374WATER

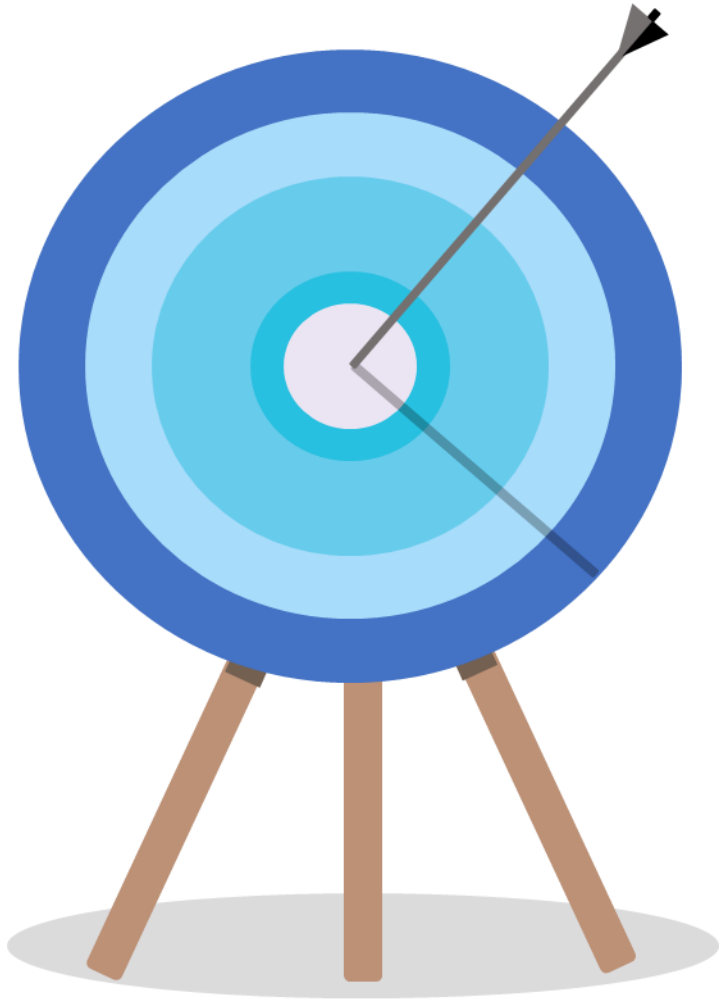
Clean and Sustainable Destruction of Organic Waste

Implementing a Demo Supercritical Water Oxidation (SCWO) system in Orlando, Florida

CIFA SRF Workshop - November 2024

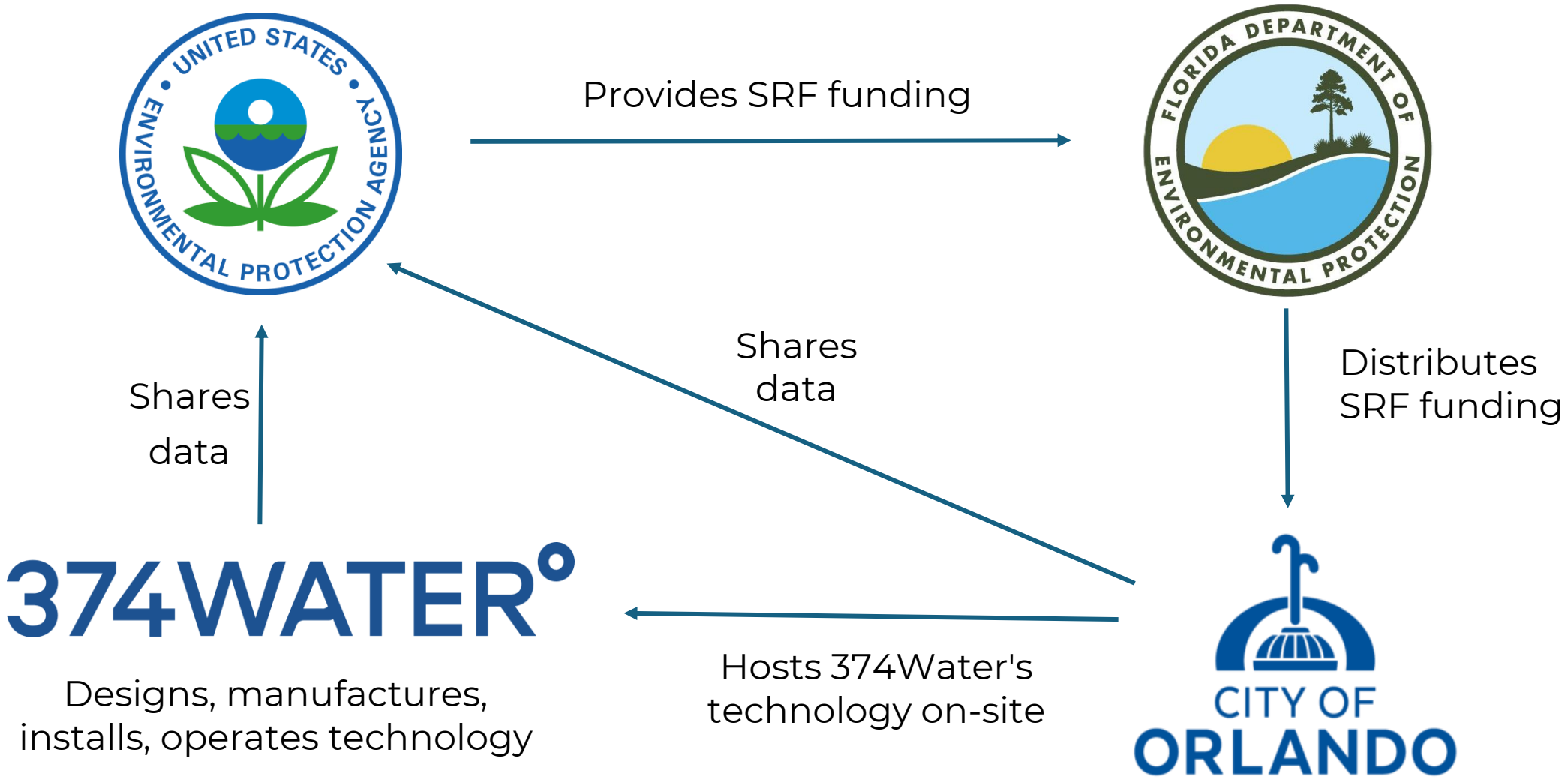
Learning Objectives

- How to apply for Clean Water SRFs for demo projects
- Carrying out an SRF funded demo for sludge treatment
- What is SCWO & how does it apply to biosolids management
- What comes next & how to fund it



Source: 374Water

Project Collaborators



SRFs in an age of innovation

Main project enablers:

- **The City of Orlando:** is uniquely committed to R&D and innovating, some examples:
  - Water Conserv II facility: "Zero Discharge" method
  - Iron Bridge Wetlands: polishes effluent, supports aquatic plants & wildlife

- **SRF Funding:** funds ---> demo (or permanently install) new technologies ---> less risk of large expenditures on new tech

- **Policy:** increased stringency on nutrient loading and contaminant removal support companies with innovative wastewater treatment tech

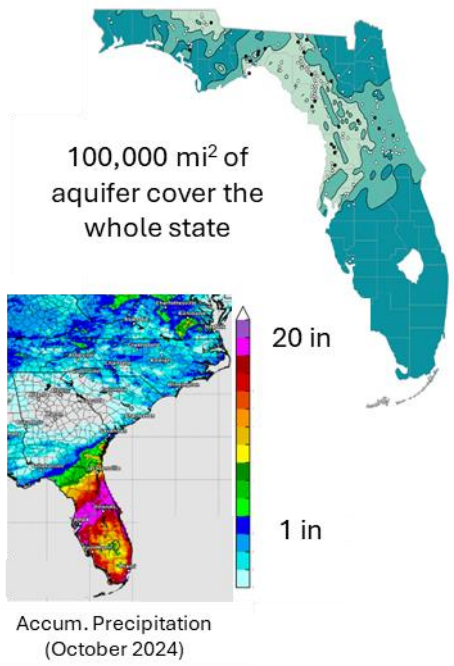
Water Conserv II infiltration Basins

Iron Bridge Wetlands

Project Motivation & Goals

Goal 1: implement an all-weather solution that reduces dependence on land application

Why? SB 712 restricts biosolids land application when groundwater is within 2 feet of the surface



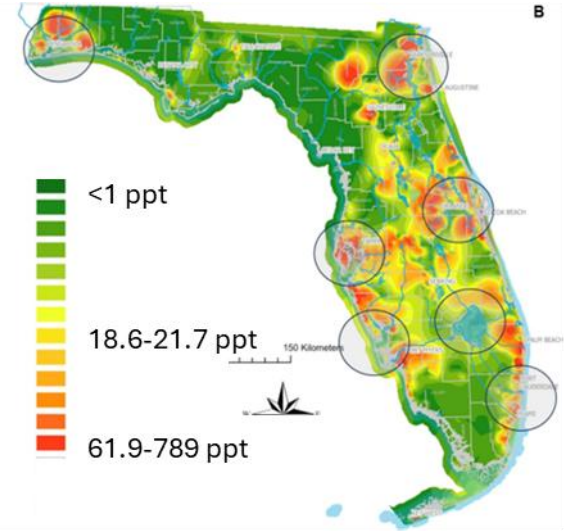
Accum. Precipitation (October 2024)

USGS

Florida's Large groundwater network & wet weather ---> frequent restrictions

Goal 2: eliminate PFAS from the treatment residuals needing management

Why? Proactive measure in response to potential PFAS in wastewater/biosolids regulations



Predicted total surface water PFAS levels (based on empirical data)

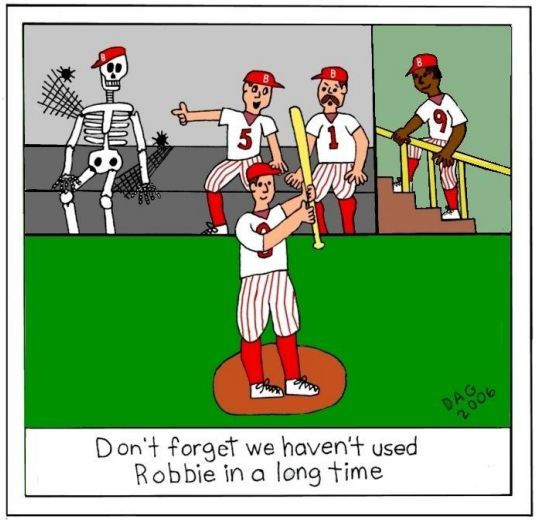
ACS EST Water 2024, 4, 10, 4343-4355

PFAS levels in surface water around FL can be very high (>50 ppt)

Proactive measures to reduce impact of WWTP effluents & residuals is vital

Technology Evaluation

	Composting	Drying w/Pelletization	Incineration	SCWO
CAPEX	Low	High	High	High
OPEX	High	High	High	Medium
End-product	Class B biosolids	Class A biosolids	Ash	Minerals
Organic CEC destruction	Low	Low	Medium	High
Main challenge	3rd party dependent	Labor intensive	Air permitting	Limited full-scale data



SCWO needs more "game time"

the City of Orlando, SRF funding, and policy drivers are enabling that!

Project Funding

SRF Application Components:

- Schedule
  - Planning documentation, engineering design, certification of site availability, permitting*
- Requested loan amount
- Pilot study plan
- Request for Inclusion submitted February 14, 2023, awarded on February 22, 2023
- Note: aside from staff time, the demo was funded 100% by the SRF grant

Task	Cost
Schedule 1 – System Design & Site Prep	$52,000
Schedule 2 – Mob, Install, Commission, Start-up	$118,000
Schedule 3 – Operation & Maintenance	$574,000
Schedule 4 - Demobilization	$68,000
Total	**$812,000**

*Note that in this case permitting was not required as it was a demonstration study

Project Implementation

- SRF Grant agreement signed February 2024
- Pilot agreement with 374Water signed February 2024 after receipt of grant agreement

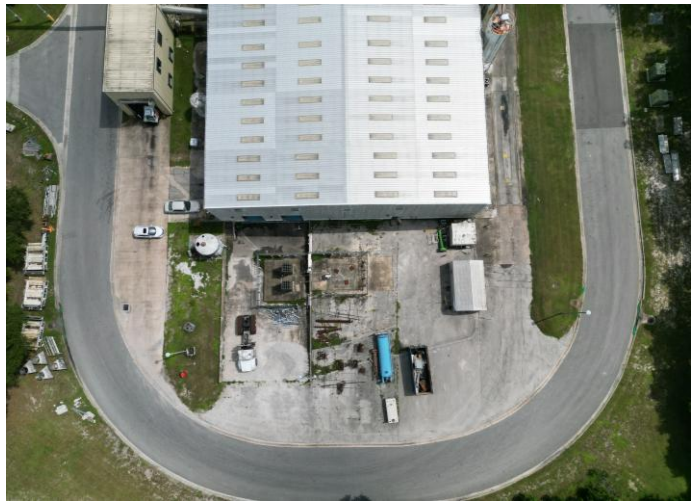
Project Implementation – Site Evaluation Stage

374Water AirSCWO Site Requirements

- Water
  - Hose or tap connection
  - Discharge or storage for distilled water
  - Discharge of SCWO effluent to headworks
- Electricity
  - 400/480 3 Phase, 200 Amps max draw during start-up
- Fuel storage (~50 gal)
- Pre-treatment equipment*:
  - Dewatering
  - Maceration
  - Screening

Iron Bridge Water Reclamation Facility

40 MGD Max / 25 MGD AADF
~56,000 wet tons sludge/ year (13.8% DS)



*Can be included in project scope if not pre-existing at site

Project Implementation – System Design

2013

- Duke University in Durham, NC built first air-based SCWO system
- AS1 was capable of processing 1 wet ton per day
- Nearly 190 different wastes processed over ~10 years

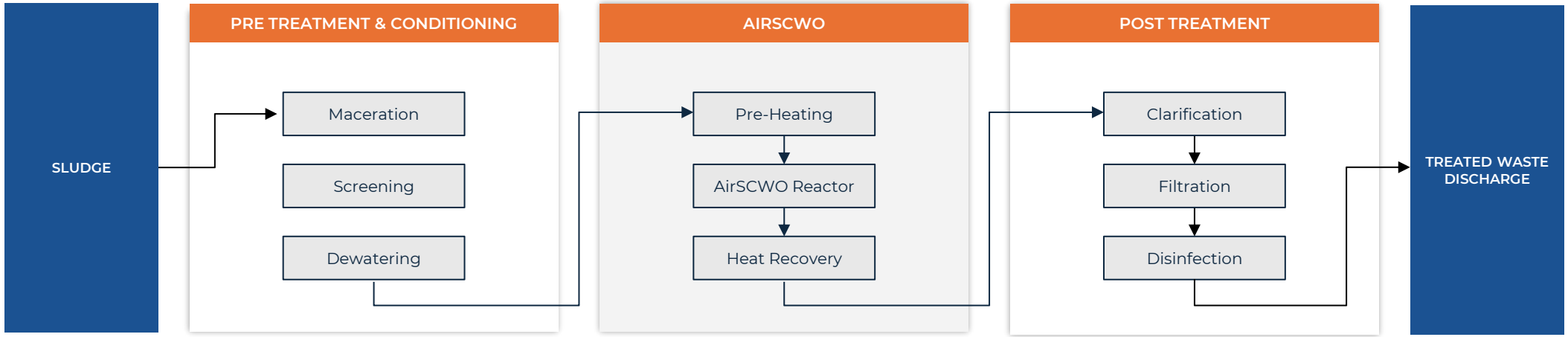
2022

- First commercial scale unit built in Kokomo, IN
- AS6 is capable of processing 6 wet tons of waste per day

2024

- AS6 unit deployed at the City of Orlando, FL

Project Implementation – System Installation



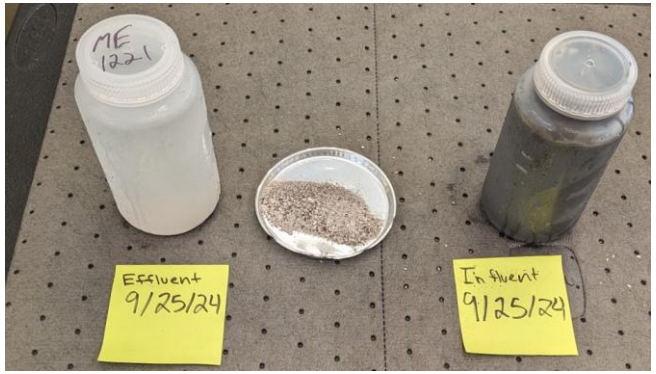
PRE TREATMENT & CONDITIONING

Macerate & remove inorganics (>2-4mm)

Adjust %DS to make pumpable & energy rich

AIRSCWO

POST TREATMENT



Project Implementation – Operation (AirSCWO Concept)

What happens inside the AirSCWO reactor?

- The sludge, water, air mixture is heated & pressurized (>374°C and >221 bar)
- The water in this mixture becomes supercritical water, a fluid that easily dissolves organics (e.g. PFAS) and gases (e.g. O_2)
- Organic compounds break into their elements, carbon gets converted to CO_2 (g), nitrogen is converted to N_2 (g) , and inorganics are oxidized

Example reaction:

$$2\ CF_3(CF_2)_6COOH + 7\ O_2 + \text{base} \xrightarrow[(>374°C\ \text{AND}\ 221\ \text{bar})]{\text{AirSCWO}} H_2O + 15\ F_2\ \text{salt} + 31\ CO_2 + \sim 8276\ \text{kJ/mol}$$

(PFOA) (air)

Project Implementation – Operation (AirSCWO Performance)

Goal 1: implement an all-weather solution that reduces dependence of land application*

- Data collection on % reduction of residuals requiring handling is ongoing (at ~3 month mark it will be assessed)

Goal 2: eliminate PFAS from the treatment residuals needing management

PFAS Compound	Detected Residual PFAS (ng/L or ppt)	% Removal
PFBA	10.2	99.86%
PFHxA	5.15	99.89%
PFNA	1.07	99.90%
PFDA	0.8	99.97%
PFUnA	<1.10	> 99.89%
PFBS	<0.19	> 99.98%
PFPes	<0.29	> 99.98%
PFHxS	0.28	99.99%
PFOS	0.65	99.99%

*while not detrimentally impacting the plant with process effluent

Next Steps

- Complete a successful pilot study
- Share results with the FDEP/EPA
- Orlando receives part 2 of the grant for design, construction and installation of AirSCWO 30
- Enter into long term relationship with Orlando to continue operations of the AirSCWO 6 to test other PFAS contaminated materials
- Build and test AirSCWO 30 at Iron Bridge
- Relocate AirSCWO 30 to Orlando's Water Conserv I facility, the City's smallest of three treatment plants which processes an average of 5.5 MGD
- The AirSCWO 30 should be capable of handling all sludge produced at Conserv I for the immediate future

Takeaways & Tips

- **Best advice** – reach out to your stat's SRF grant coordinator and see if they have any Clean Water (wastewater) emerging contaminants funding available
- If so, put together a draft proposal for their consideration and present to the state for review
- Find out what the approval cycle is for SRF projects and get on the list.

Bottom line: SRF Funding enables wastewater facilities that may not otherwise have the means to take on new R&D projects that can save $$, make meeting permits easier, and better protect the environment and human health

THANK YOU

Many thanks to:

US EPA, FL DEP, The City of Orlando, & all at 374Water, who each have uniquely contributed to get this demo off the ground

Visit 374Water.com or contact

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