Water & Environmental Technology Center

An Industry & University Cooperative Research Center

TEMPLE UNIVERSITY

ASU ARIZONA STATE UNIVERSITY

THE UNIVERSITY OF ARIZONA

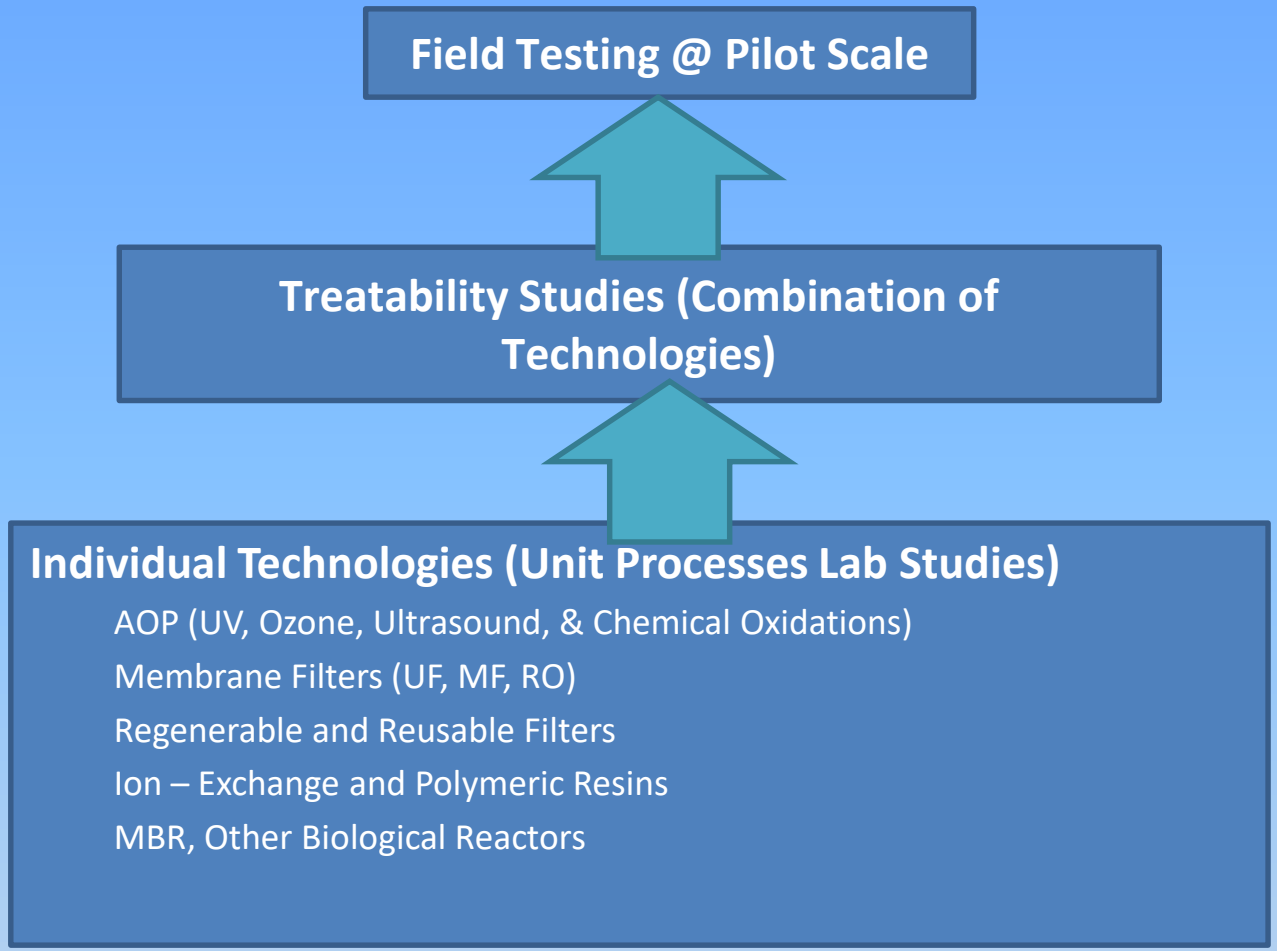
WET Center Overview

- Industry & University Cooperative Research Center founded in 2009
- Oversight by the National Science Foundation (NSF)
- Temple U is lead University + UA & ASU
- Conducts industry relevant, pre-competitive research
- Focused on emerging contaminants, water, & wastewater
- **Industrial Advisory Board (IAB) directs research done by the Center**
  - 35 Members – companies, DoD, & municipalities
- Funding from NSF & IAB members “pooled”
- IAB members get intellectual property rights to research

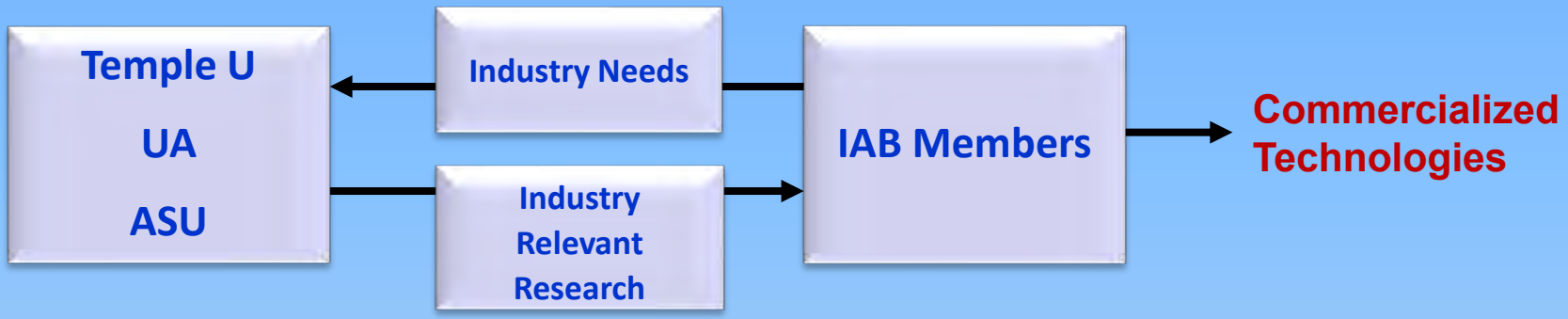
Types of Research Conducted

IAB Members developed a "Technology Roadmap" to Bound Research Efforts

Lab to Field Progression



University-IAB Synergy



- IAB expresses needs
- Universities develop project proposals
- IAB guides research
- IAB implements technologies via commercialization

New Expanded Center Proposed

- **Proposed "Center for One Water" under review by National Science Foundation**
  - Covers "all things" related to water

- **Proposed additional universities**
  - University of California, Irvine
  - University of Nevada, Reno
  - Johns Hopkins University

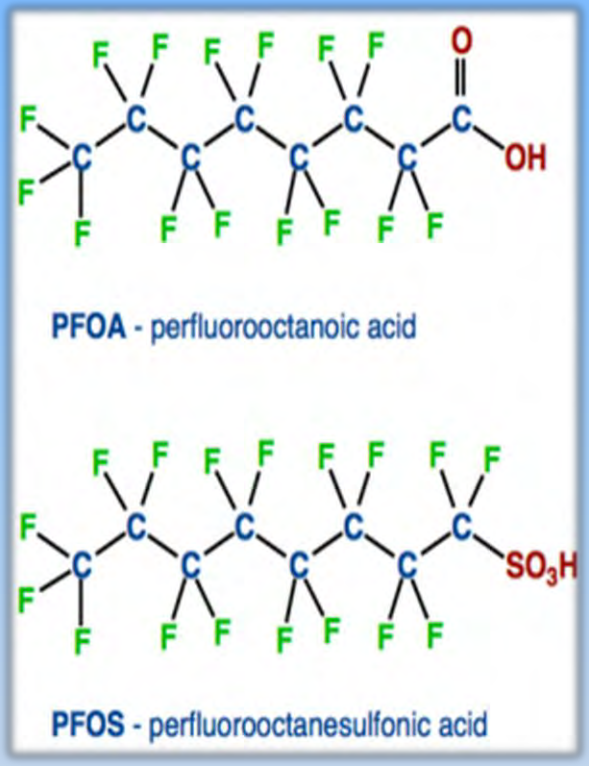
Each University Adds Specific New Expertise

Key Takeaways

- **Research is directed by Industrial Board**
- **Membership fees are "pooled" & used for projects**
  - Leverages scarce resources
- **Objective is to conduct research that leads to real world solutions, implemented by the private sector**

Per- and Polyfluoroalkyl Substances (PFAS)

Wet Center Capabilities & Projects



WET Center PFAS Capabilities

- Detection in the environment
- Sampling and state-of -the science analytical techniques
- Innovative treatment technologies
- Human & ecological health assessments (e.g., assessing toxicity and estrogenicity)

PFAS Treatment Technology Assessment

- **Developed for DoD by the WET Center**
- **PFAS Technology Categories**
  - Adsorption/desorption
  - Ion Exchange
  - Precipitation/Sludge Disposal
  - Oxidation/Reduction
  - Membrane Filtration

PFAS Treatment Technology Assessment
Key Conclusions

- Lot's of research & field studies on PFAS technologies
- Only a few are proven, reliable, controllable
- Granular Activated Carbon (GAC) and/or Ion Exchange (IX) currently best for groundwater/water treatment
  - Some limitations with GAC on short chain PFAS
  - Spent media can be incinerated (single-use) or regenerated
  - WET Center investigating PFAS destruction from media regeneration
  - Some important differences between GAC/IX

*** WET Center Results Consistent with Assessments by National Groundwater Association and Interstate Technology & Regulatory Council**

PFAS Treatment Technology Assessment
Key Conclusions

- Low-pressure reverse osmosis (LPRO) looks promising for polishing drinking water to remove PFAS
  - $99M LPRO plant under design by CDM Smith in Brunswick County, NC
  - Pros: Pilot plant reduced 45 PFAS species to non-detectable
  - Also 94% reduction of 1,4-dioxane
  - O&M costs estimated less than methods requiring media change-outs
  - Con: Concentrated LPRO waste requires NPDES permit…planned discharge back to Cape Fear River…drinking water source

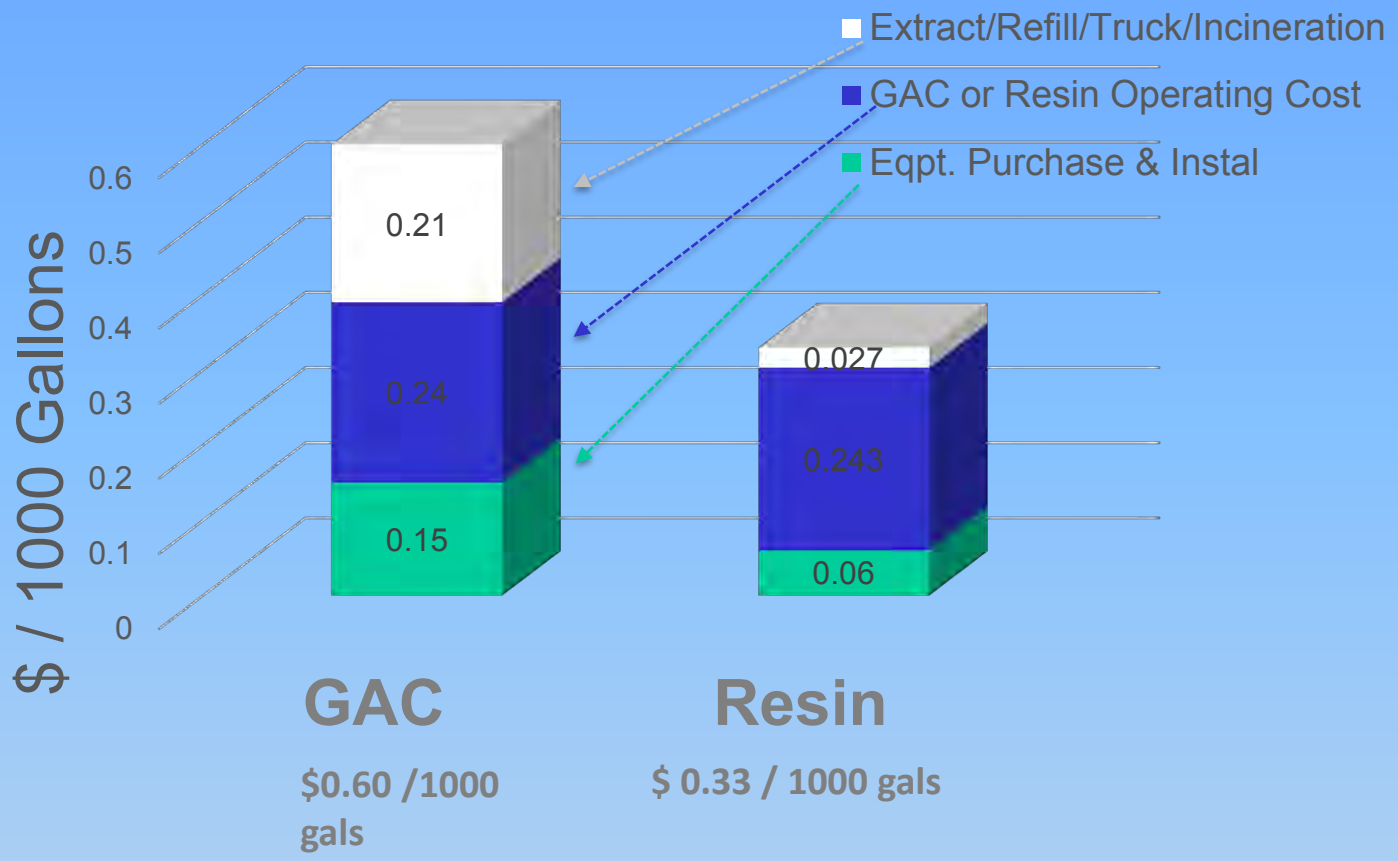
Observations on Single-Use Selective IX Resin

Based on Field Results from Horsham & Warminster, PA & Cherry Point, NC

• Simple, field-proven	Commercially available
• > 99.99% reduction to ND	Short & long chain PFAS
• Lower CAPEX ~ ½ of GAC	3X lower contact time
• Reduced footprint /headspace	Important in crowded areas
• High operating capacity	100,000 to 350,000 BV
• Competitive OPEX	Typical $0.15 to $0.40 / Kgal

Courtesy of Purolite, Inc.

Total Cost $ /1000 gals
Capital + Operating Cost - 500 gpm system



Treatment to < 70 ppt of combined PFOS + PFOA

Courtesy of Purolite, Inc.

IX Case Study

- Paper: “Polishing PFAS To Non-Detect Levels Using PFAS-Selective Resin”
- Published in *Water Online*
- Authored by personnel from Horsham Township PA, Gilmore & Associates, and Purolite

https://www.wateronline.com/doc/polishing-pfas-to-non-detect-levels-using-pfas-selective-resin-0001

Example WET Center PFAS Projects

- Removal of PFAS contaminants using ion-exchange and polymeric resin
  - Process commercialized by Purolite, Inc., a WET Center IAB member
  - Removes short and long-chain PFAS
  - More cost-effective than GAC*
  - Excellent pilot project results/data from sites at Warminster & Horsham PA & Marine Corps Air Station, Cherry Point, NC

* According to published field data from Purolite, Inc.

Example WET Center PFAS Projects

- Degradation of PFAS Using Advanced Oxidation Processes
  - Example: Persulfate oxidation in-situ
- In-vivo and in-vitro Toxicity Assessment of PFAS
- Regenerable Polymer Coated Sand adsorbent for the Removal of PFAS, VOCs and Chromium from Water
  - Goal is to destroy PFAS waste on-site…no off-site waste
  - DoD funded a project to advance development of process

Backup Slides

What Are PFAS?

- Per- and polyfluoroalkyl substances (PFAS) were widely used in a variety of consumer products and in fire-fighting foams used by the military, municipal fire departments and airports
- Found at very low levels both in the environment and in human blood
- PFAS bioaccumulate, meaning their concentration increases over time in human blood and organs.
- In May 2016 EPA established “health advisory” levels at 70 parts per trillion for PFOA and PFOS (either or combined)
- Carbon-Fluorine bond in molecules is very strong; Persistent in the environment & resist degradation/treatment
- Efficient & cost effective treatment technologies needed

Temple Advanced Analytical Capabilities

Equipment List

- UPLC/PDA/QToF
- UPLC/MS/MS
- GC/MS/MS
- GC/MS-P&T
- Ion Chromatograph

PFOA/PFOS History

1949 – 3M begins producing PFOS compounds; used in "Scotchgard"

1960s-2001- PFOS used in making AFFF (fire fighting foam)

1999 – EPA begins investigating PFCs risks

2006 – EPA & 8 companies announce PFC Stewardship program for production phase-outs by end of 2015

June 2007 – DoD EC Program completes a Phase I Impact Assessment for PFOA & PFOS

** Assessment notes risk related to PFOS releases at AFFF sites*

~2007 – Military Services begin to identify sites; response actions delayed due to uncertainty in toxicological science

January 2009 – EPA issues Preliminary Health Advisories for PFOA & PFOS & indicates plans for full assessment of science

May 2012 – EPA issues UCMR #3 with PFOA & PFOS

February 2014 – EPA Office of Water issues draft risk assessment

May 2016 – EPA issues new Lifetime Health Advisory