Studies and Research

- Understand occurrence of PFAS
- Develop guidance and regulation
- Inform policy

Public Health Studies

Exposure assessment	Kent County
Biomonitoring	Statewide Firefighters
Health Study	Kent County Parchment Cooper Township
Other Investigations	Oscoda County

EGLE

Michigan's Approach

- Coordinated
- Proactive
- Evidence-informed policy-making

Michigan PFAS Action Response Team (MPART)

www.Michigan.gov/PfasResponse

EGLE
Michigan Department of Environment, Great Lakes, and Energy

Michigan Department of Agriculture & Rural Development

MDHHS
Michigan Department of Health & Human Services

MDOT
Michigan Department of Transportation

Department of Natural Resources DNR Michigan

LARA
Licensing and Regulatory Affairs
Customer Driven. Business Minded.

Department of Military and Veterans Affairs Michigan

Question and Answer Session

We will draw initial questions and comments from those submitted via the chat box during the presentations.

Today's Speakers

John Scott – zhewang@illinois.edu
Ganga Hettiarachchi – ganga@ksu.edu
Steve Sliver – slivers@michigan.gov

Thank you for participating in today's *The Current*!

Visit our website, northcentralwater.org, to access the recording and our webinar archive!