U.S.ARMY

PET3

Persistent & Emerging
Threats Toxicology Team

ENVIRONMENTAL APPLICATIONS OF 3D PRINTING: BENEFICIAL USE OF DREDGED SEDIMENT

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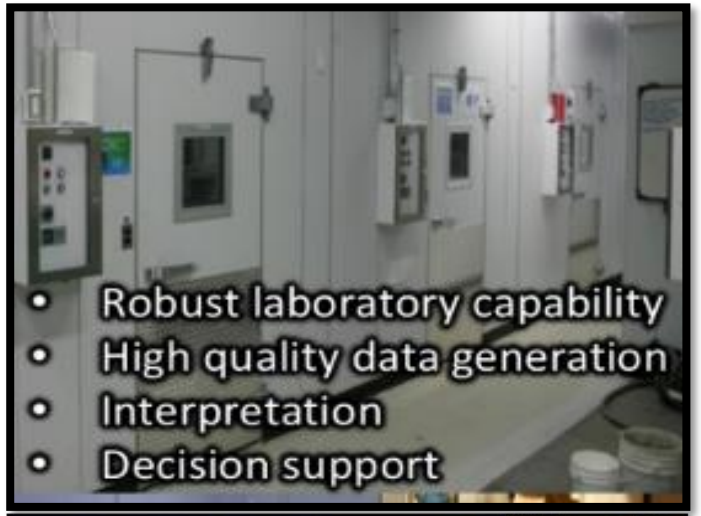
ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

Click for project information (ERDC EWN site)

Type of Work

Facilities: >10,000 sq. ft

- Environmental Toxicology Research Center
  - ➢Animal testing
  - ➢Sediment processing & storage
- Sediment, Particle and Polymer Characterization Lab
- Advanced aNd Additive Manufacturing Environmental Applications Lab (ANAMAL)
- New: Environmental Contaminant Mesocosm Effects Lab (EcoMEL)



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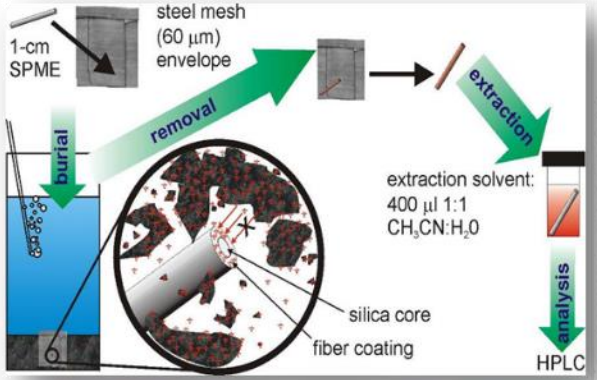
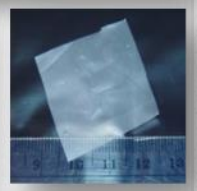
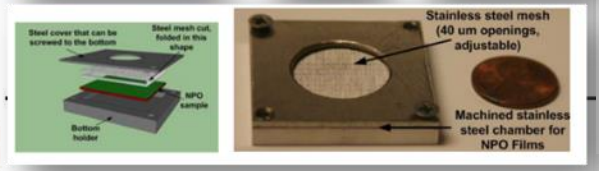
Sediment Passive Samplers

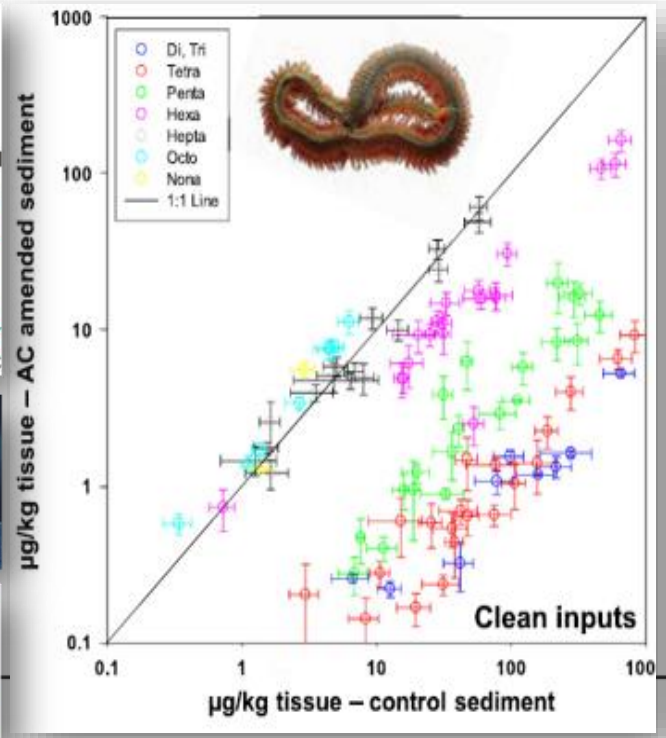
Can they be 3D printed?

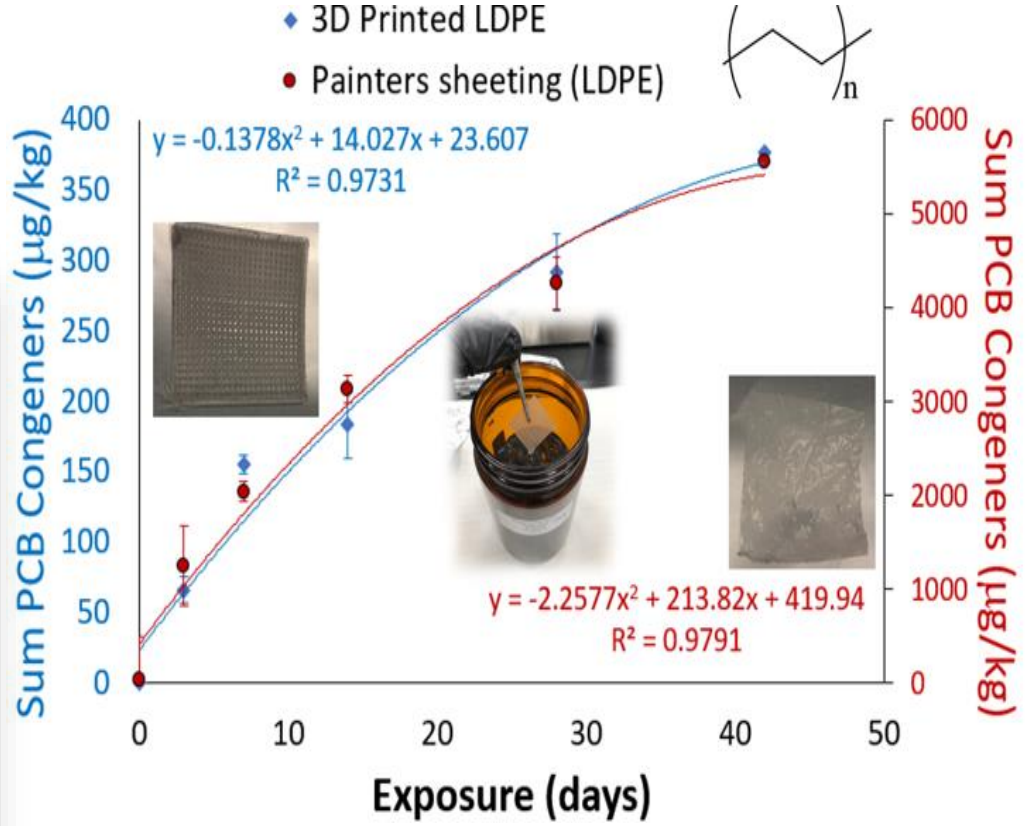
Sampling Phase or Media	Configuration
Polydimethylsiloxane (PDMS-SPME)	Coated fiber, vial
Polyethylene (PE)	Film/sheet, tube
Polyoxymethylene (POM)	Film/sheet
Ethylvinylacetate (EVA)	Coated vial
Silicone rubber	Sheet, Ring











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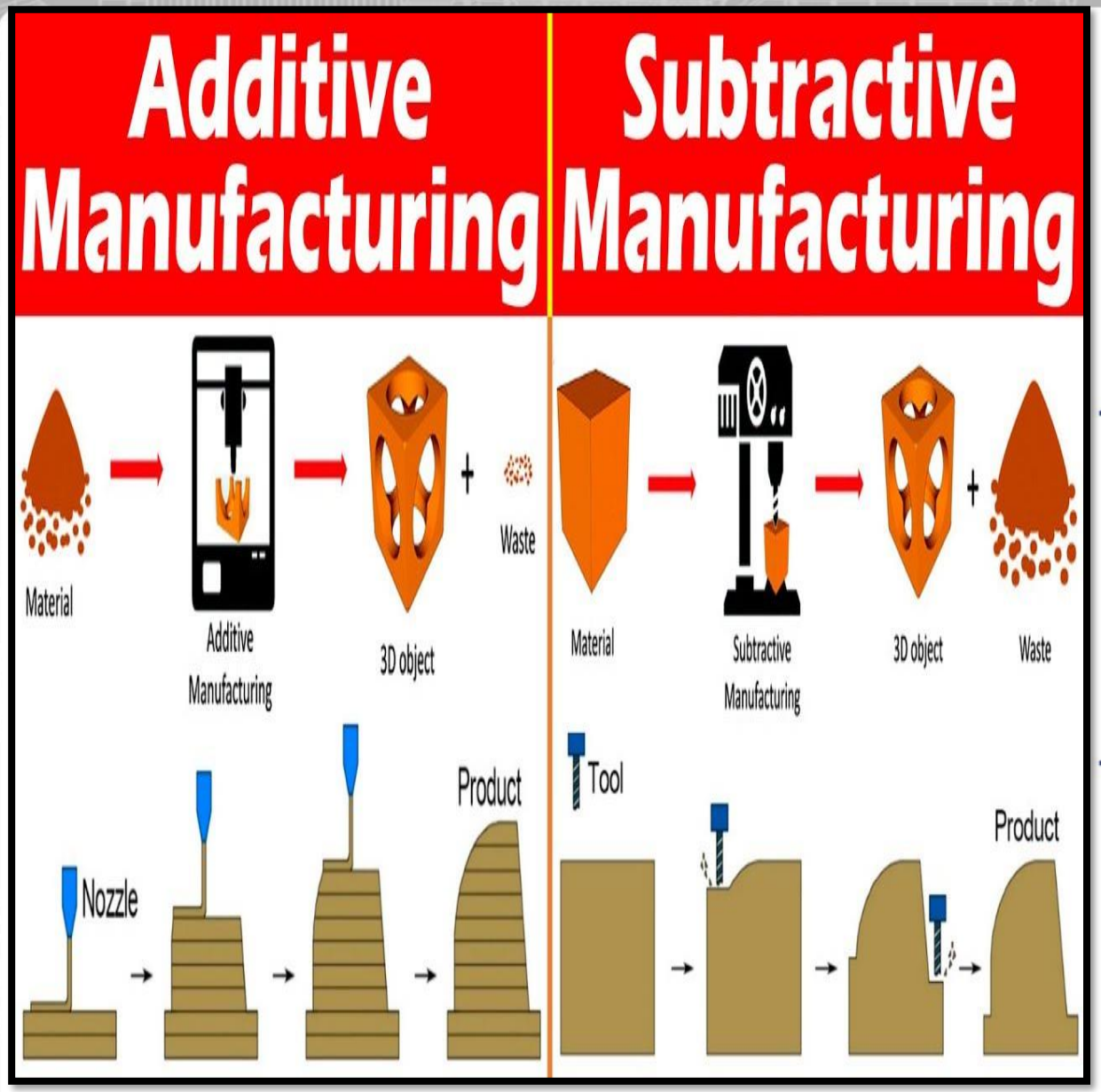

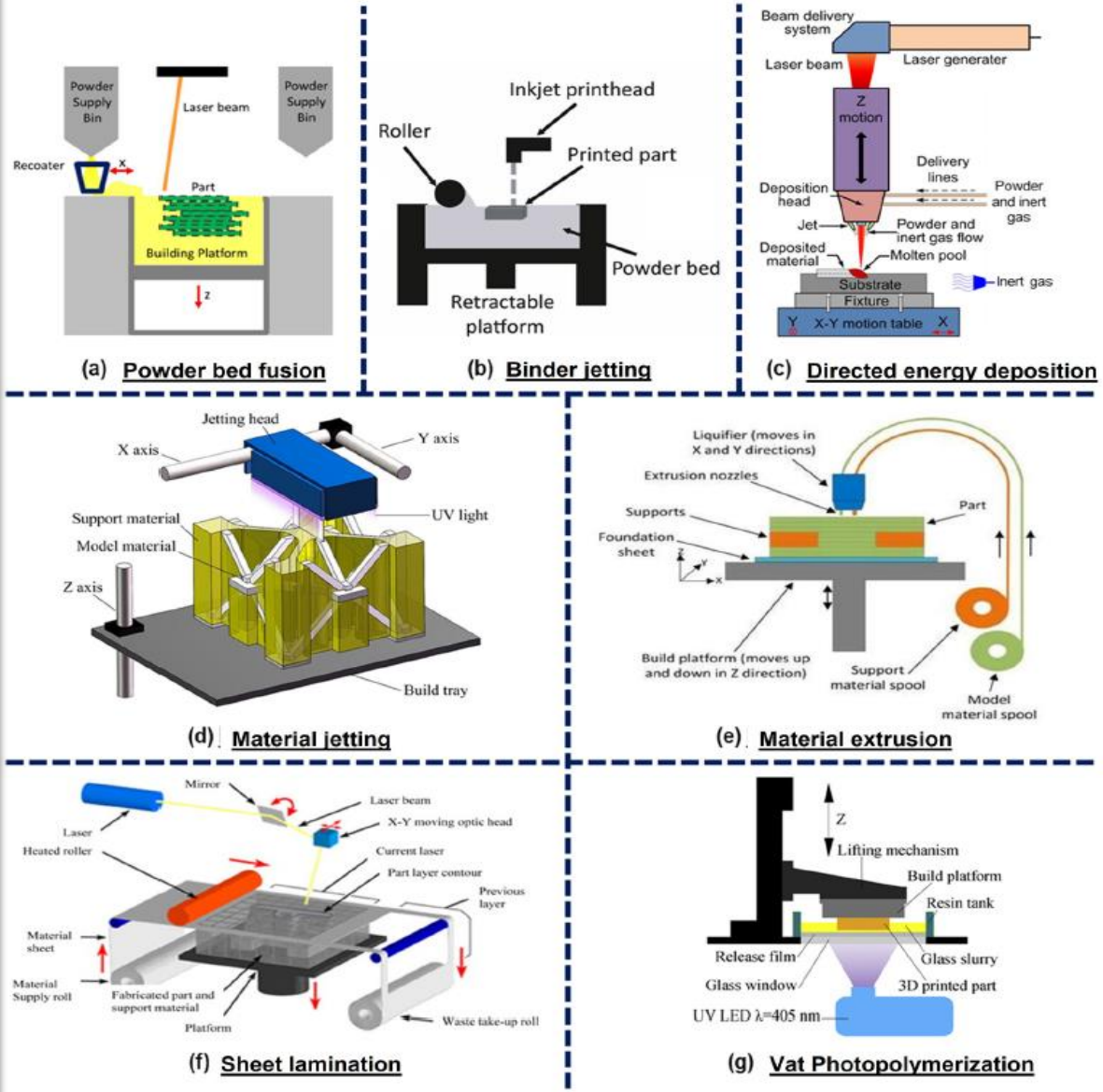

https://link.springer.com/chapter/10.1007/978-3-031-23156-8_8

Yusoff et al. *J Water Process Eng* **2023,** *51*, 103410.

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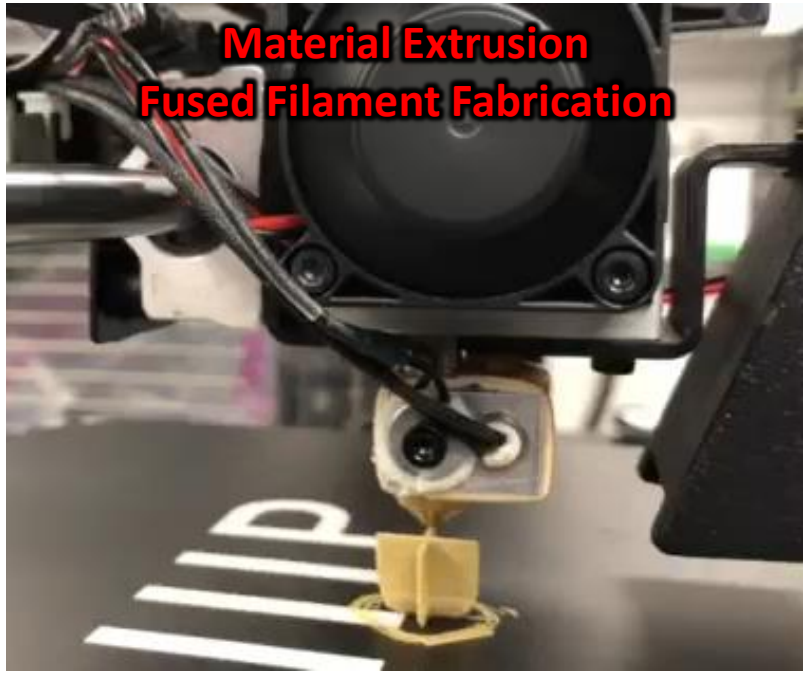
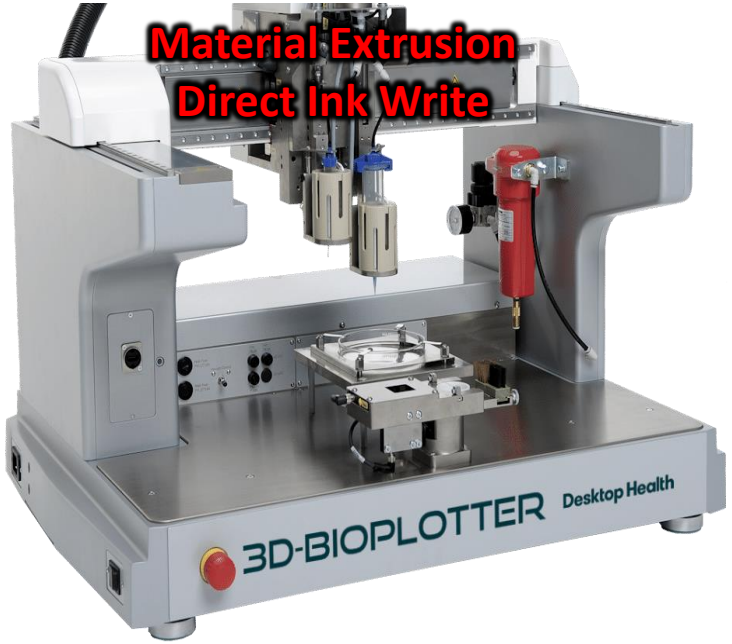
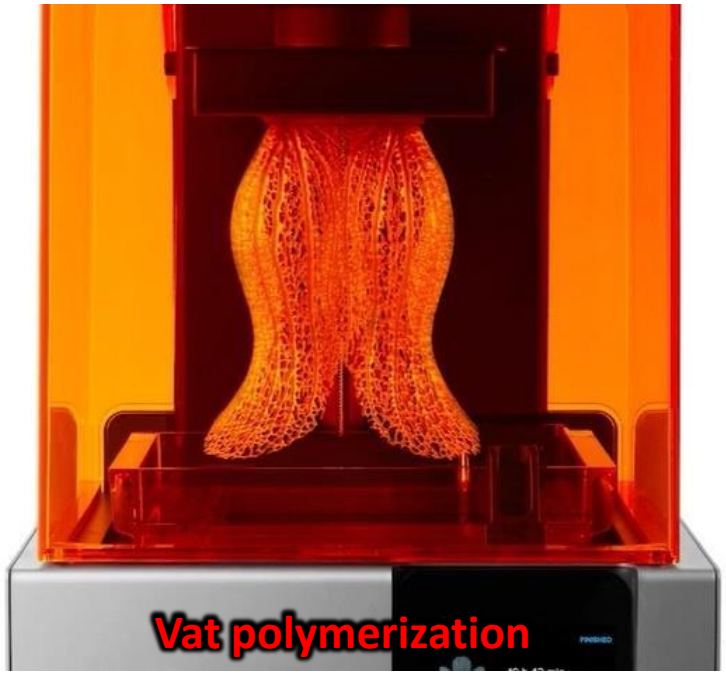
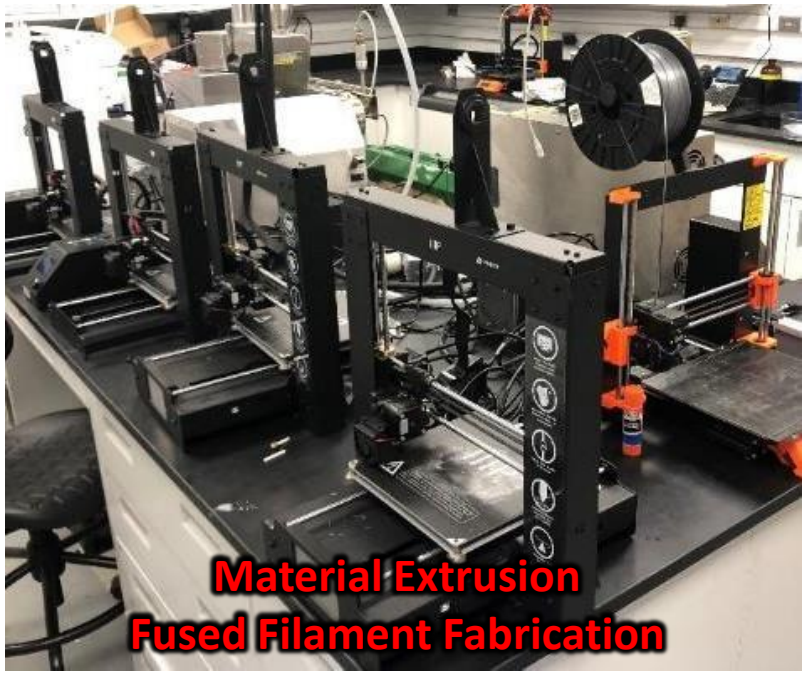
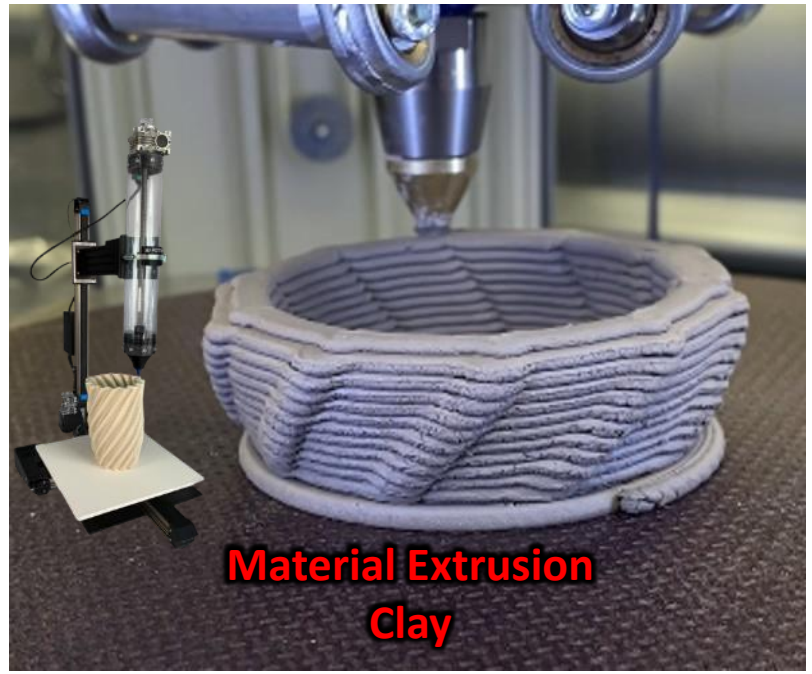

Material Extrusion
Fused Filament Fabrication


Material Extrusion
Direct Ink Write
3D-BIOPLOTTER
Desktop Health


Binder jetting

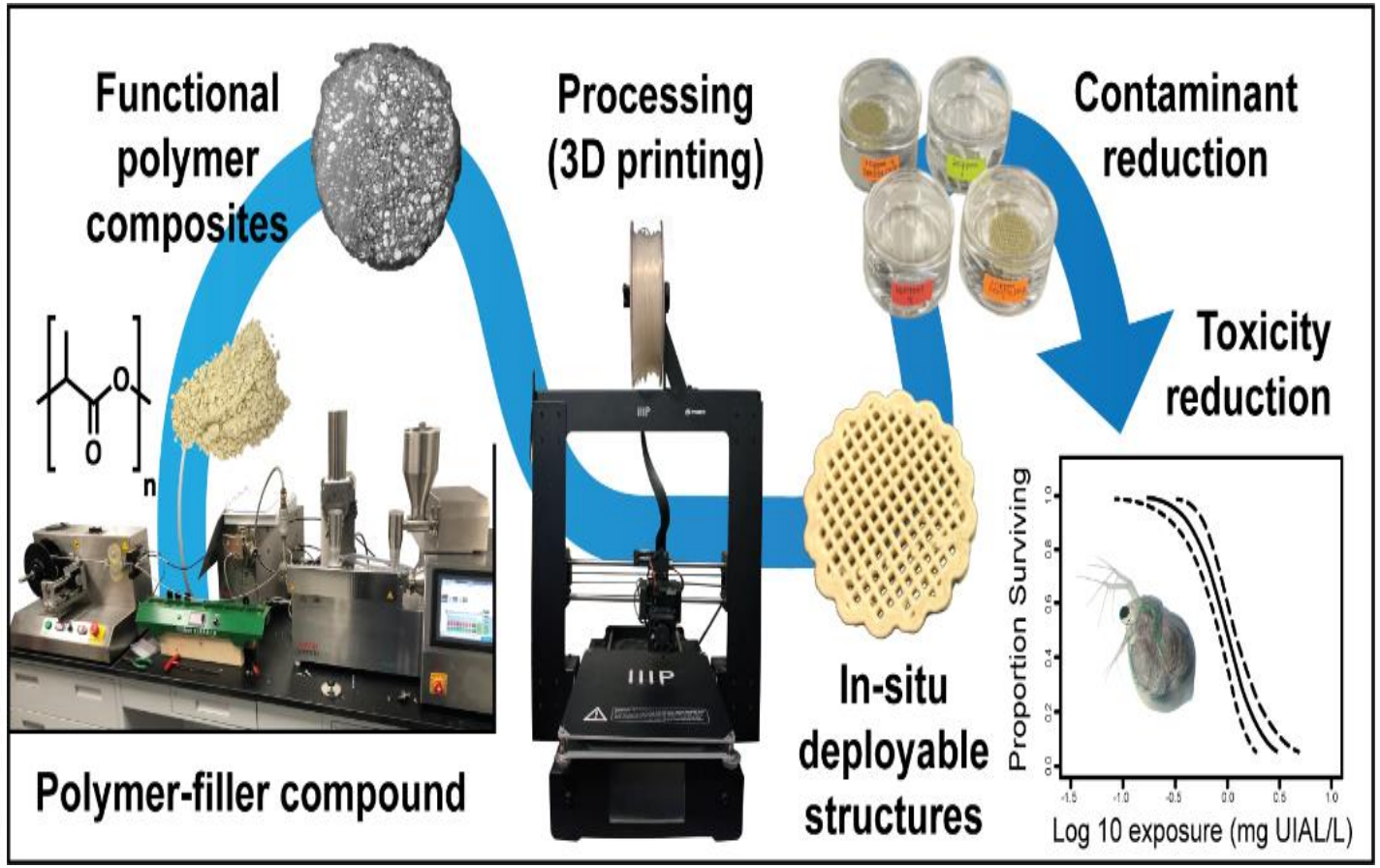

Vat polymerization


Material Extrusion
Fused Filament Fabrication


Material Extrusion
Clay

Motivation

Why AM for Environmental Applications???



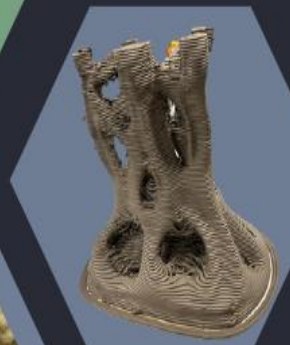
Consideration	Traditional	AM
Complex geometry *Overlapping structure*	**0**	**++**
Design Freedom *Customization, prototypes, iteration*	**--**	**++**
On-site, On-demand *Printing on vessels at sea*	**--**	**++**
Multi-material/functionality *Adsorption & destruction*	**-**	**+**
Porosity *H_2O & chemical absorption*	**--**	**++**
Scale up	**++**	**--**

Kennedy, A. J.; Ballentine, M. L.; May, L. R.; Das, A.; Bednar, A. J.; Griggs, C. S.; Hull, M. S.; Bortner, M. J., Simplifying Complex Contaminant Mixtures: Selective Ammonia Adsorption and Toxicity Reduction using 3D Printable Polymer-Zeolite. *Water, Air and Soil Pollution* **2022,** *233* (5), 148.

3D PRINTING NATURE-INSPIRED INFRASTRUCTURE

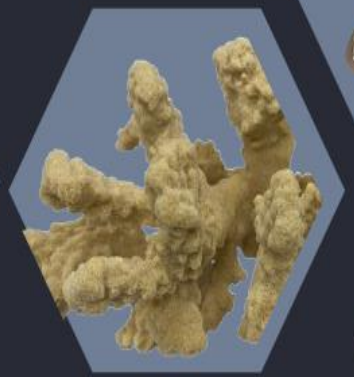
COLLABORATIVE RESEARCH WORKSHOP

7-8 Feb 2024 | Vicksburg, MS



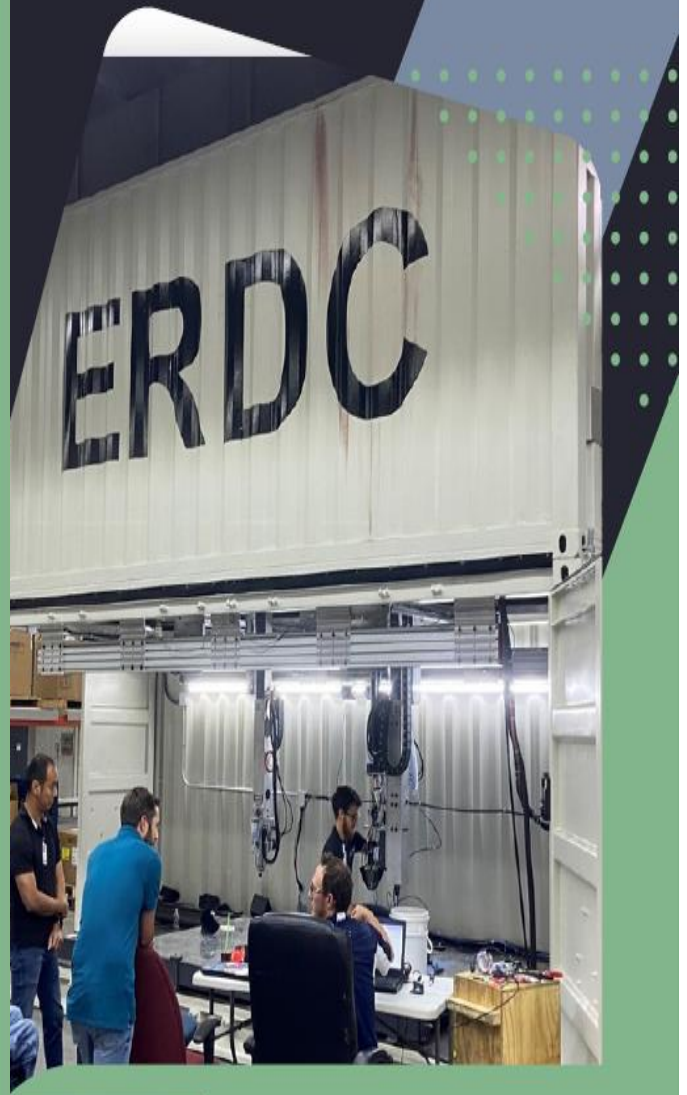
Achieve optimized 3D printed structural morphologies, ensuring successful habitat functionality and biocompatibility.

REGISTER TODAY



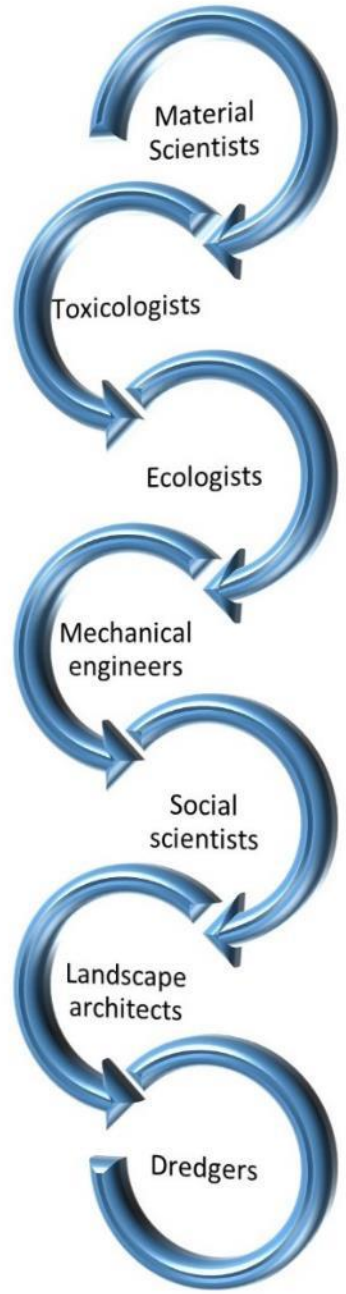
SHARE IDEAS
BUILD COMMUNITY
PLAN STRATEGICALLY

CONTACT: ALAN.J.KENNEDY@USACE.ARMY.MIL
ANDREW.D.MCQUEEN@USACE.ARMY.MIL



Featured on the EWN Podcast

3D Printing Nature-Based Solutions



70/30% Beneficial Use Goal By 2030

3D Printing for Environmental Solutions

Beneficial Use of Dredged Material

CHALLENGE:

- **Perception:** dredged sediment = **liability**, ≠ **resource**
- **Artificial Reefs** lack natural geometric **complexity**
- Constructed of **unsuitable**, **contaminated** materials

SOLUTION:

- **Demonstrate** power of 3DP to transform **dredged sediment** into **Nature-Inspired Infrastructure**

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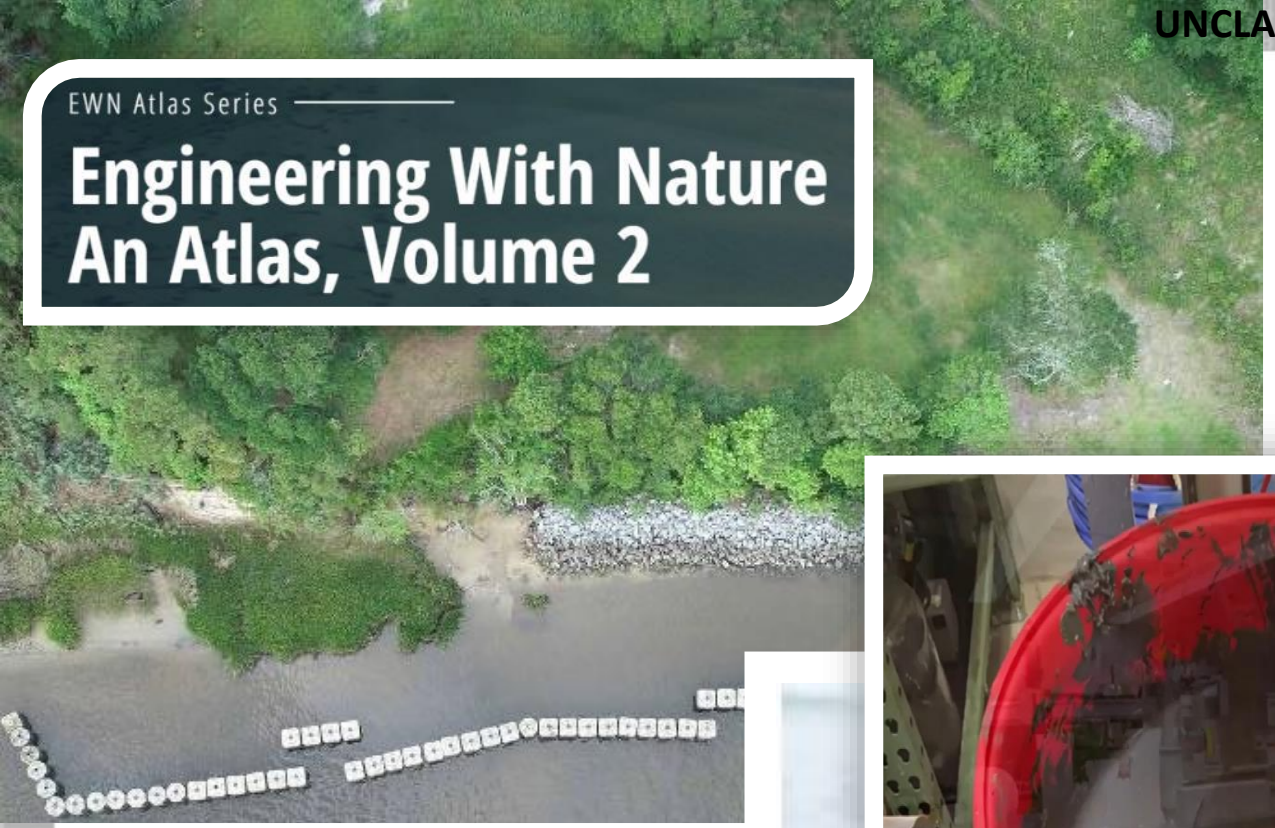
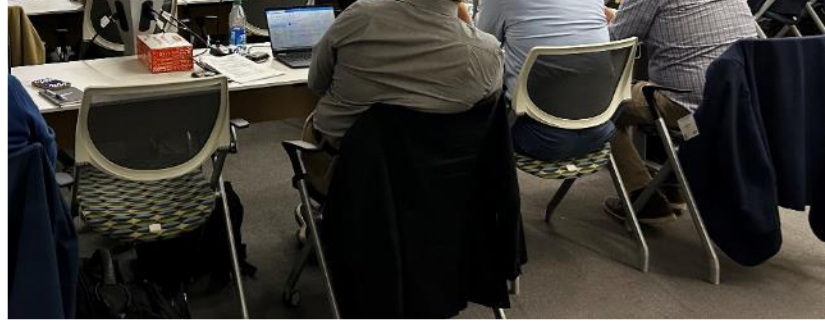
EWN Atlas Series

Engineering With Nature An Atlas, Volume 2




REMOVING "ARTIFICIAL" FROM ARTIFICIAL HABITATS: 3D PRINTING NATURAL MATERIALS TO UNLOCK COMPLEX NATURE-INSPIRED INFRASTRUCTURE
ERDC




ERDC Locations

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ITA INTERNATIONAL
C|C Coastal & Marine Engineering
Heidelberg Materials
decision partners
ASH GROVE
A CRH COMPANY
HAB 3D
ARCTOS
GSL
ERDC
CHL COASTAL & HYDRAULICS LABORATORY
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science for a changing world
EL
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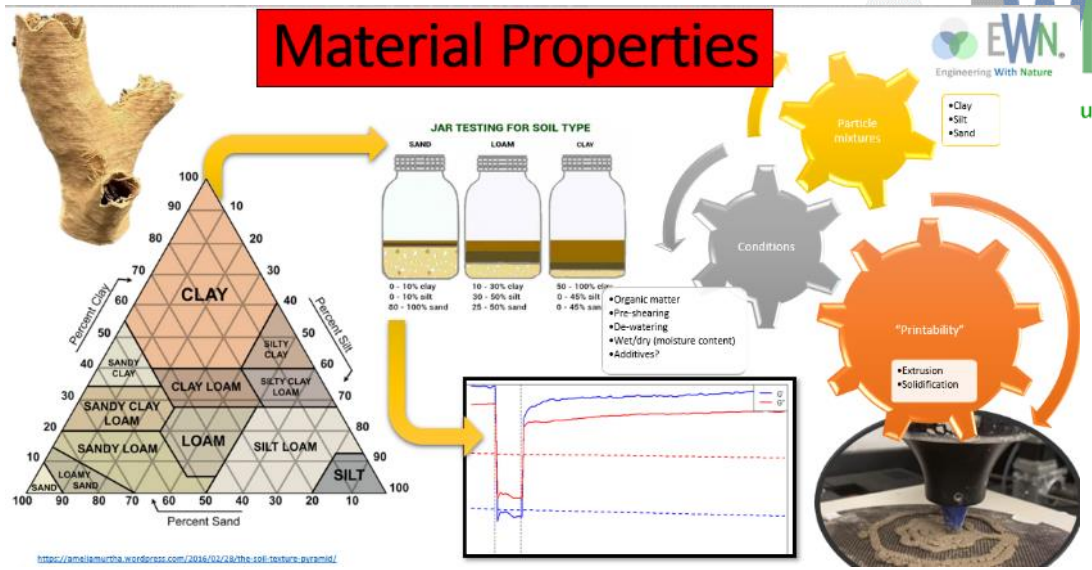
VIRGINIA TECH
ASU
CHARLESTON
STATE
PennState
TEXAS A&M UNIVERSITY
RUTGERS
Academic
Federal
Industry

Ecosystem Restoration & Bio-inspired design

Material Properties



Coastal Resilience & Sustainability

Scale-up: bigger, faster, better???

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The Contaminated Sediment ~~Problem~~ Perception

- EPA 1997 sediment survey report concluded 1 billion m^3 surface sediment "pose potential risks"
  - ≈350 sediment sites in Superfund
  - Contaminated sites adversely impact navigation projects
- CONTAMINATED SEDIMENT MANAGEMENT COSTS RANGE FROM $5-1,000 PER CY

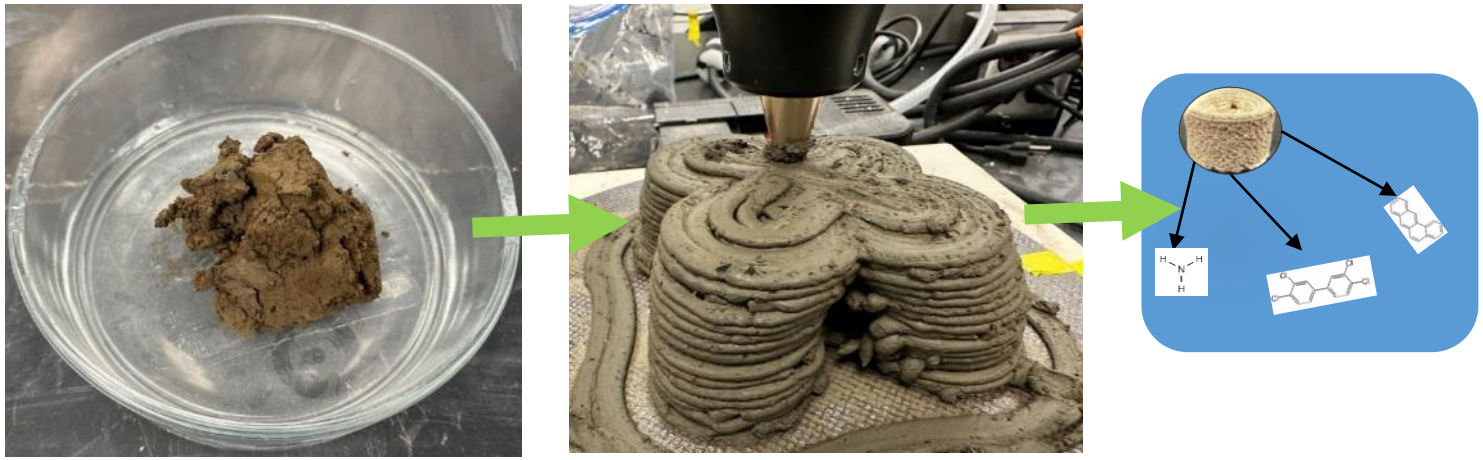
- Reduce organics
- Reduce ammonia
- Degrade PAHs, PFAS

Fish are plentiful at the lagoon near state Highway 101 in Brisbane.

Sequestering 3D printed dredge sediment leachate

Experiment 1 – Material resilience

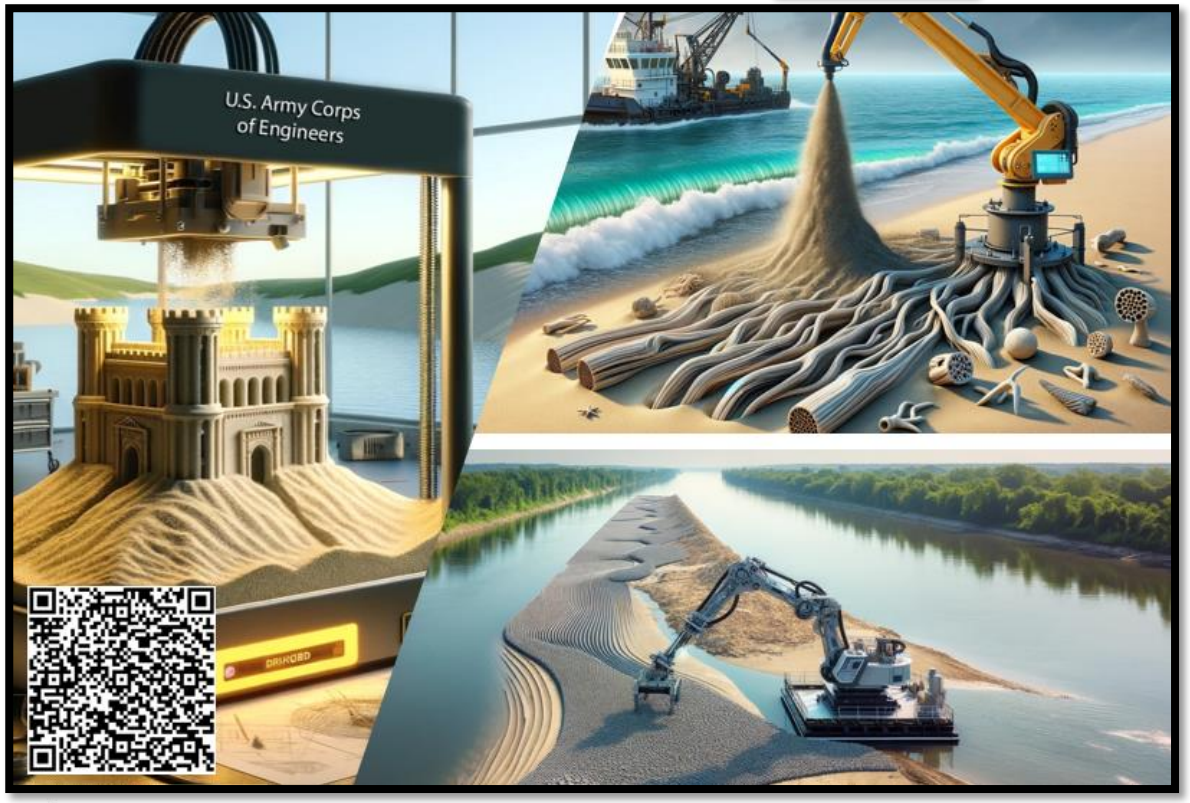
Experiment 2 – Leachate testing



Method development | 3D printed dredge material | Leachate testing

Questions?

ENVIRONMENTAL RISK ASSESSMENT
ADVANCED MATERIALS



Engineering With Nature®
Additive Manufacturing

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