



Development of a Deployable Wastewater Treatment System for Forward Operating Bases

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Wastewater Treatment Issues at FOBs & Disaster Locations

- Wastewater treatment requires space, energy, and personnel.
- Delivery of water and offsite treatment of wastewater
 - requires fuel for transport
 - exposes personnel to danger
 - every delivery truck is a security threat
- Delivery of wastewater to treatment plants and equilibration of flow
 - Sewer lines may be nonexistent, severely damaged, or flooded
 - Flow needs to be equilibrated
 - Storage can be in tank, lined pit, or large bladder.



Wastewater Treatment Issues at FOBs and Disaster Locations

- Population may be using portable outhouses or latrine pits.
 - Vacuum truck(s) may be needed to transport sewage to centralized location for treatment.
 - Deodorizers and disinfectants used in portable toilets can drastically impact ability to treat wastewater.
 - High concentration wastewater/solids.
- Fate of treated effluent?
 - Flow to any water body.
 - Can be reused for non-potable purposes.
 - Discharge can be problematic due to geography.
- Weather



Army Goals

- Zero footprint FOB/NetZero Installations
- Reduce/eliminate energy required for wastewater treatment
 - Reduce overall energy demands
 - Produce energy from wastewater
- Reduce need for potable water transport
 - Reuse wastewater to maximum extent for nonpotable purposes
 - Reuse wastewater for potable purposes

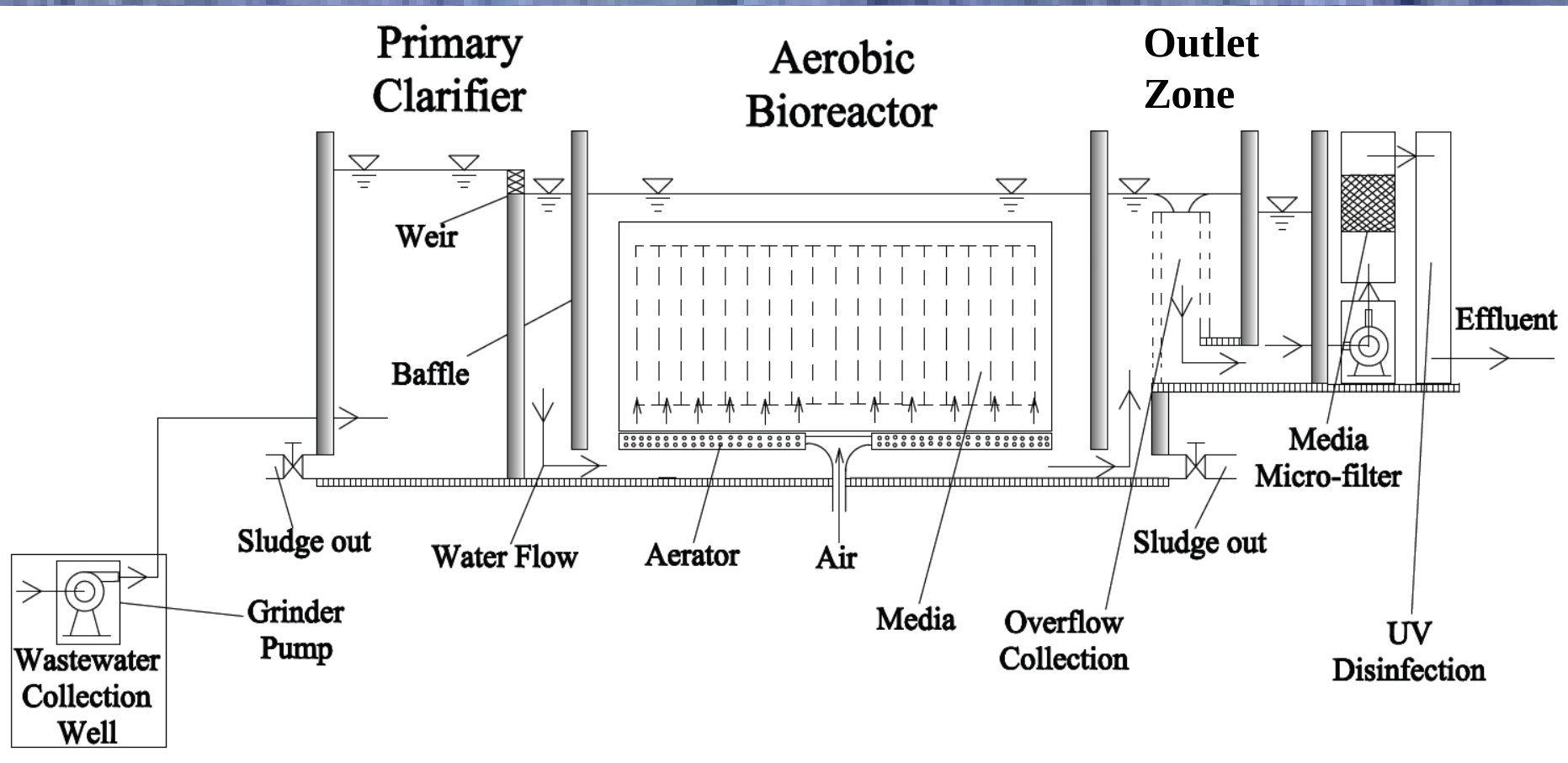


Deployable Aerobic Aqueous Bioreactor (DAAB) Goals

- Operate in austere environments
 - FOBs
 - Disaster relief
- Easily transported
- Rapid startup
- Minimize support requirements
 - Operator training and time
 - Energy
 - Supplies



Basic Flow Diagram



Gravitational flow after wastewater intake.



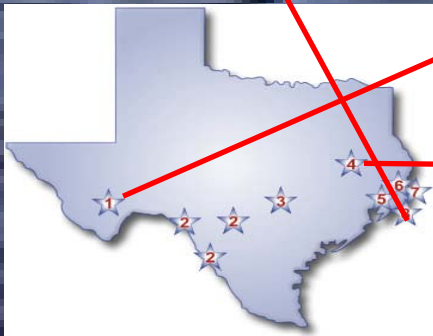
Prototype Demonstration Sites



Beaumont, TX



Alpine, TX



Huntsville, TX



DAAB vs. Activated Sludge

Parameters	DAAB System	Conventional Activated Sludge	Extended Aeration System
Organic Loading (kg-BOD ₅ m ⁻³ day ⁻¹)	0.3-0.5	0.3-0.6	0.2-0.4
HRT (hr)	7-15	4-10	18-36
Recycle Ratio	-	0.3-1.0	0.7-1.5
Depth, m	2	1.5-5.0	1.5-5.0
Kg-O ₂ /Kg-BOD ₅	1.1	1.2	2.2
R % (BOD)	80-95	85-95	75-95
Sludge Production	Minimal	Medium	Low



Biofilm Pros and Cons

PROS

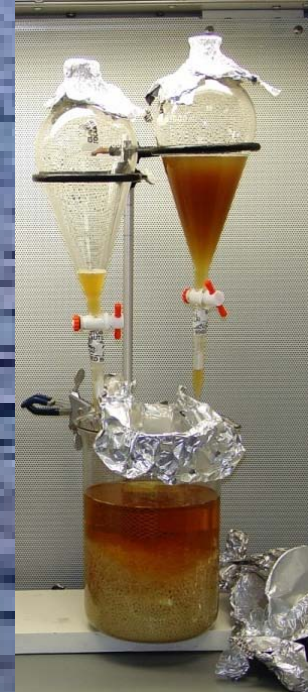
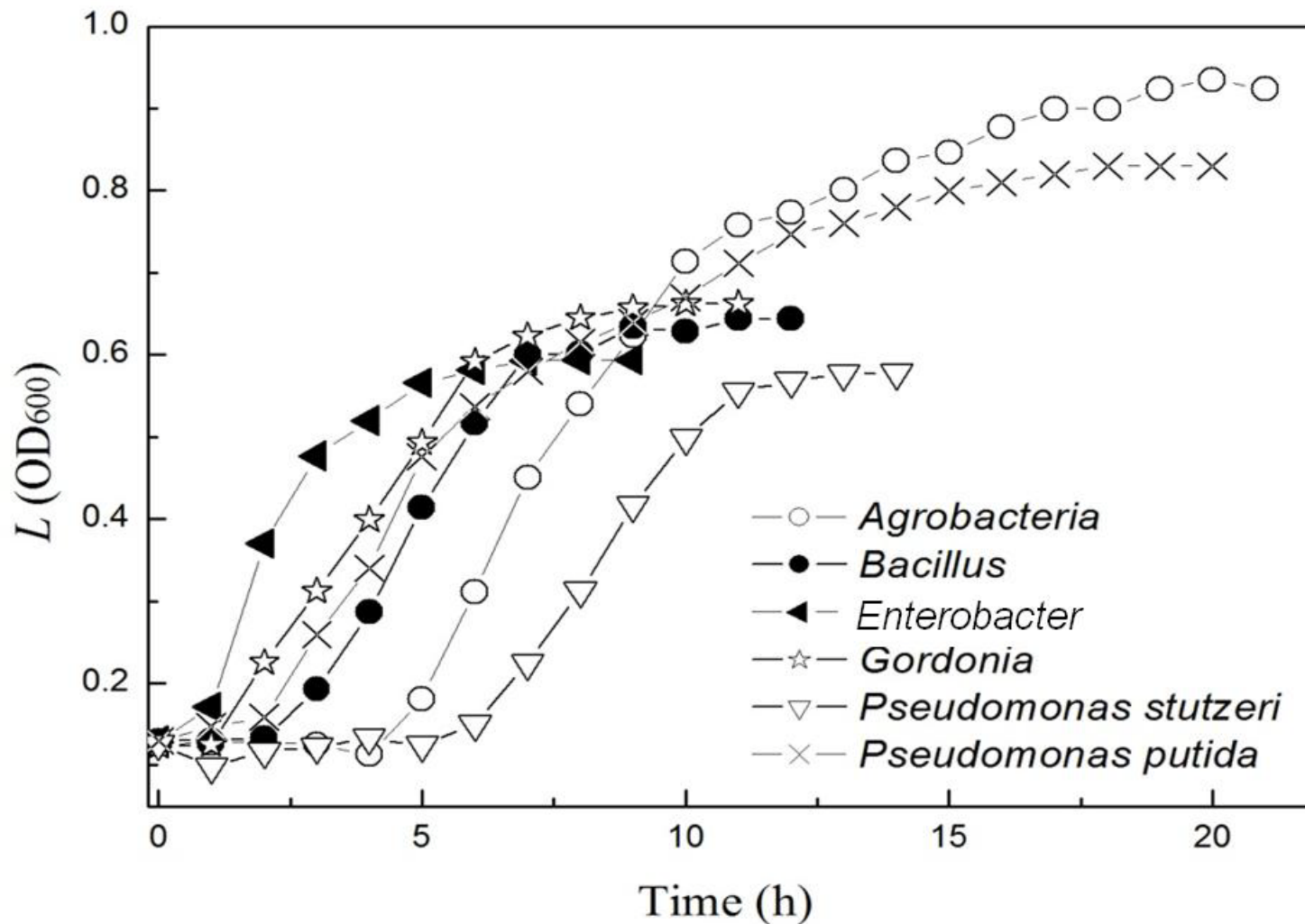
- Biomass will not washout due to hydraulic overload
- Resistant to chemical shock
- Simplified operation requirements
- Reduced sludge production

CONS

- Slightly lower treatment rate
- Good biofilm establishment can be tricky

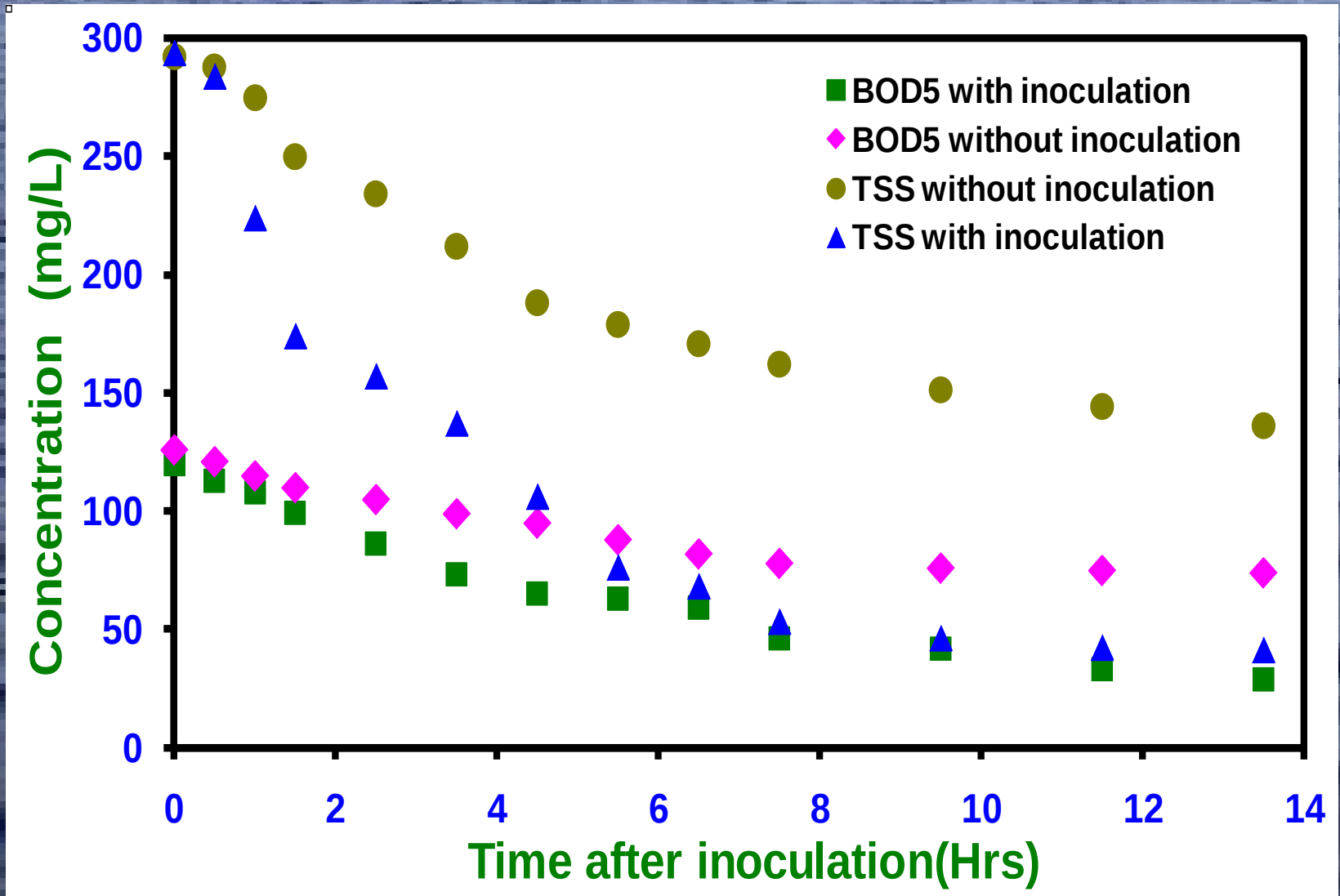


Biofilm Cultures



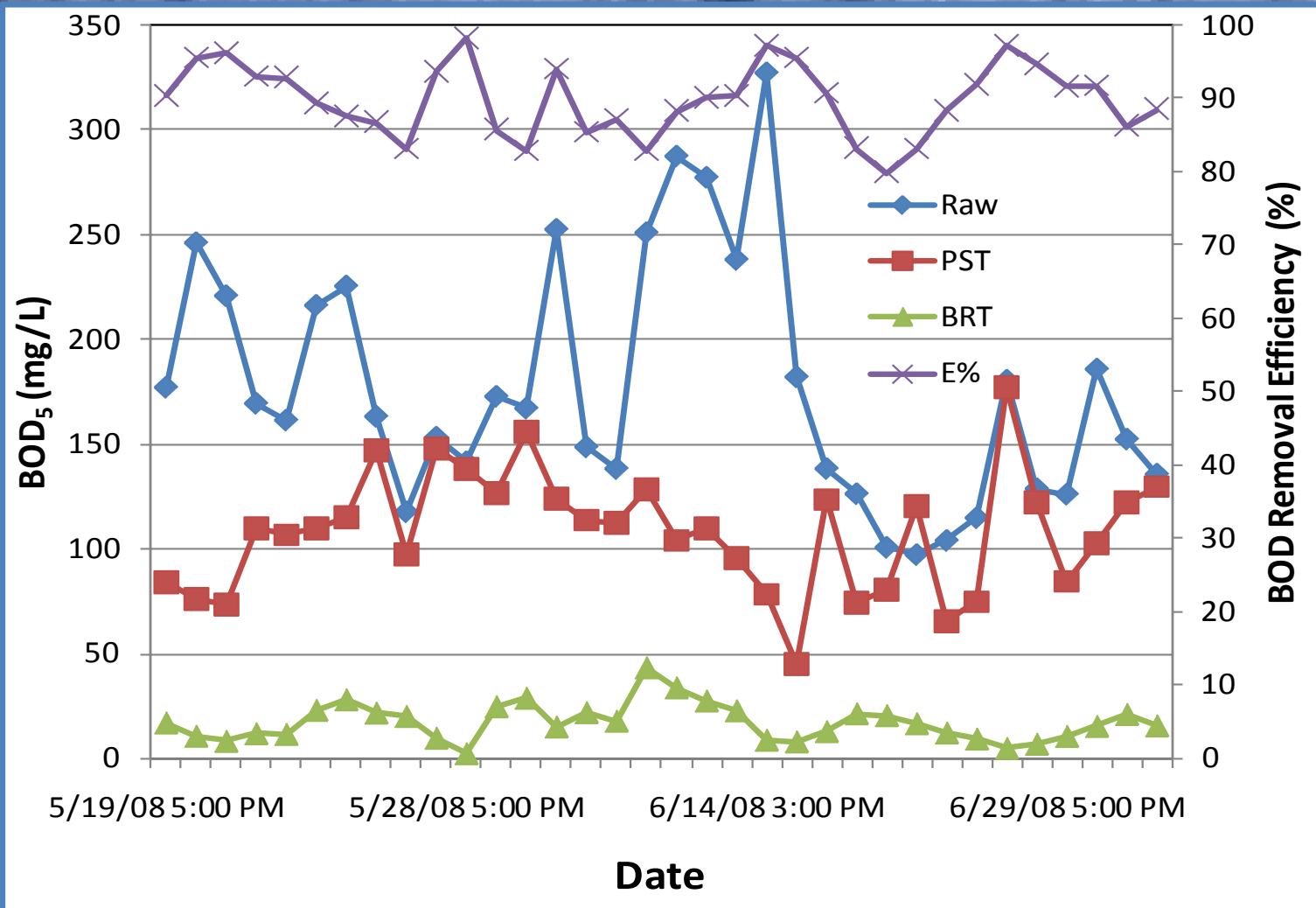


Impact of the Consortium





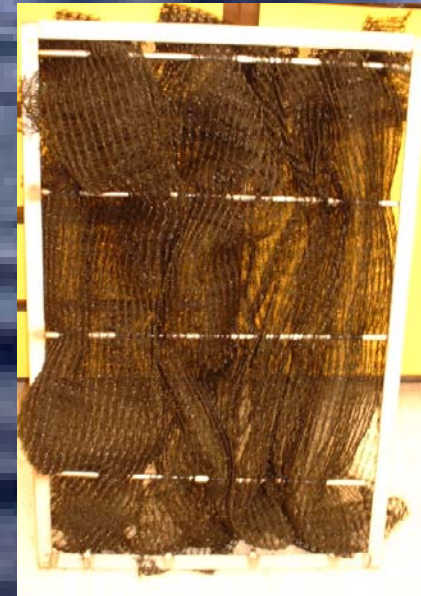
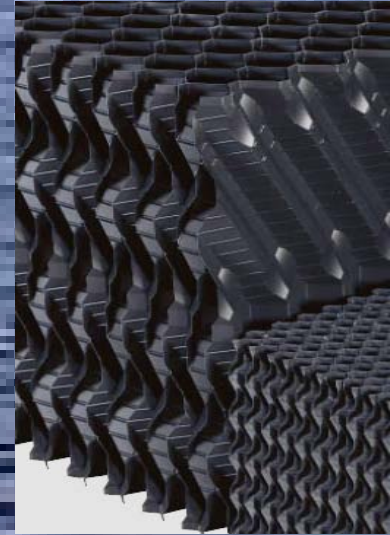
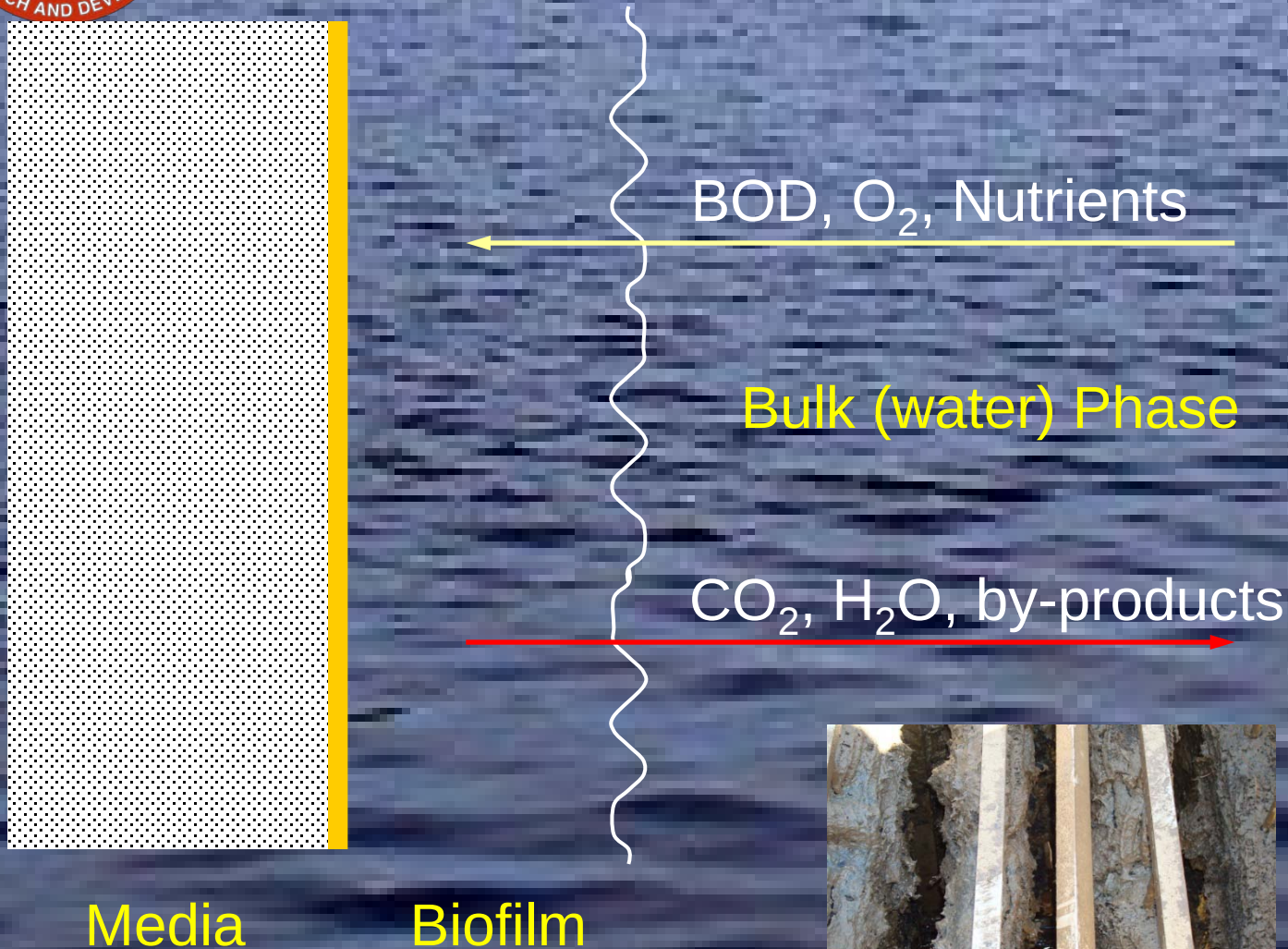
System Performance



(Continuous flow at 7500 gal/day)

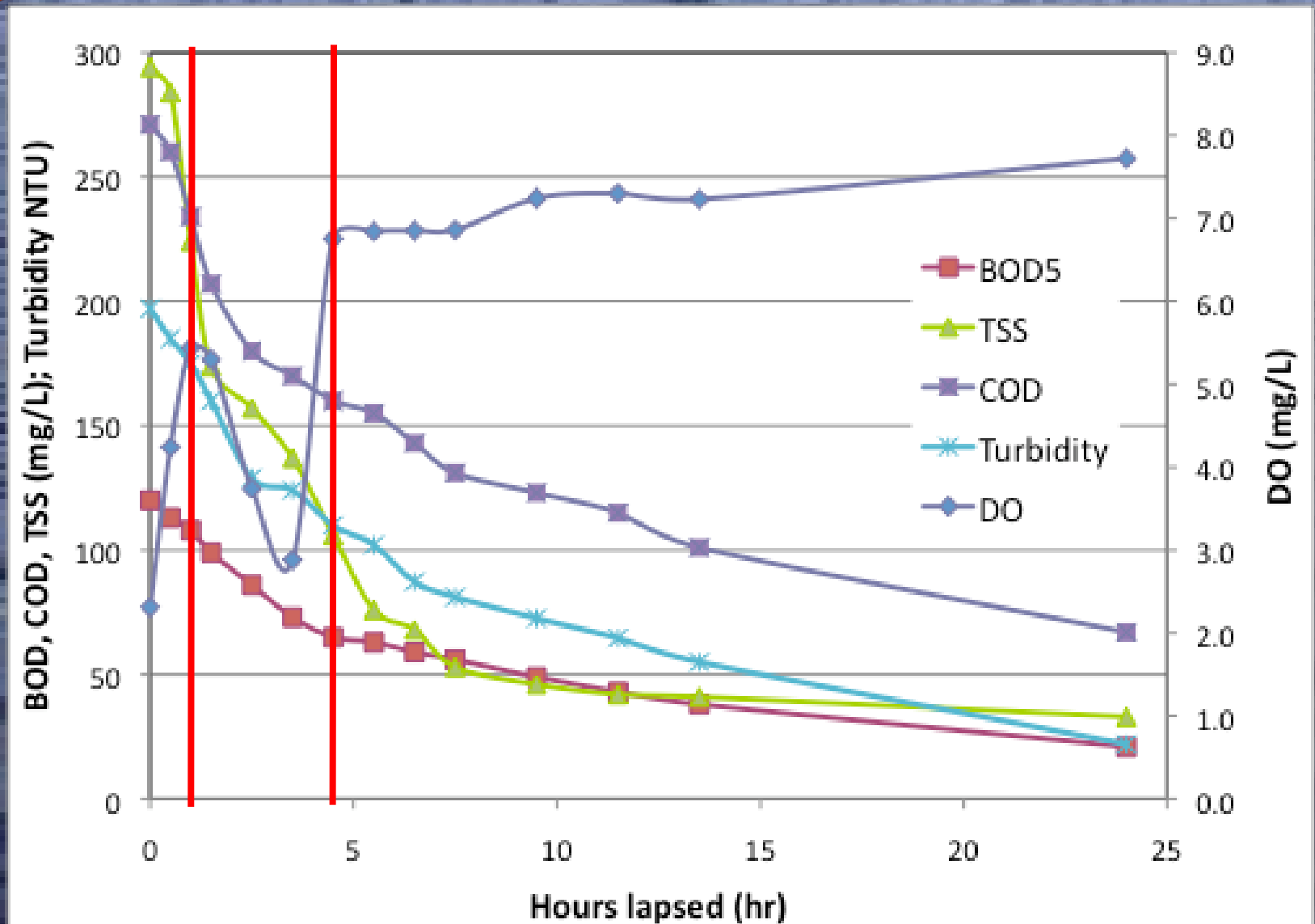


DAAB – a Biofilm Process





Startup in Bioreactor





Basic DAAB System

Biological Treatment Unit "BTU"

Wet Unit

Water intake – grinder pump
Primary sedimentation tank
Aerobic bioreactors
Aeration blowers

Control and Power Unit "CPU"

Dry Unit

Control systems
Biological amplification tanks
Diesel power generator
Mulimedia filter system
UV disinfection system

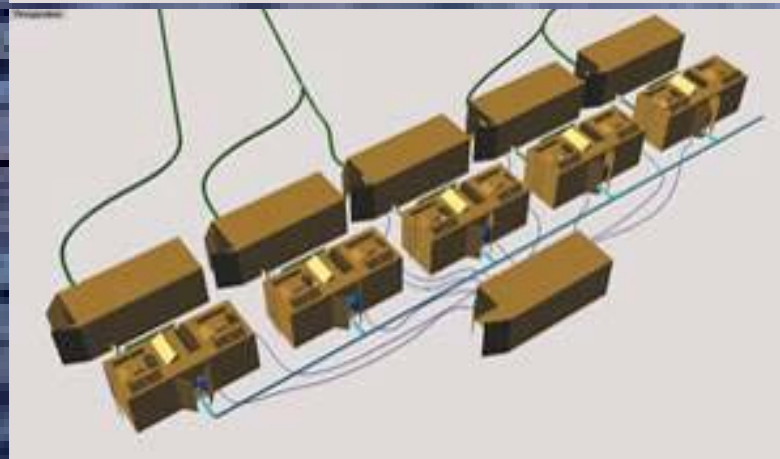
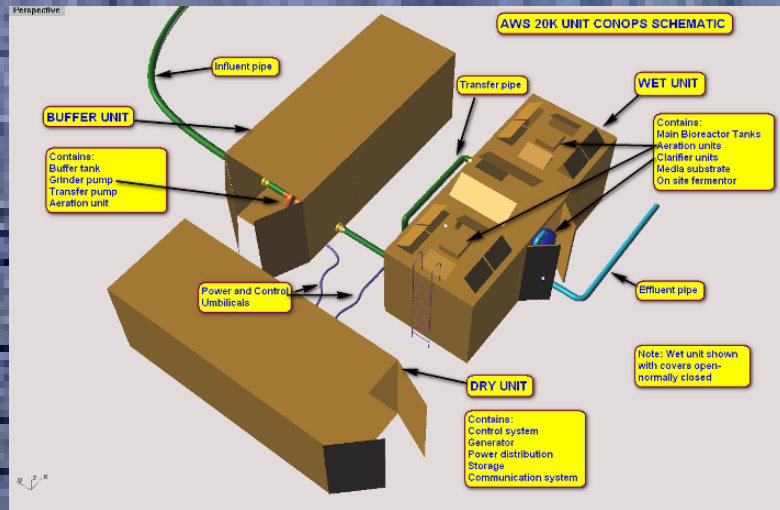
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Top View

Synthetic growth media with bottom aeration.



Deployable Aerobic Aqueous Bioreactor (DAAB)



DAAB shipping to Afghanistan

6 commercial units based on the DAAB design were shipped to Afghanistan by the Army in 2010.



Biological Treatment Unit (BTU)



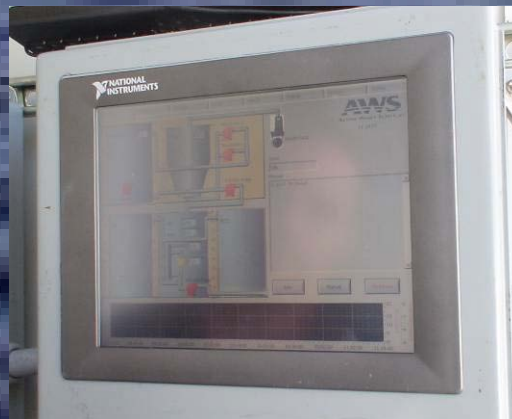


Control & Power Unit (CPU)



Control side:

- control center
- Fermenter
- refrigerator for biological seed



Power side:

- 30 kW diesel generator capable of powering 4 BTUs
- filtration unit with automated backwash



Project Outcomes

- Prototype built to meet military shipping requirement (U.S. DoD 4500.9-R) and operates in one 40-foot or two 20-ft ISO containers.
 - 20-ft ISO containers can be delivered by HEMTT w/PLS
- Treats 20,000 gal/day of municipal wastewater within 48 hours of placement.
- One CPU can support up to 3 BTUs.
- Meets USEPA municipal wastewater discharge requirements, BOD & TSS < 30 mg/L (< 20 typical before filtration)
- Successful demonstrations at domestic sites
- Six units based on DAAB design deployed to Afghanistan
- Estimated capital costs: \$146k/CPU, &188k/BTU



Ongoing/Future R&D

- Electrochemical disinfection unit
- Pharmaceuticals – removal kinetics and efficiencies
- Impact of portable toilet chemicals on DAAB
- Wastewater equilibration and intakes
- Development of design that deploys in TRICONS, which can be helilifted
- Energy reduction
 - Low pressure membrane filtration unit (ultrafiltration) to replace multimedia filtration
 - Microbial fuel cells to replace one of the BTU aeration tanks