# Microalgae for wastewater treatment and energy and nutrient recovery (RRS8)

## *Energy and resource recovery*

Re-Inventing the Nation's Urban Water Infrastructure (ReNUWIt)


Martin Lynch

**Martin Lynch, Isuru Abeysiriwardana, Nirmala Khandan**
New Mexico State University

## Background

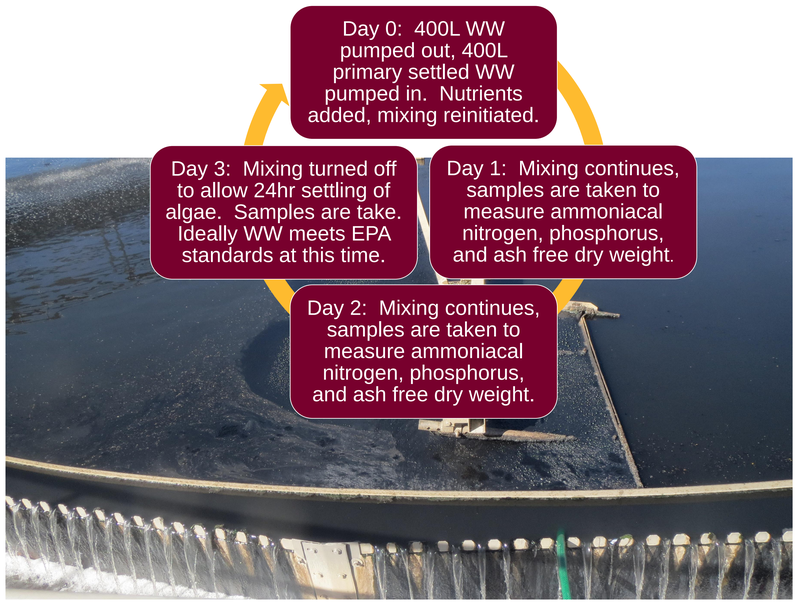
An algal-based wastewater treatment system developed at New Mexico State University (NMSU) has been shown to lower the energy consumed for wastewater (WW) treatment systems when compared to current technologies.[1]

The primary goal of this study was to compare removal of nitrogen and phosphorus across a pilot scale version of NMSU's algal system against that from a conventional treatment system that utilizes activated sludge. The 700L pilot scale algal system was deployed at Jacob A. Hands wastewater treatment plant in Las Cruces.

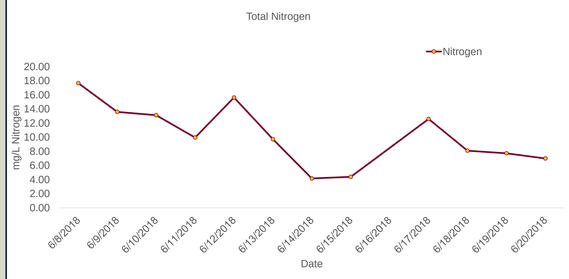
We found that this WW treatment system removes significant amounts of nitrogen and phosphates in a cycle time of 3 days.

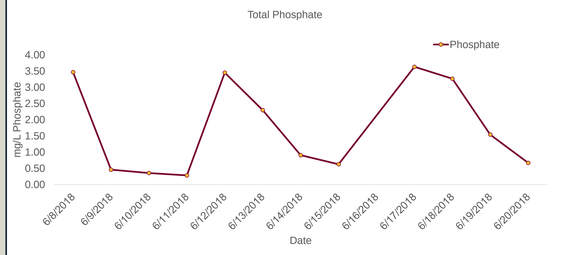
## Approach

The red algal *Galdieria sulphuraria* was used as the heterotrophic algae. The process is a 3 day batch reaction where 400 Liters of WW (wastewater) is treated. Sulfuric acid is used to lower the initial pH to approximately 2.5




## Results

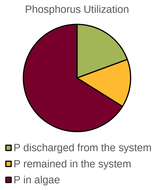


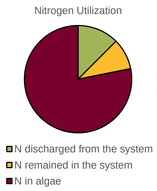

Nitrogen and phosphate levels dropped consistently over the three week experiment. The spikes indicate nutrient concentration at the start of a cycle.

26% of the total algae biomass was harvested after each cycle providing up to 33mg of algae per liter. This harvest allows the algae to remain at the minimum density it needs to process out the excess nitrogen and phosphates while still providing the maximum quantity biomass harvest.

| | Influent | Effluent |
|---|---|---|
| Total nitrogen in wastewater | 7.56g | 1.04g |
| Nitrogen in Photobioreactor | 1.057g | 0.78 |
| Nitrogen in Harvested algae | N/A | 6.509g |
| total | 8.617g | 8.329g |



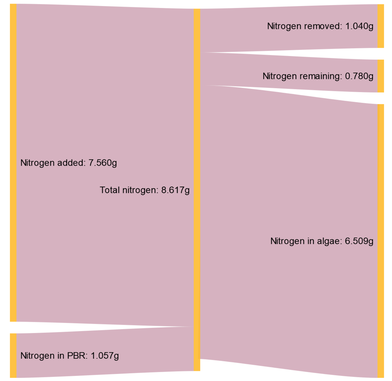

| | Influent | Effluent |
|---|---|---|
| Total phosphorus in wastewater | 1.268g | 0.264g |
| phosphorus in Photobioreactor | .0167g | 0.198g |
| phosphorus in Harvested algae | N/A | .901g |
| total | 1.435g | 1.363g |

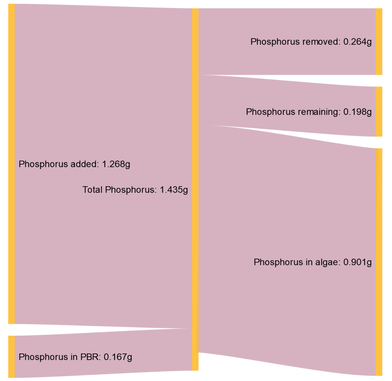



We have shown that *Galdieria sulphuraria* can consistently remove sufficient amounts of nutrients from wastewater. While the pilot scale does not grow a lot of algae, a full scale plant, operating in ranges exceeding 100 million liters, could produce significant amounts of biomass. Additionally, energy efficiency and biomass production have room for improvement, including optimizing harvesting times and amounts. Also developing a mixing system with lower energy consumption, and maximizing the amount of wastewater that can be treated per batch will help improve the system.

## Conclusions

In summary our work shows this algae system designed by New Mexico State University can effectively remove nutrients from wastewater in a single step. Furthermore, this system can be modified to consume significantly less energy than conventional systems. The algae consumes nutrients in a controlled environment creating an energy source from what previously was only a waste stream and turns it into resourceful coproducts including bio crude and struvite.[2]




## Next Steps

Now that we have shown that the 200L system will work we have been spending this semester building up two 2000L systems that will be going into operation soon. These two algae ponds are more convenient to use with permanent pumps for liquid transfers and air lines for $CO_2$ bubbling.

These ponds also use a low energy method for circulating the water, helping to reduce the costs of operation.

Continued testing will hopefully yield similar if not better results and proof of concept can continue to move towards a full scale algae WW treatment System.

## Acknowledgements

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1: Henkanatte-Gedera, S., Selvaratnam, T., Karbakhshravari, M., Myint, M., Nirmalakhandan, N., Voorhies, W. V., & Lammers, P. J. (2017). Removal of dissolved organic carbon and nutrients from urban wastewaters by Galdieria sulphuraria : Laboratory to field scale demonstration. *Algal Research, 24*, 450-456. doi:10.1016/j.algal.2016.08.001

2: Chisti, Y. (2007). Biodiesel from microalgae. *Biotechnology Advances, 25*(3), 294-306. doi:10.1016/j.biotechadv.2007.02.001

**Research Scholar Contact Information**
Martin Lynch | Mrlynch@nmsu.edu

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