PFAS THREAT TO LAND APPLICATION

Ian Pepper
The University of Arizona

EVALUATION OF FATE AND TRANSPORT OF PFAS FOLLOWING LONG-TERM LAND APPLICATION OF BIOSOLIDS: A COLLABORATIVE NATIONAL STUDY

National Collaborative Project Overall Objective

To evaluate whether or not land application of biosolids is a significant public health route of exposure to per- and polyfluoroalkyl substances (PFAS)

THE ISSUE

- PFAS identified as causing adverse human health effects
- PFAS known to be present in wastewater and ultimately in biosolids

THE QUESTION

- Does land application of biosolids result in significantly increased human exposure to PFAS?
- Will it lead to a national ban on land application?

ROUTE OF EXPOSURE

- Exposure to PFAS in groundwater (leaching through soil)
- Exposure to PFAS in crops (plant uptake)

LOCAL PROBLEM SOLVED BY LOCAL STUDY

- January 2020 – Pima County Board of Supervisors impose moratorium on land application in Pima County (Tucson, AZ)
- March – October 2020 – University of Arizona Water and Environmental Technology Center (WET) in collaboration with Pima County Wastewater evaluate incidence and transport of PFAS following long-term land application
- Data showed low incidence of soil PFAS and limited mobility of PFAS through soil and vadose zone
- Data presented to Pima County Administrator and Board of Supervisors
- December 2020, moratorium rescinded
- Peer review publication: 793 (2021) 148449

FOR A NATIONAL PROBLEM WE NEED A NATIONAL STUDY

SPECIFIC OBJECTIVES

Evaluate

- Conduct a literature review of land application/PFAS studies, past and present to ensure collaborations with, and extensions of, ongoing work and negation of duplicative research
- Incidence of PFAS analytes in soil following long-term land application of biosolids
- Mobility (leaching) of PFAS analytes through soil and vadose zone under natural conditions including the influence of rainfall and/or irrigation
- Crop uptake of PFAS analytes
- Utilize paired data sets of soil PFAS concentrations versus plant uptake

These specific objectives should be evaluated over a variety of different soils, depth to groundwater, and climates, by studying land application plots nationally, across the entire United States, including irrigated and non-irrigated soils.

Depth and breadth of dataset should be sufficient to allow future predictions of possible groundwater contamination events and crop uptake of PFAS.

HOW THE PROPOSED STUDY IS UNIQUE AND DIFFERENT FROM EPA-FUNDED RESEARCH ON PFAS

- National scope over all of the US
- Research at each study site will be identical allowing for direct comparison of results
- Study will allow for unique model development
- Proactive stance will pre-empt any attempt to ban land application nationally

SCOPE OF WORK

- This is a draft scope of work suitable to aid fundraising
- The final scope of work will be developed once we know what funds are available for the project
- Careful planning is vital to ensure project is complementary to past and present ongoing research

SCOPE OF WORK IN YEAR 1

GOAL: Evaluate the incidence and mobility of PFAS in soil following long-term land application of Class B and/or Class A biosolids

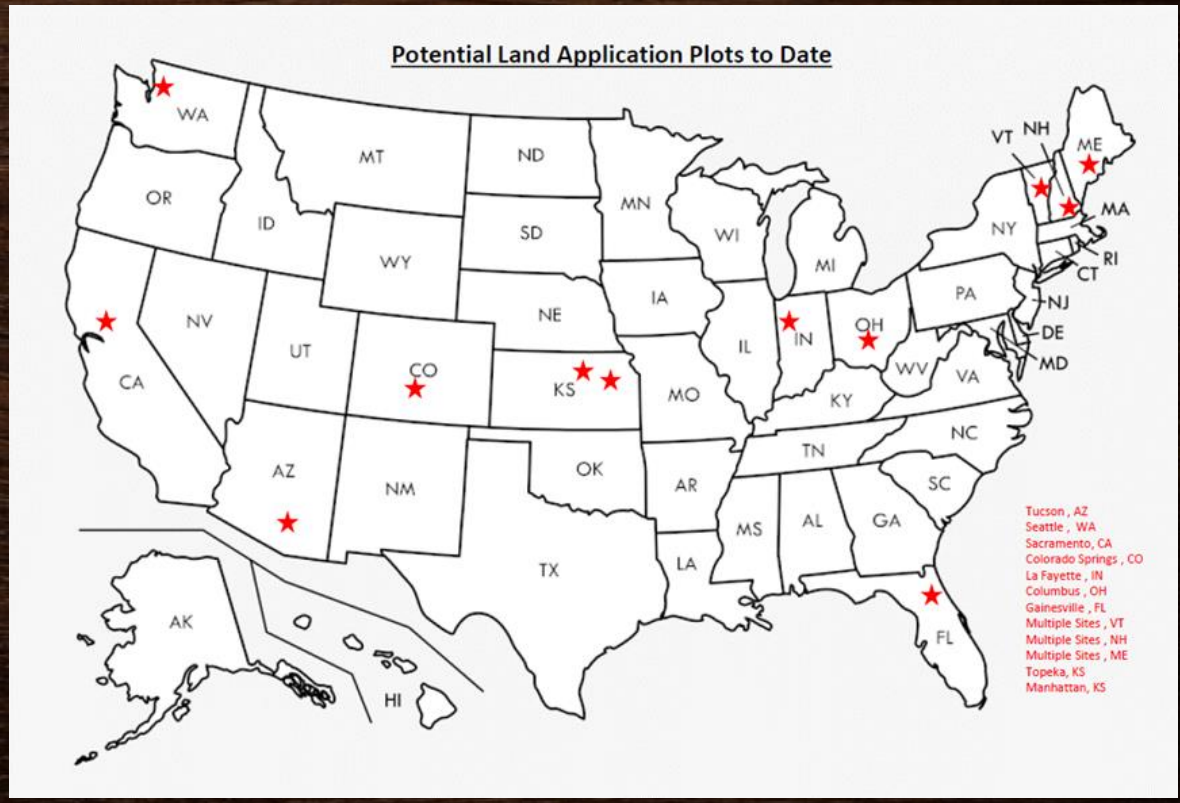
Soil Sample Collection at Select Sites

- Soil samples taken at 1, 3 and 6 feet depths from the surface
- 4 replicates
- Samples collected from across the U.S.
  - Farmers with long-term land application plots, with records of biosolid loading rates
  - Academic researchers with established long-term land application plots with known biosolids applications at different loading rates
  - We anticipate at least 30 sample sites across broad geographic regions

POTENTIAL SITES TO BE SAMPLED (to date)

- We already have potential sites identified in 10 states nationally and anticipate many more.

- Necessary criteria to be eligible for the project
  - Long-term (>10 years) land application
  - Known loading rate of biosolids
  - If possible, multiple loading rates (2 or 3 different rates) plus control (no biosolids)
  - Any soil PFAS data from prior years
  - Rainfall or irrigation data, if possible
  - Soil characterization data, if possible
  - Depth to groundwater
  - PFAS analytical data from biosolids, if available



COLLECTION AND PROCESSING OF SOIL SAMPLES

- Stringent precautions must be followed to avoid contamination
- Protocols already in place will be sent from the University of Arizona
- Samples should be collected via the use of 4” soil augers
- Approximately 1000g samples of soil should be collected
- Samples should be sent to the University of Arizona
- Samples will be air dried and sieved (2mm) at the University of Arizona
- Samples will be sent to Eurofin Los Angeles for PFAS analysis via UPS or reliable University labs e.g., University of Arizona, Purdue University

SOIL CHARACTERIZATION

- Biosolids applied soil and control soil (no biosolids) samples will be analyzed from each site
  - Texture, pH, organic matter, metals
  - CEC, Electrical conductivity, N P K
  - Hydraulic conductivity, soil-water characteristic curve

SUITE OF PFAS ANALYTES TO BE CONDUCTED (this is not the final list – needs discussion)

DONA
F-53B Major
F-53B Minor
HFPO-DA (GenX)
N-ethylperfluorooctanesulfonamidoacetic acid (NEtF)
N-methylperfluorooctanesulfonamidoacetic acid (Nme)

Perfluorobutanesulfonic acid (PFBS)
Perfluorodecanoic acid (PFDA)
Perfluorododecanoic acid (PFDoA)

Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)

Perfluorohexanoic acid (PFHxA)
Perfluorononanoic acid (PFNA)
Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorotetradecanoic acid (PFTeA)
Perfluorotridecanoic acid (PFTriA)
Perfluoroundecanoic acid (PFUnA)

GROUNDWATER ANALYSIS

Groundwater from sites with existing monitoring wells will be analyzed for PFAS analytes

- Number of samples TBD

DATA ANALYSIS

- All data will be recorded at the University of Arizona
- Data for individual sites will be sent to the PI responsible for the site for statistical analysis
- Any available soil PFAS data from previous years should also be identified
- These data will ultimately be used to quantify the incidence of PFAS following land application under a broad range of influencing factors. They will also be used for the development and testing of models to predict PFAS leaching potential. Such models can be employed to help assess risks of groundwater contamination, and to determine soil screening levels that are anticipated to be protective of groundwater quality

PFAS TRANSPORT WITHOUT BIOSOLIDS

- Dr. Brusseau (University of Arizona) will evaluate PFAS transport through pristine soils via a $1.2m Department of Defense grant
- Data will allow for an evaluation of the effects of biosolids on mobility, relative to non-biosolid PFAS transport and will aid in model development

SCOPE OF WORK FOR CROP UPTAKE STUDIES (Year 2)

Goal: Evaluate the potential for crop uptake of PFAS following land application

In the interest of time, only general concepts are presented here. Actual details or proposed studies will be developed by the W4170 National Research Group on land application over several months.

- Uptake studies likely to begin Fall 2022 or Spring 2023
- Uptake from existing long-term land application plots utilized in Year 1 for incidence and mobility study with and without fresh application of biosolids
- Depending on funding availability new land application sites may be developed
- Biosolids will be analyzed for PFAS prior to application for inclusion in study
- Crops to be grown: these will include two crops that can potentially be grown all over the United States e.g. wheat + ??
- All sites will be “real world” in size and subject to standard agricultural and biosolids application practices
- All studies will be replicated (4 reps ?)
- PFAS analysis of plant material will be conducted following harvest of each crop
- PFAS analytes to be investigated will be determined based on analytical capability

DATA ANALYSIS

- Data will be statistically analyzed by PI responsible for the site
- Data will be interpreted with respect to uptake from different soils, climate zones, crop type and biosolid loading rates
- Data will also be analyzed with respect to potential health hazards from PFAS ingested via intake of crop residues through risk assessment

FUNDING REQUIRED (YEAR 1)

Estimate

Cost Per Site:

3 soil depths x 4 replicates x 3 loading rates (hypothetical) = 36 samples

1) Soil Sampling Personnel = Cost covered by partners	
2) Shipping	TBD
3) Soil Processing	$800
4) PFAS Suite Analysis ($400/soil sample @ 36 samples)	$14,400
5) Groundwater collection & PFAS analysis ($300/sample)	TBD
	$15,200 + shipping + groundwater analysis

Soil sampling and analysis for 30 sites = $456,000 + shipping

Groundwater monitoring cost = $300/sample, total for all sites TBD

Total project cost estimate (year 1) ≈ $0.5 million

FUNDING REQUIRED (YEAR 2)

- Funding requirements for crop uptake of PFAS is difficult to estimate without knowing details of specific experiments
- We anticipate that we need to raise at least $500,000 to conduct these studies in a meaningful manner
- The specific number of uptake studies will be tailored to the available amount of funding

TOTAL PROJECT COST≃ $1m PLUS

SUGGESTED CONTRIBUTIONS

Design flow greater than 50 MGD	$25,000
Design flow between 25 and 50 MGD	$20,000
Design flow between 5 and 25 MGD	$15,000
Design flow between 1 and 5 MGD	$5,000
All others	$1,000
Non-profit associations	$3,000
Consulting firms	$5,000
Biosolids private sector management firms	$10,000

LIKELY PARTNERS

1. Utilities: Any wastewater treatment plant that recycles its biosolids via land application may be interested in funding the project (16,000 WWTPs nationally)
2. Non-Profit Associations: Groups such as CASA, NACWA, NEBRA, MABA, NW Biosolids, Arizona Business Council will be contacted. These groups in turn are well connected with utilities.
3. Private Sector: Companies that manage biosolids for public agencies will be contacted. These include companies like Synagro, Denali Water, Material Matters and others.

PROGRESS TO DATE

- Advisory Committee formed
- Scope of Work created (Draft)
  - reviewed by Advisory Committee
  - would like input from W4170
- Draft Scope of Work will be sent to potential partners and contributors to aid in fundraising
- $85,000 pledged to date

PROJECT COORDINATION

- It is recommended that all funding contributions be sent to the University of Arizona, Water and Environmental Technology Center (WET)
- Need a central collection agency (WET) which will document all contributions within an Advisory Committee oversight
- All funding of projects will also be documented with Advisory Committee oversight i.e. $$ going from project funds at UA → collaborating research groups
- All funding transactions will be transparent and well documented
- University of Arizona will apply low overhead (indirect cost) rate of only 10%
- WET Center has 20 years of experience of collecting membership funds (input) and establishing subaccounts for chosen research projects (output)
- A project advisory subcommittee will provide input on project as it proceeds and recommend improvements as appropriate
- USEPA will be communicated with in every step to ensure the project provides them what is needed in order to perform credible risk assessment

PROJECT OUTCOMES

- Documentation of whether or not land application of biosolids is a significant public health route of exposure to PFAS via contamination of groundwater and/or crop uptake
- Development of models to predict whether or not significant leaching of PFAS through soil and vadose zone is likely to occur
- Risk assessment of ingestion of crops grown on land applied plots
- Specific recommendations for the need of:
  - groundwater analysis for PFAS
  - impact, if any, to crops at land application sites
  - continued land application due to low potential risk of PFAS exposure
- Presentations at national and international meetings
- Final report and recommendation to EPA
- Other ??

IF YOU'RE INTERSTED IN THE PROJECT, CONTACT:

Ian Pepper
ipepper@email.arizona.edu or 520-626-2322

Greg Kester
gkester@casaweb.org or 916-446-0388