
# Investigating the Capability of Nutrient Removal and Biomass Production in an Algal Turf System

## Design and Implementation

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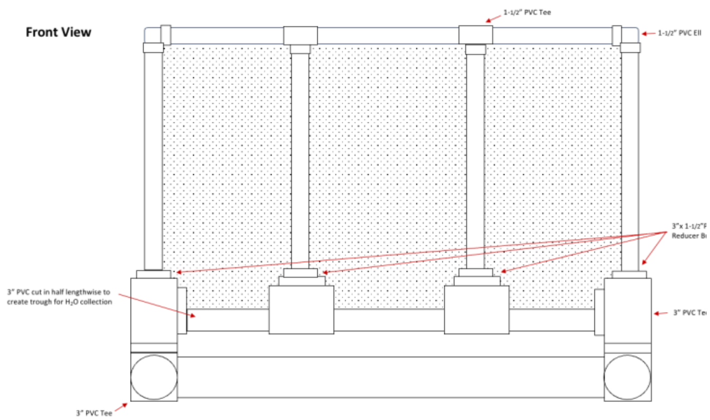
# WHAT IS AN ALGAL TURF SYSTEM?

Algal Turf Systems (ATS) are a type of novel technology that is being used in wastewater treatment practices. This affordable and easy to use ATS was created for smaller scale farmer use to treat wastewater runoff from their farms.

# WHY CREATE AN ATS?

This could be a sustainable way for farmers to treat their wastewater that gets harmful excess nutrients from things like fertilizers and animal feed. There is a lot of potential with the algae that is grown on the ATS. Algae has been investigated as a food source for small animals like chickens, for a greener bio- fertilizer and for aquatic fish as well. There is a lot of sustainability potential in using these systems as a wastewater treatment that would help the farmer and the local people a lot by reducing environmental pollution and improving overall water quality.

# Raft Construction

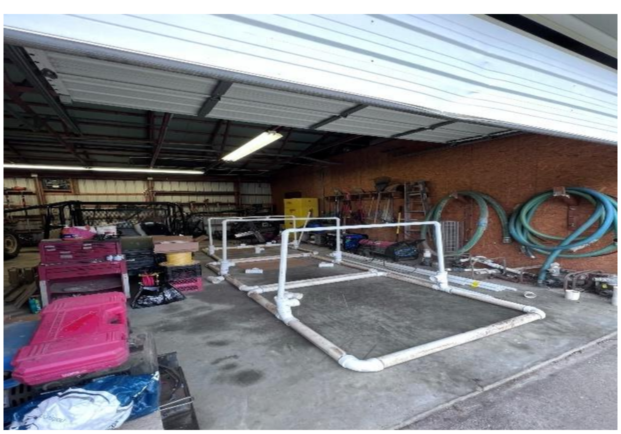



Rafts were constructed based on the model above and each raft consisted of the following materials:

- 3” PVC pipe: 75’
- 3” PVC T joint: 18 pieces
- 3” to 1.5” PVC reducers: 12 pieces
- 1.5” PVC pipe: 70’
- 1.5” PVC L joint: 6 pieces
- 1.5” PVC T joint: 6 pieces
- 20 lpm Pond master submersible water pump
- 40 lpm Supreme submersible water & air pump
- 80 lpm Hydro farm submersible water pump
- 11” UV resistant zip ties trimmed to fit
- PVC pipe primer + glue
- Silver spray paint to attract sunlight
- 1.5” hose clamps: 3 pieces
- 1.5” PVC pipe caps: 6 pieces
- 1.5’’ PVC female adapters: 3 pieces
- 1.5” braided tubing: 15’
- 3’ x 2’ UV-treated Polyethylene pond netting: 9 pieces

***Creating replicate sections to each raft***

***Attaching mesh to raft***



***Assembly of frames of the rafts***

***Attachment of water pump to raft***

# Raft Deployment

On August 28th, 2023, all three rafts were placed in an Aquaculture pond with the same depth, held in place by iron rods and rope to avoid sinking.

***Empty pond where rafts were placed.   Rafts on Aug. 28th at implementation.***

# Care of Systems

Weekly cleaning of the water collection basin, the water pump, and the holes where the water trickled onto the mesh was preformed to remove excess algae in the basin, avoid build up of debris and dirt in the pump, and prevent clogging.

***Weekly rafts maintenance***

# Experimental Setup

Three systems were created with water pumps that had 3 different flow rates to examine the optimal for growth and nutrient removal. Raft 1 had the lowest flow of 20 liters per minute (lpm), raft 2 was 40 lpm and raft 3 was 80 lpm. Each system has a vertical for algae growth that was separated into three equidistant sections. The systems were deployed in the ponds all day and night and checked on twice a week. The systems were not inoculated with algae; all algae grew naturally. The goal is to explore what types of algae naturally grew and determine if that was usable for feed purposes.

***Weekly algae growth update***

## Data Collection

Four weeks after raft deployment, water and algae samples were collected weekly. Water quality samples were collected in Wide-Mouth Lab Quality HDPE bottles from the area nearest to the water pump (the inlet) as well as from the collection basin that was directly under the vertical mesh netting where the algae grow. Collection of samples from both areas allowed us to track potential differences in water quality between samples before and after the water interacted with the algae. Three algae samples were collected from each top middle and bottom section of each raft to allow for replicates (9 samples total from each raft). Algae samples were collected using lab scalpels and forceps. Ten ml of algae (if enough available) were collected and placed into Corning™ Polypropylene Centrifuge Tubes. Weekly photos of growth were also taken to document changes in growth, and each section was photographed.

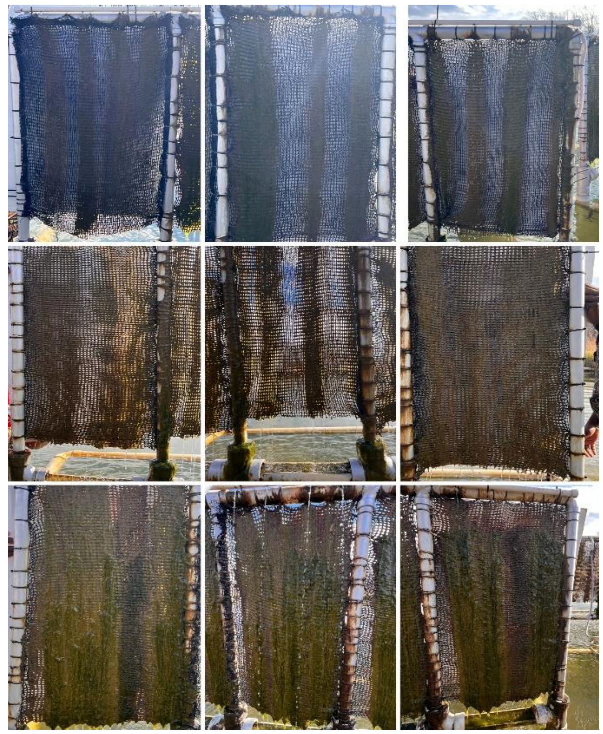
***Collection of algae samples***

## Further Research

Systems will be redeployed in a more nutrient rich location when the weather warms in late March or early April to continue to evaluate nutrient removal potential and get more algae biomass to use. Solar panels will also be added to the system to power the pumps allowing each to be self-powered, allowing remote deployment and cost effectiveness for farmers. If the algae growth increases and continues after numerous collections, collected algae will be taken to identify the natural growing algae species. Algae will be dried, and lipids extracted for exploration of the potential use of the algae as a chicken feed and fish feed.

# Results

Algae growth on raft 1 and 3 had significant algae growth, while raft 2 faced many problems growing and minimal to no growth over the 15-week period. Raft 3 had the most growth and had the pump with the highest lpm. Raft 1 had good growth as well although it was about half of what raft 3 produced. While high levels of nutrient removal did not occur as anticipated, a higher amount of nutrient removal was detected in the rafts with higher lpm.



***15 weeks of algae growth -- top images are raft 1, middle raft 2 and bottom raft 3***

## Challenges Faced

Raft 2 had problems throughout the entire 15-week deployment. Raft 1 and raft 3 were similarly designed pumps; the pump of raft 2 was completely different. It got clogged easier and flow wasn't as consistent causing little to no algae growth on this raft. Rafts were deployed in late August. By November, when the weather started to change, problems occurred such as freezing of the water on the system and algae drying due to the colder temperatures. Nutrient removal may not have been as significant as anticipated due to the water not being as nutrient-rich as initially believed.

## References


- **Gan, X., Klose, H., & Reinecke, D. (2022).** Optimizing nutrient removal and biomass production of the Algal Turf Scrubber (ATS) under variable cultivation conditions by using Response Surface Methodology. Frontiers in Bioengineering and Biotechnology, 10. https://www.frontiersin.org/articles/10.3389/fbioe.2022.962719
- **P. A., & Bani, R. (2011).** Wastewater Management. In F. S. G. Einschlag (Ed.), Waste Water (p. Ch. 20). IntechOpen. https://doi.org/10.5772/16158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