Utilizing Microalgae for Nutrient Recovery from Wastewater

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Drivers

Phosphorus:

- Enters our WRPs in the raw wastewater
- Is a non-renewable, dwindling resource necessary for life
- Also a pollutant of concern with EPA and will soon be regulated in NPDES permit
- Traditional treatment methods involve chemical addition, precipitation, filtration, and disposal
- "Recovery and reuse" of is preferable to "removal and disposal" SUSTAINABLE

Process:

Algae cultivation requires:

- Water 
- Nutrients 
- Sunlight 
- Moderate water temperatures 
- Large land areas 

Challenges of Traditional Algal Culture Systems

- Long HRT & low cell productivity
- Large footprint & land intensive
- Low light use efficiency

Algae harvesting is costly and energy intensive

- Low algal cell densities (99.9-99.95 % water)
- Separating microscopic cells from water requires specialized technologies which increase cost

Earthrise Nutritionals LLC, California

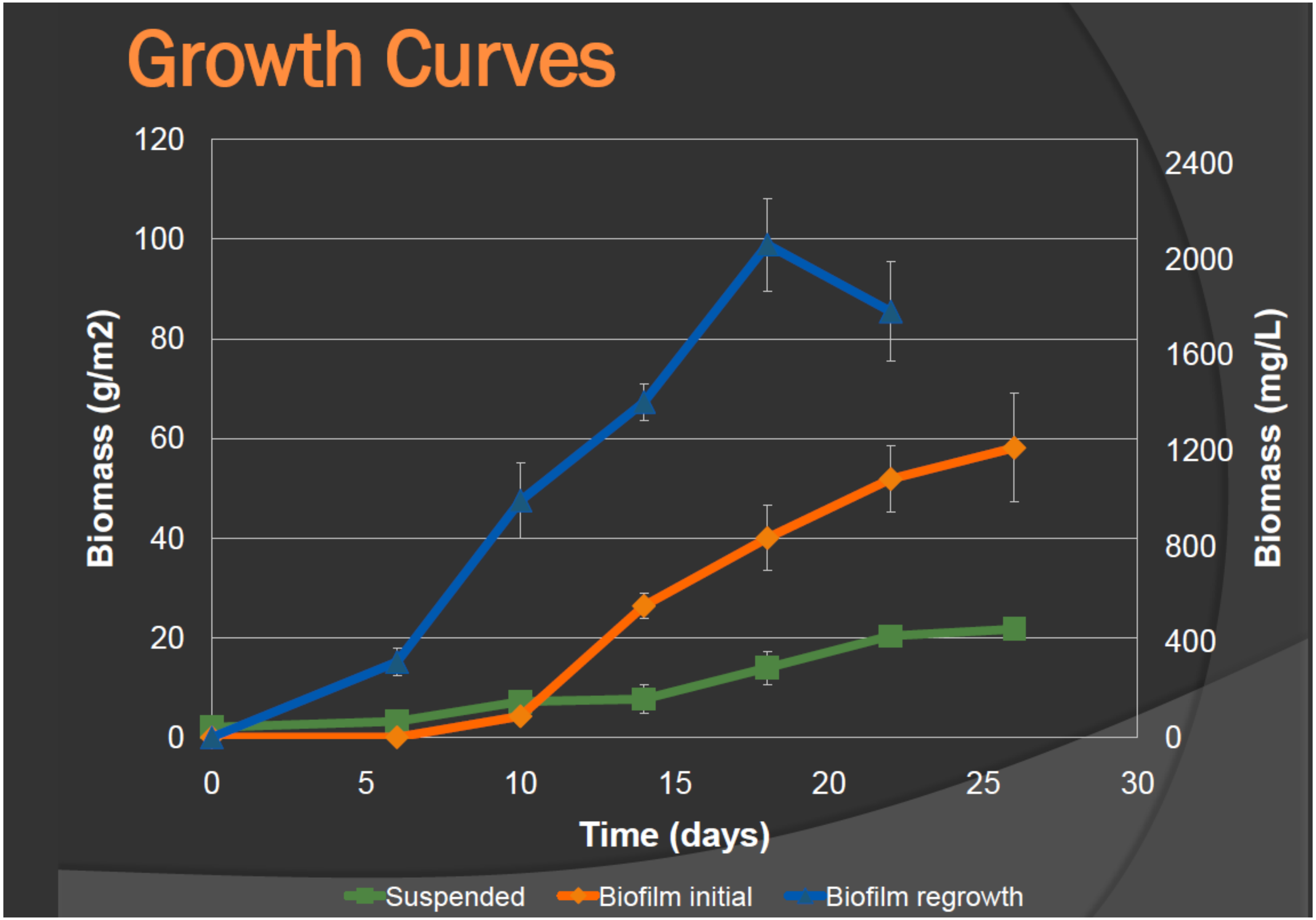
Pilot Plant Goals

- Seek an approach that breaks the ***"footprint barrier".***
- Determine the effect of seasonal conditions on the efficiency of the processes.
- Develop a working knowledge of the ***mechanics of algae harvesting and drying***, for further beneficial use of the algae as a feedstock.
- Support research both in-house and in the industry.

Technologies Evaluated

- Raceway Ponds
- Photo-bioreactors
- Revolving Algal Biofilm (RAB)

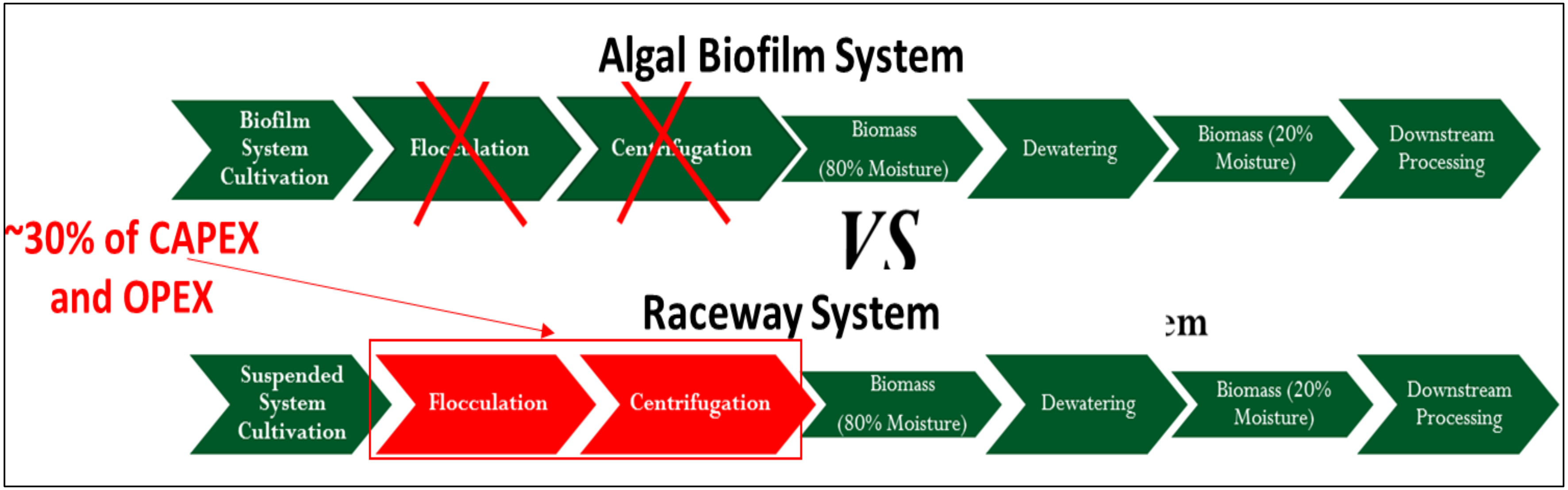
Early Lessons



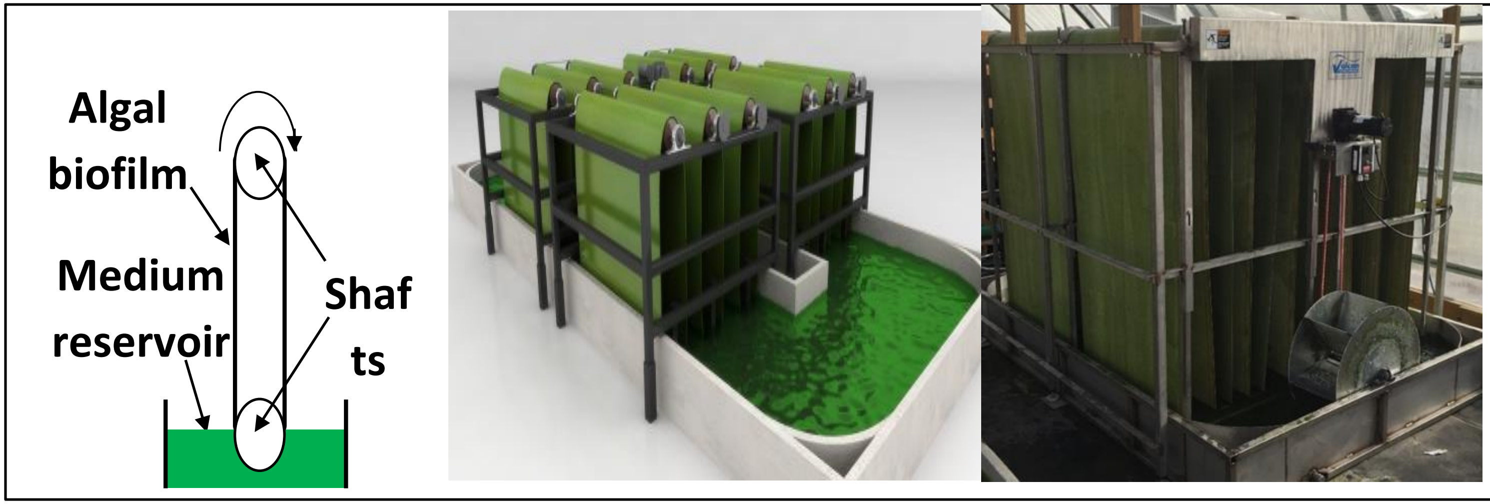
Biofilm-based Algae Systems - Concept

- Algal cells are allowed to grow on a surface of a material to form a biofilm
- Harvesting can be done simply by scraping algae off attached surface
- Harvested algae has similar water content as algae post centrifugation

Johnson and Wen (2010)



Revolving Algal Biofilm (RAB) Treatment System

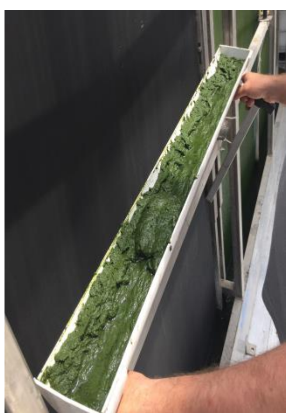


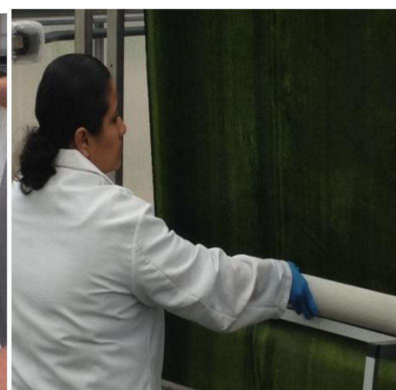
Features/Advantages

1. Inexpensive harvest
2. Efficient space utilization
3. Reduced light limitation
4. Enhanced CO_2 mass transfer
5. Enhance algal productivity
6. Adsorption of N,P, & metals

Revolving Algal Biofilm Treatment System

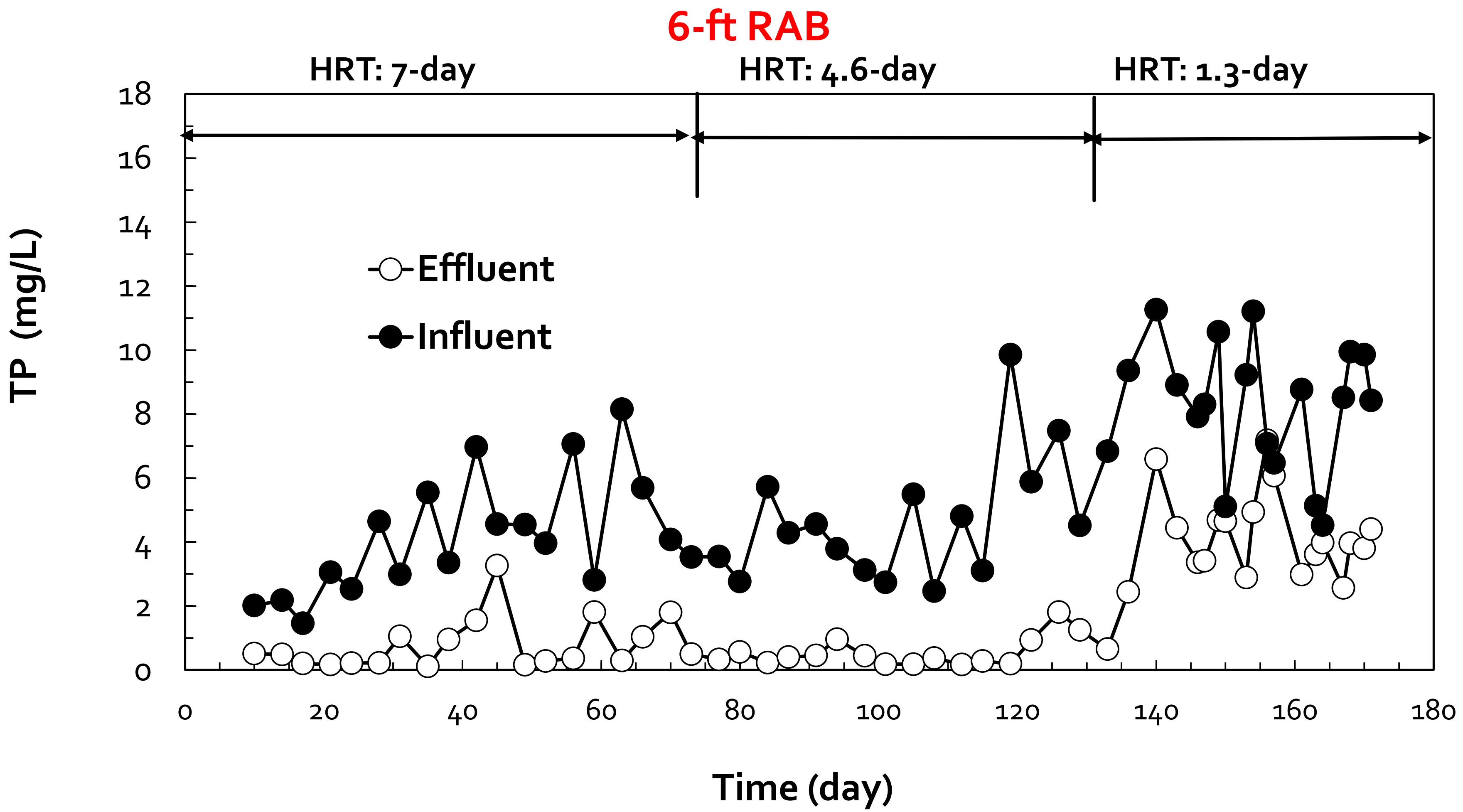
O’Brien Water Reclamation plant, Skokie, IL



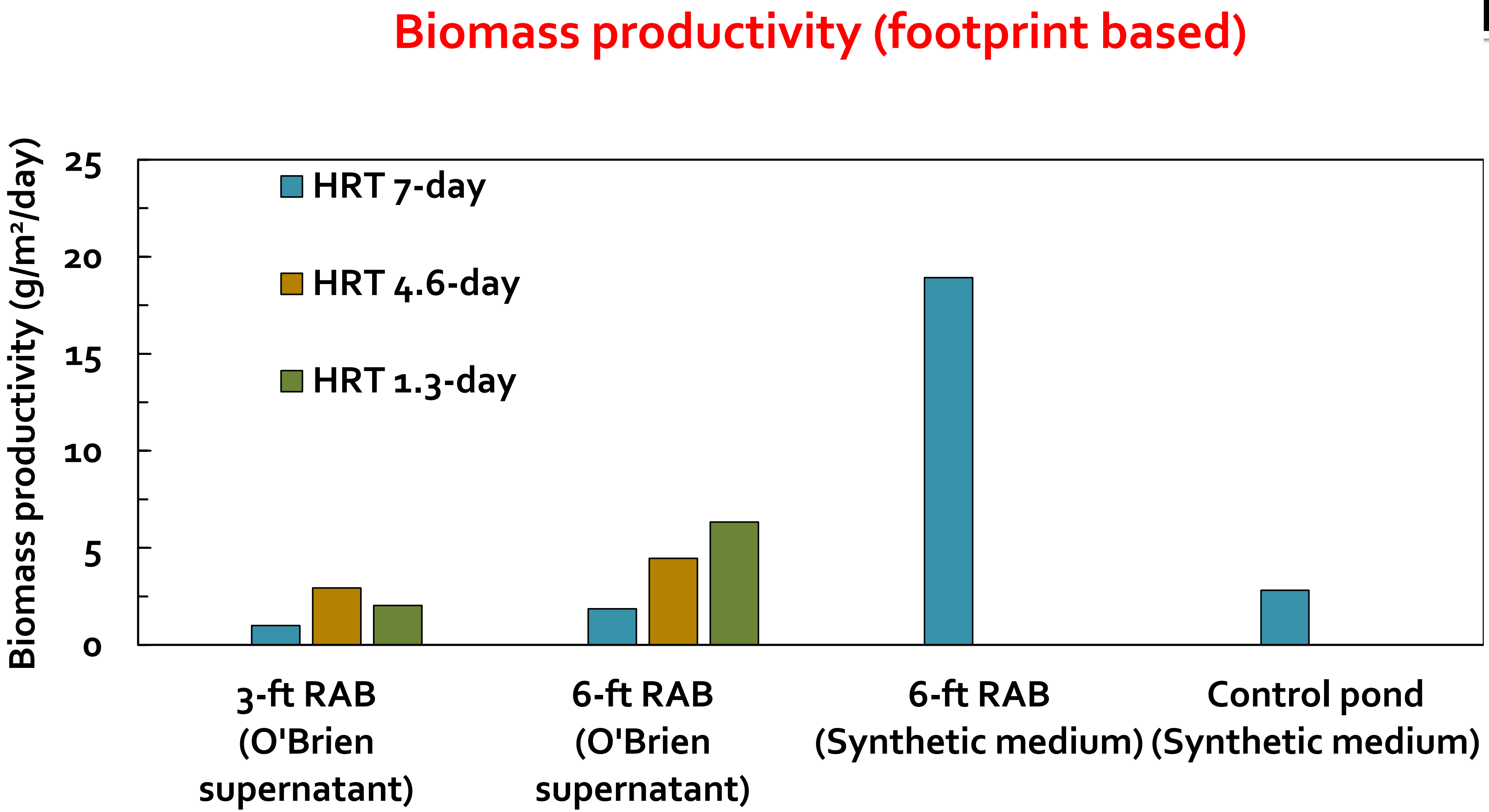


Goal: Determine if RAB system is a viable nutrient recovery method

Total Phosphorus (TP) Concentration in Influent and Effluent

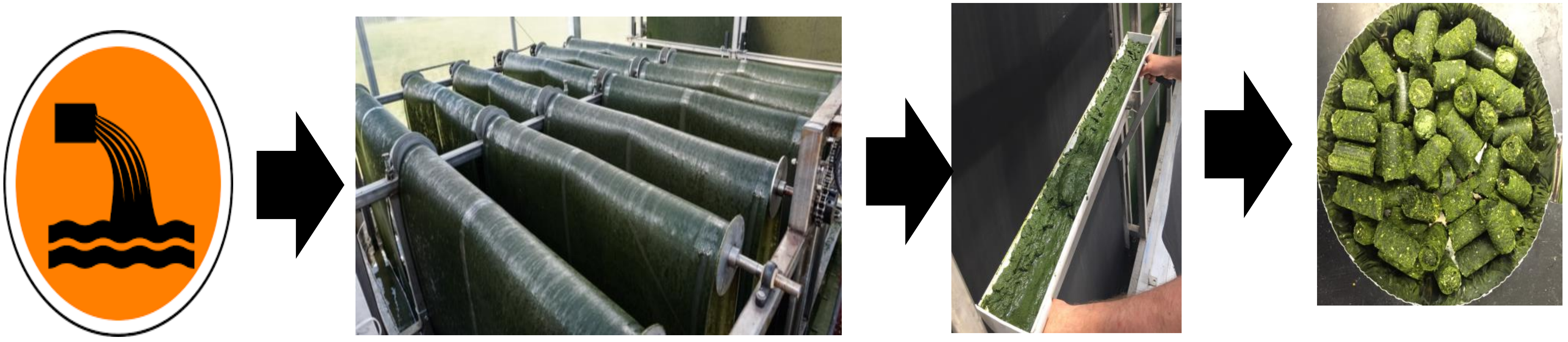


Comparison of Biomass Productivity (footprint-based)



Conclusions – Phase I

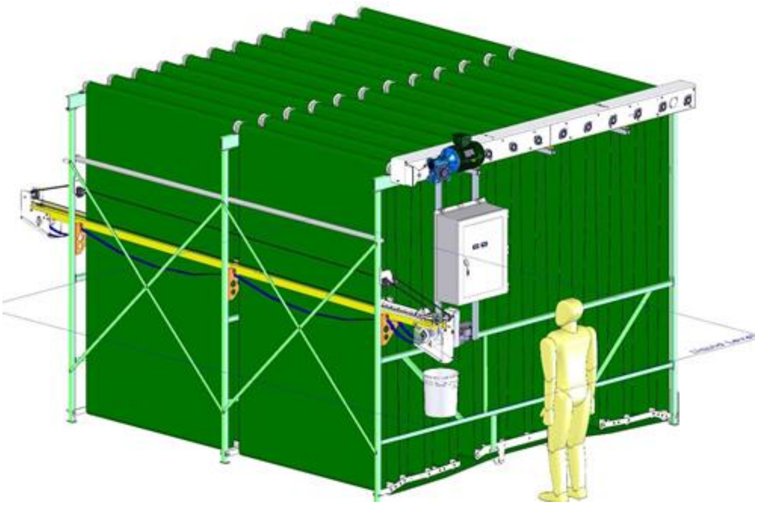
1. RAB system has the potential for recovering nutrients from wastewater
2. Between 4 and 7-day HRT, total P (TP) and Total Kjeldahl N (TKN) removal efficiency reached > 80%, while ortho-P and ammonia removal efficiency reached to 95%.
3. Reducing the HRT to 1.3-day, the removal efficiencies declined to ~ 50%.
4. RAB system is capable of producing concentrated algae biomass (10-15% solids)
5. The algae biomass from the RAB system has value and can be used to produce a variety of products

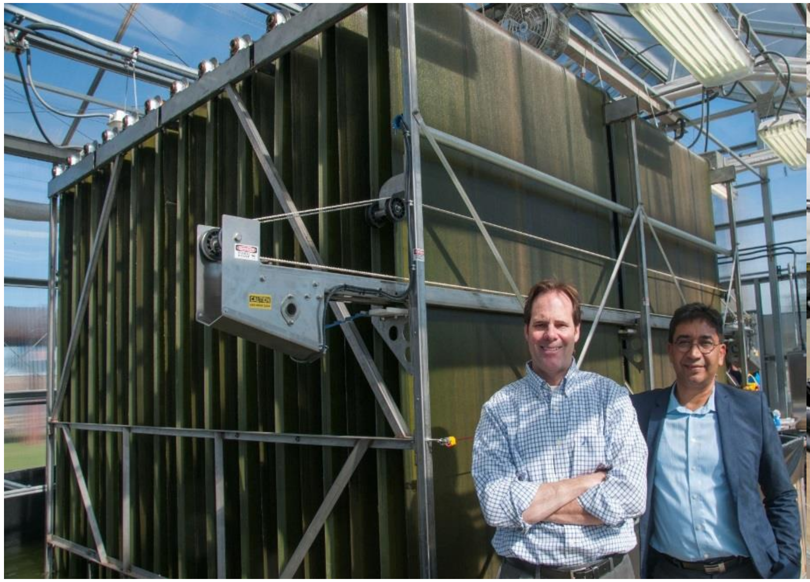


Future Work – Phase II

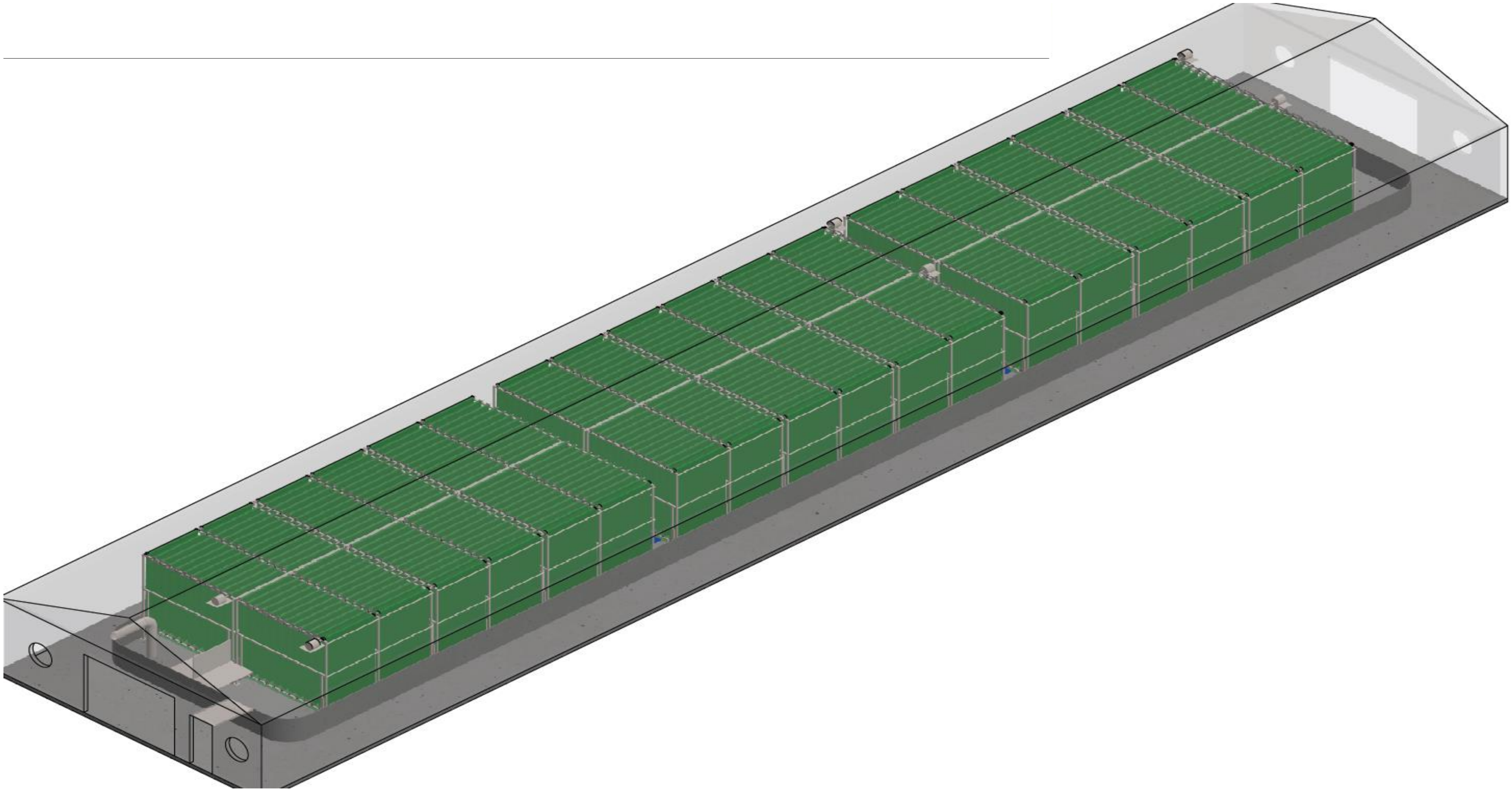
1. Running the RAB system at much lower HRT levels (ranging from 1-24 hr)
2. Increasing height of RAB to ~ 10 ft
3. Improving performance by LED lights
4. Testing plant effluent for tertiary treatment
5. Evaluating biomass for commodity products

Phase – II Studies ongoing on O'Brien Effluent with new 10-ft Tall RAB system and automated algal biomass harvesting system Objective: Reduce HRT to < 12 hrs and Removal Efficiency to > 90%





Vision: Commercial Scale RAB System



Algae Biomass Uses

- FERTILIZERS
- BIOPLASTICS
- SPECIALITY CHEMICALS/COMPOUNDS
- Pharmaceuticals
- Dyes
- Aquaculture feed
- Food supplements
- Many more

Algae Biomass – Fertilizer Value

Algae Biomass Uses – Suitability for Bioplastics – AlGIX

	Moisture	Protein	Ash	N,S, & Furans @140C	# of 200C peaks
Limit	< 10 %	> 30 %	< 20 %	< 20 %	< 200
O'Brien Sample	9.8	52	19	16	116

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Questions?