

ENGINEERING DEPARTMENT

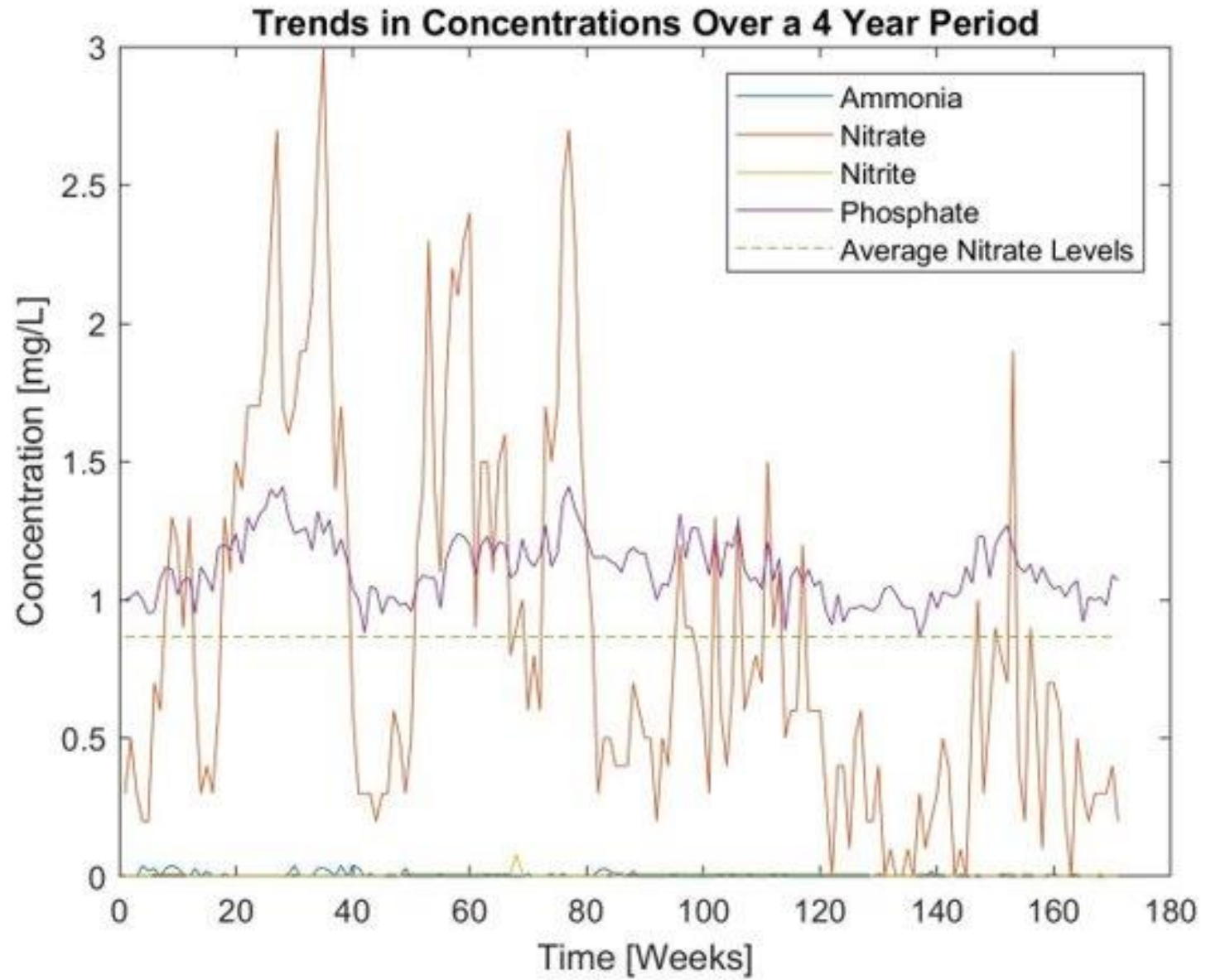
**UTILIZING BIOREACTORS TO REMOVE
DISSOLVED NUTRIENTS IN WASTEWATER**

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INTRODUCTION

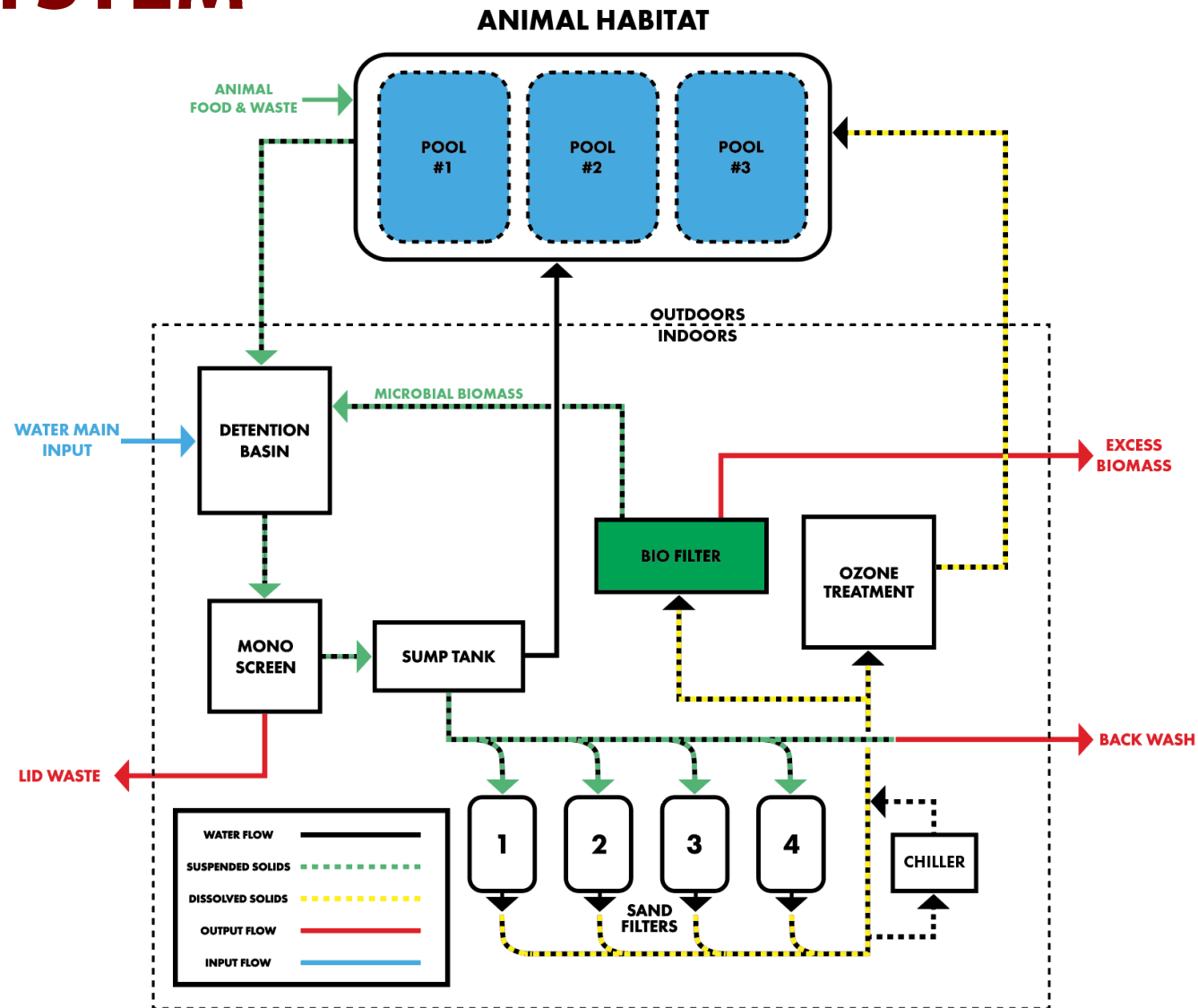




DESIGN REQUIREMENTS

- Find mean value where nitrogen is sitting during summer, and say we are trying to reduce it at least by half (will at least decrease the cleaning time by a factor of two)
- Average Concentrations:
 - 0.8761 mg/L Nitrogen - N
 - 0.0049 mg/L Ammonia – NH_3
 - 0.0057 mg/L Nitrite – NO_2^-
 - 0.8655 mg/L Nitrate - NO_3^-
 - 1.1119 mg/L Phosphate – PO_4^{-3}

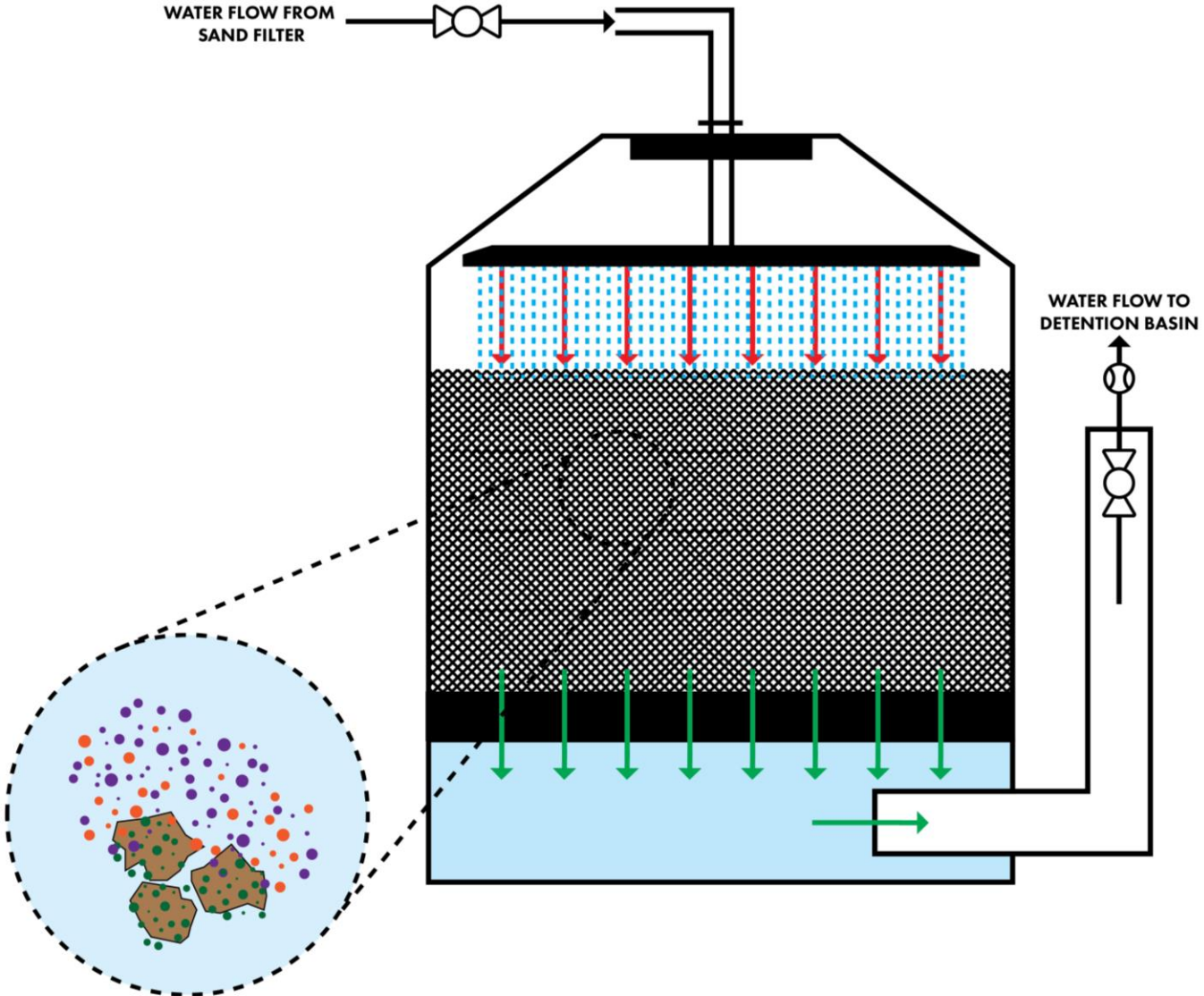
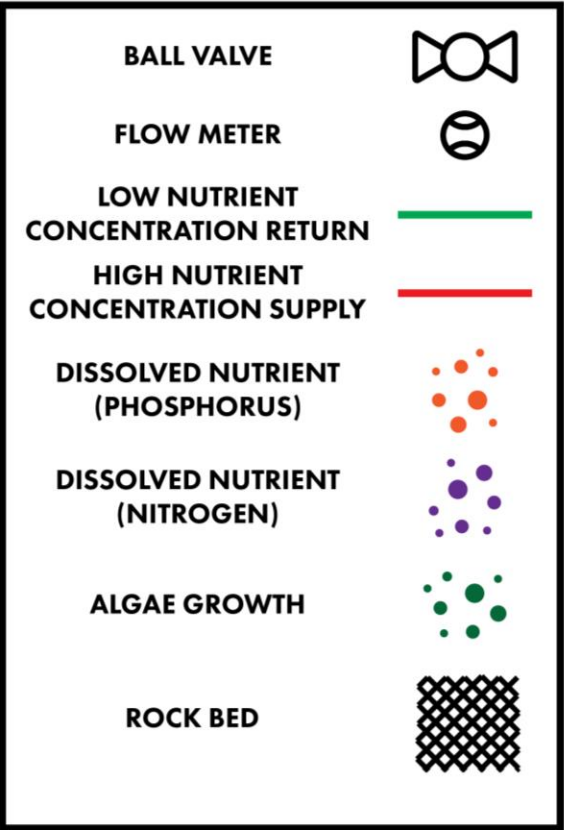
WATER SYSTEM



ATTACHED GROWTH FILTERS

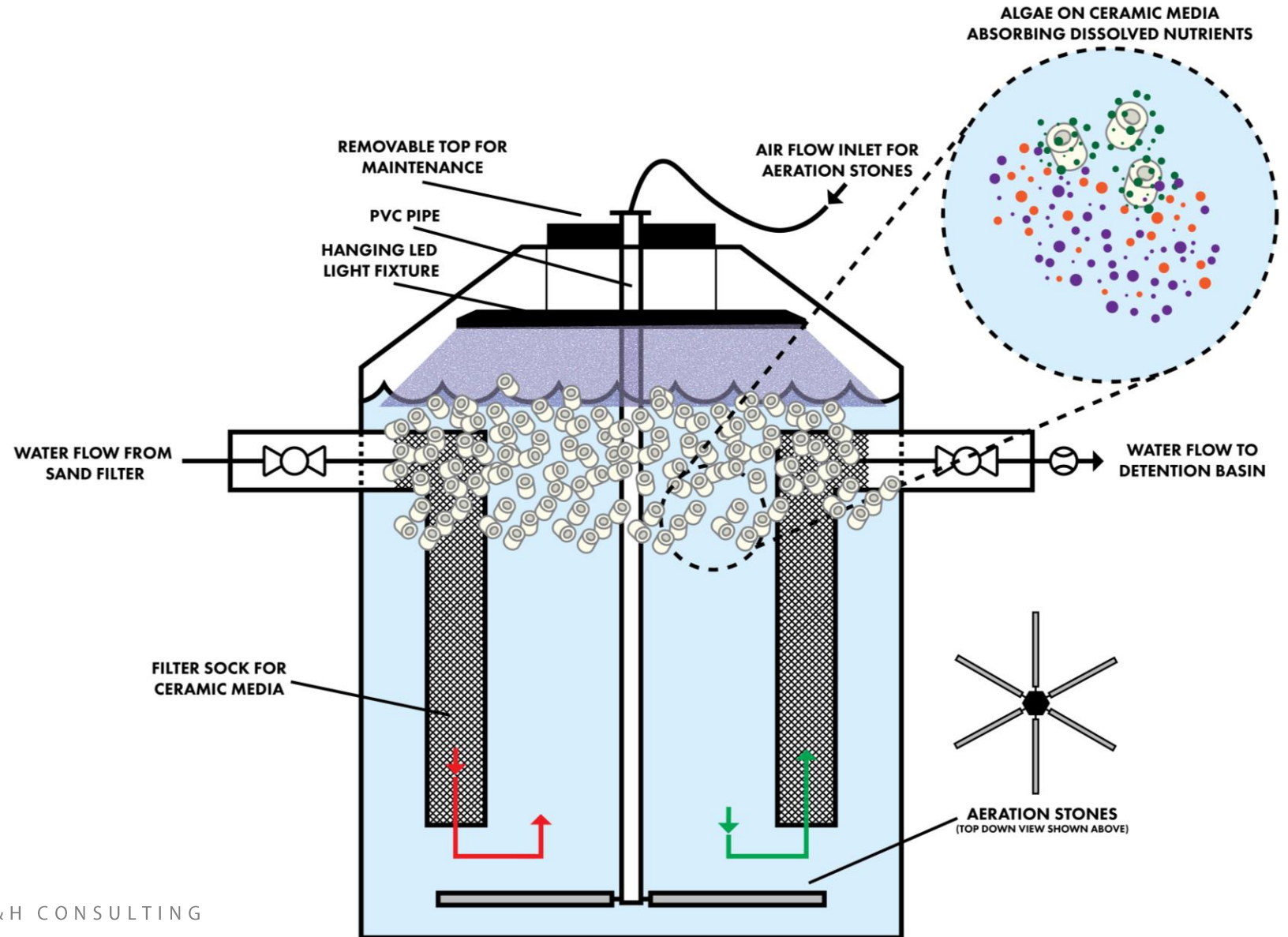
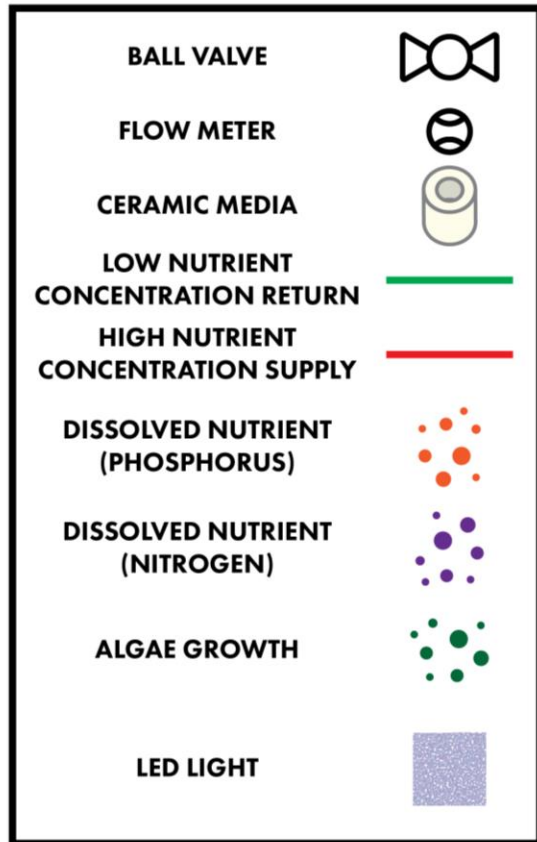
- Designed to filter out nutrients with the use of microorganisms
- Microorganisms consume nutrients (dissolved solids) and form biomass that can be physically removed (suspended solids)
- Utilizes packing materials or medias to support and facilitate the growth of microbes

TRICKLING FILTER

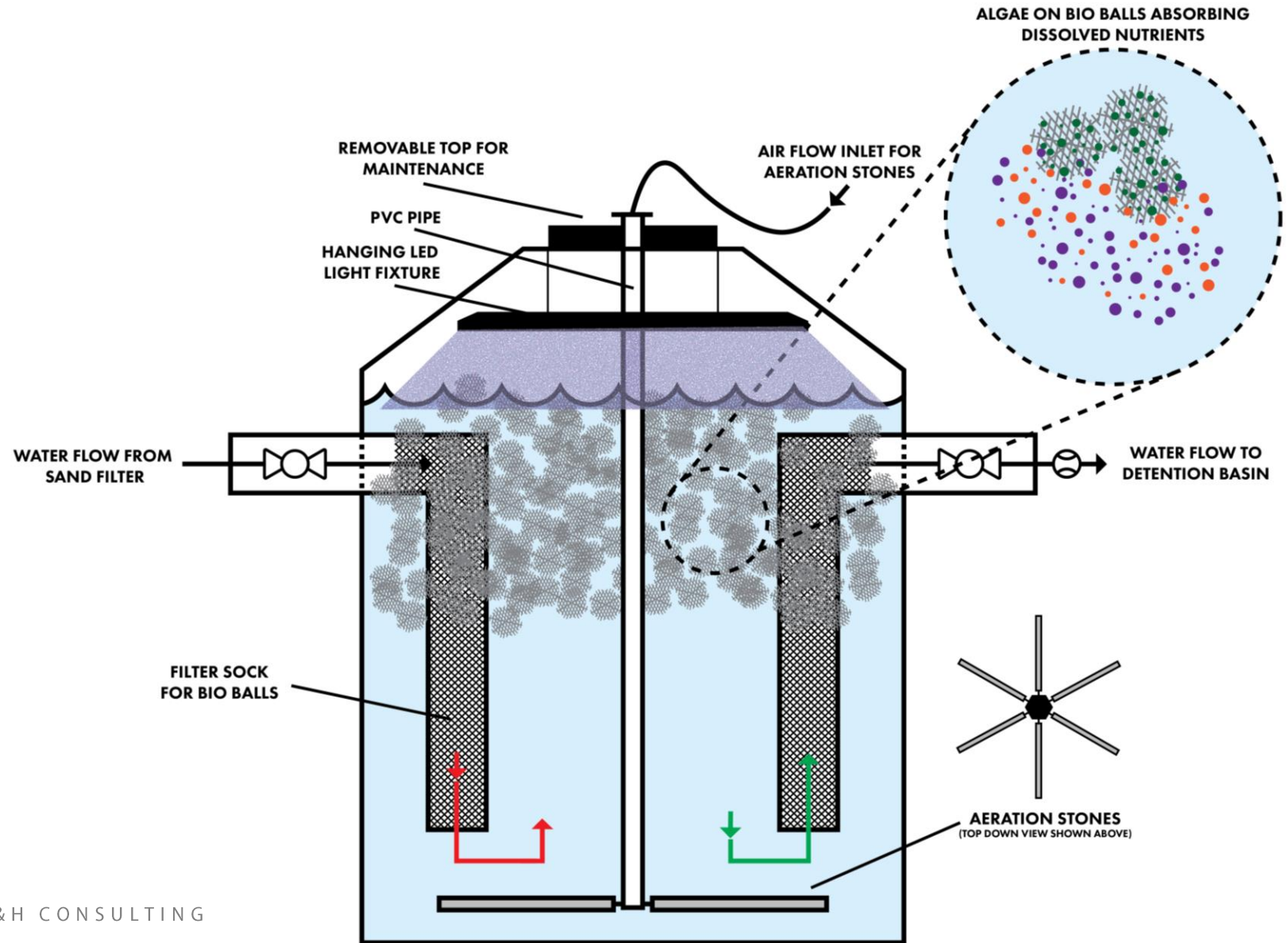
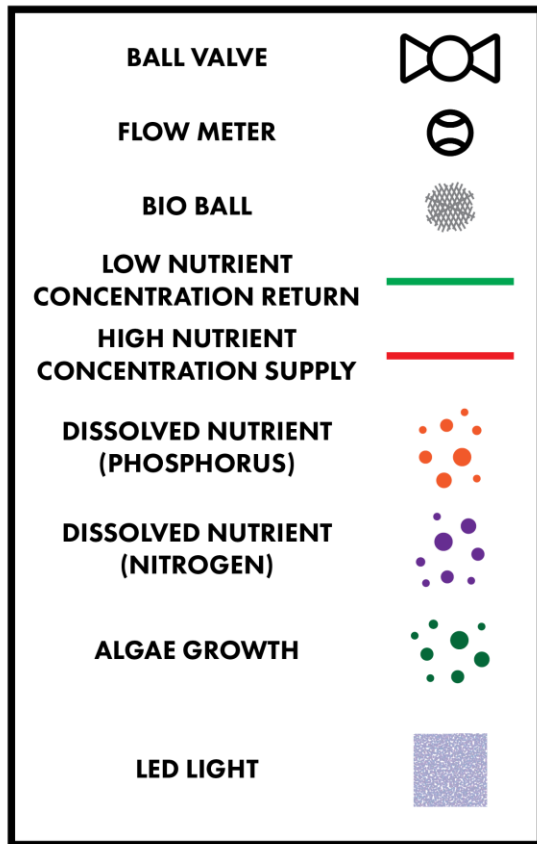


ALGAE ON ROCK/GRAVEL MEDIA ABSORBING DISSOLVED NUTRIENTS

ATTACHED GROWTH WITH CERAMIC MEDIA



ATTACHED GROWTH WITH PLASTIC MEDIA



TESTING

Experiment Goal: Optimize algae growth within closed system

- Variables:
 - Media
 - Type and quantity
 - Lighting
 - Color and duration
 - Aeration
 - HRT (Hydraulic Residence Time)
 - Flowrate
 - Volumes

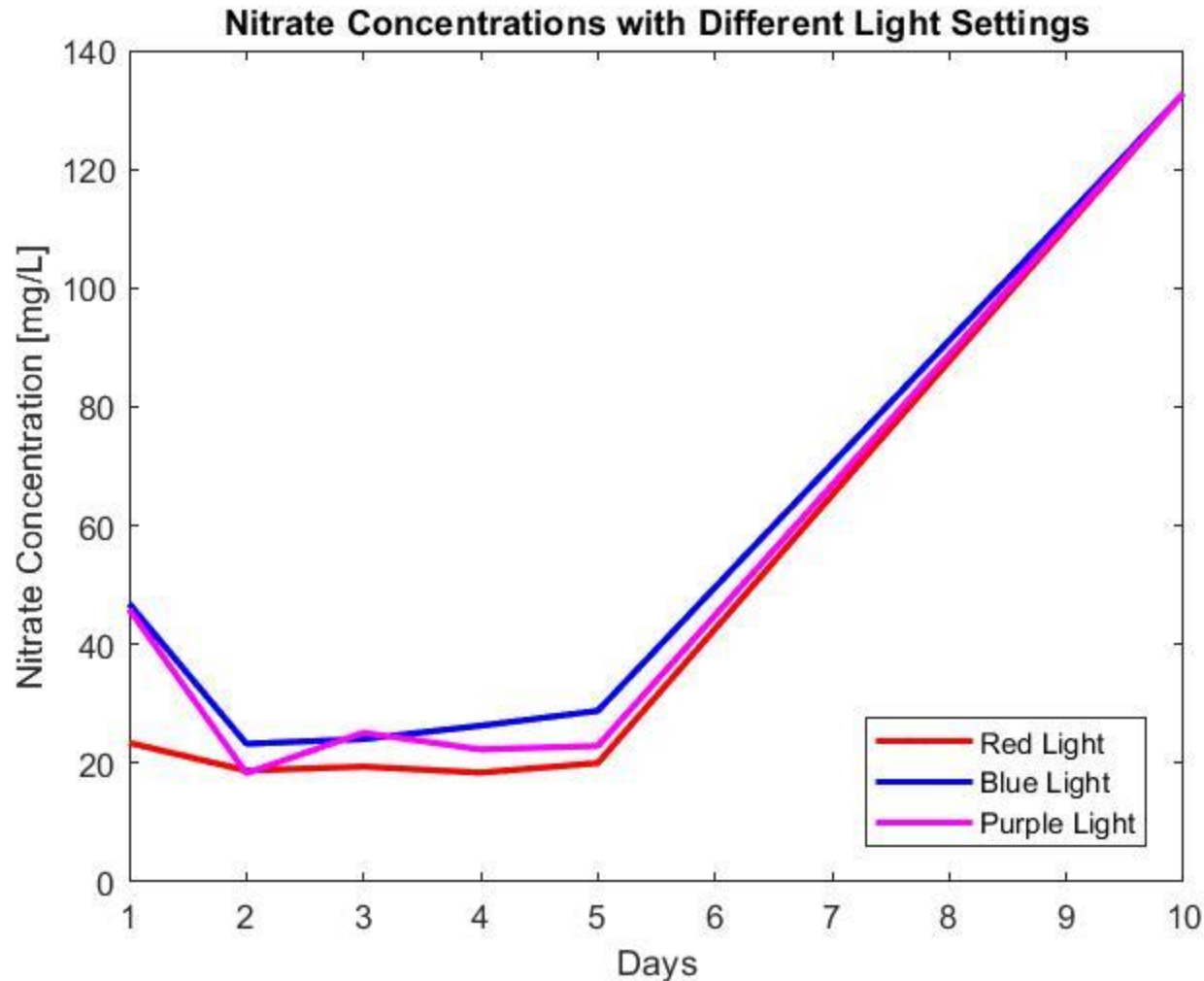


MEDIA

- Surface area of media
 - Pool surface area: 10,000 ft²
- Type of media
 - Ceramic: 45 ft²
 - Plastic: 2 ft²



LIGHT



- The blue and purple bucket visually showed the most growth along with faster nitrification
- Red algae grew brown algae, but the goal is to grow primarily green algae

NITRATE LEVELS WITH NITRIFICATION

- Total Nitrogen will be reduced with attached growth filters
- Nitrification will cause nitrate (NO_3^-) to increase while nitrite (NO_2^-) and ammonia (NH_3) decrease

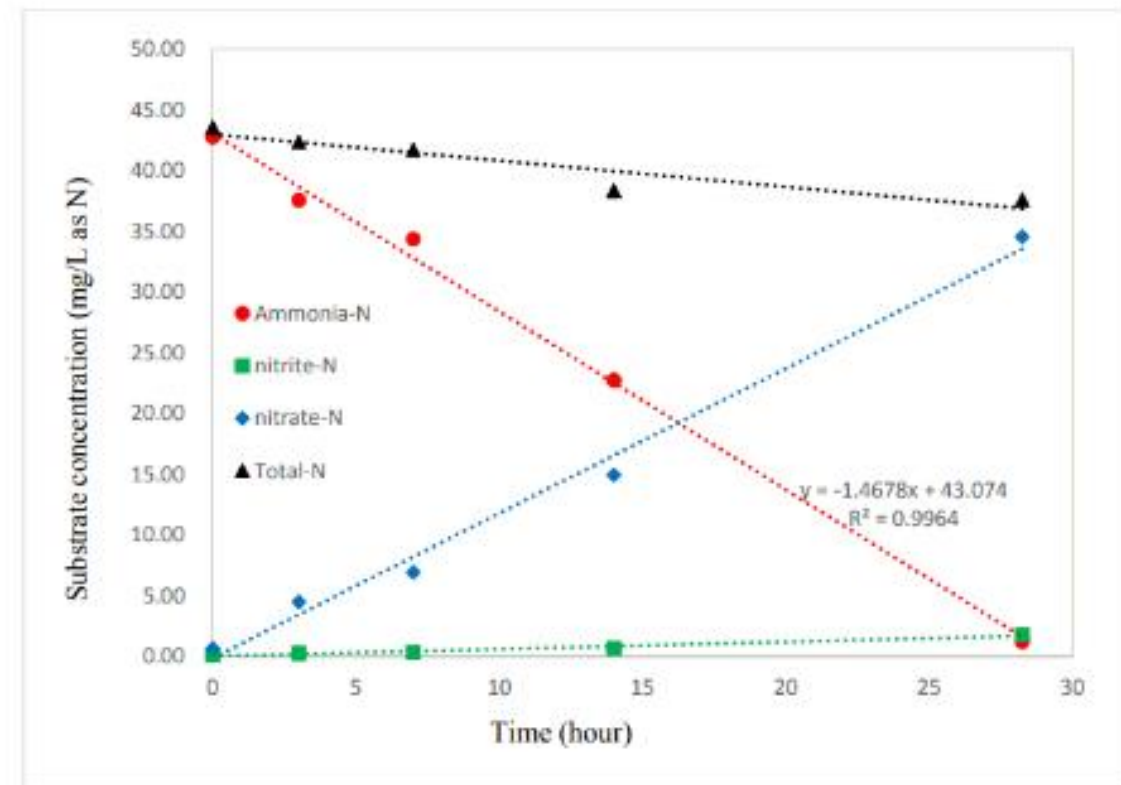
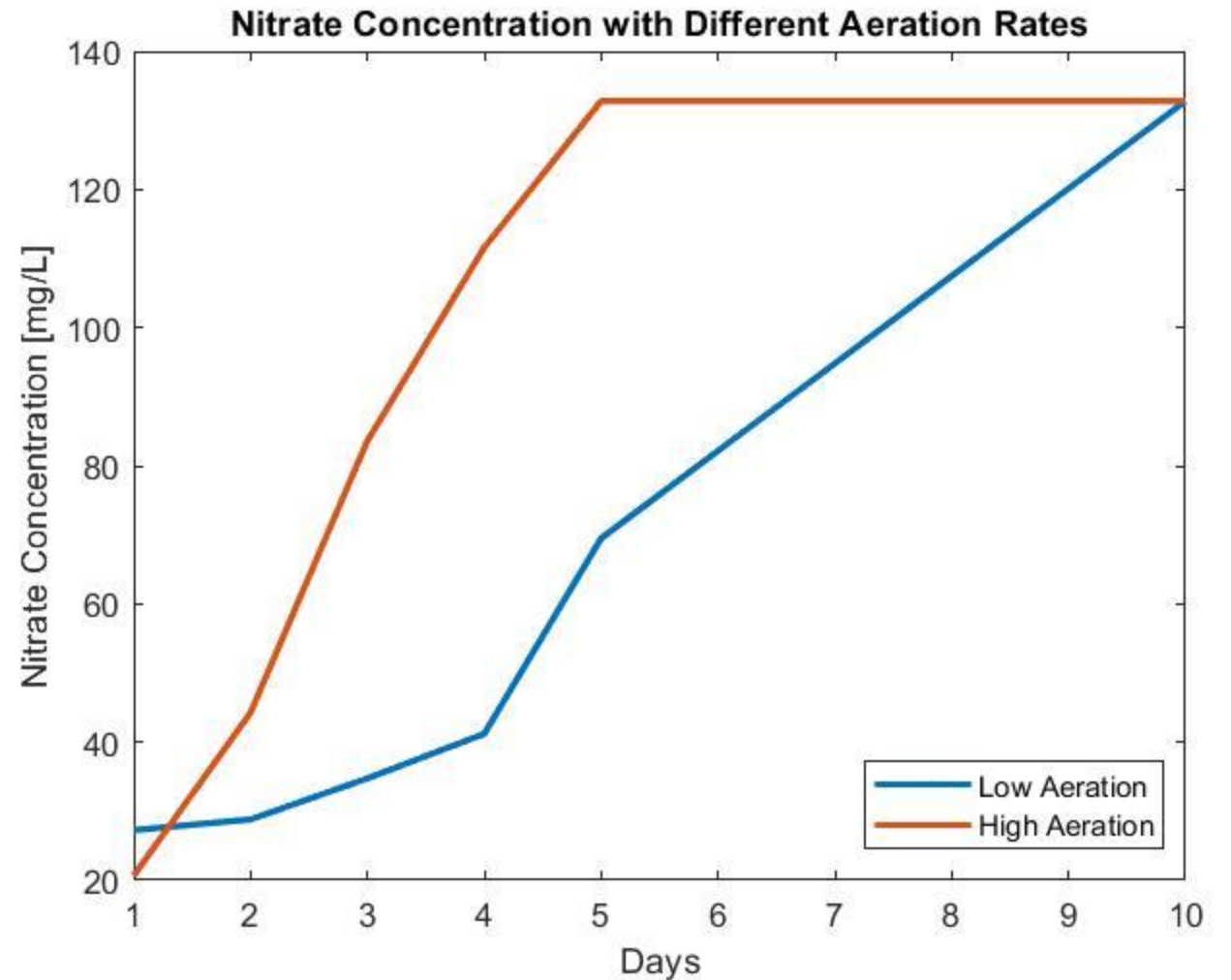


Figure 4.11. Time-course behavior of measured forms of N in attached-growth batch experiments at 20 °C.

AERATION

- Oxygen demand is a limiting factor in growth

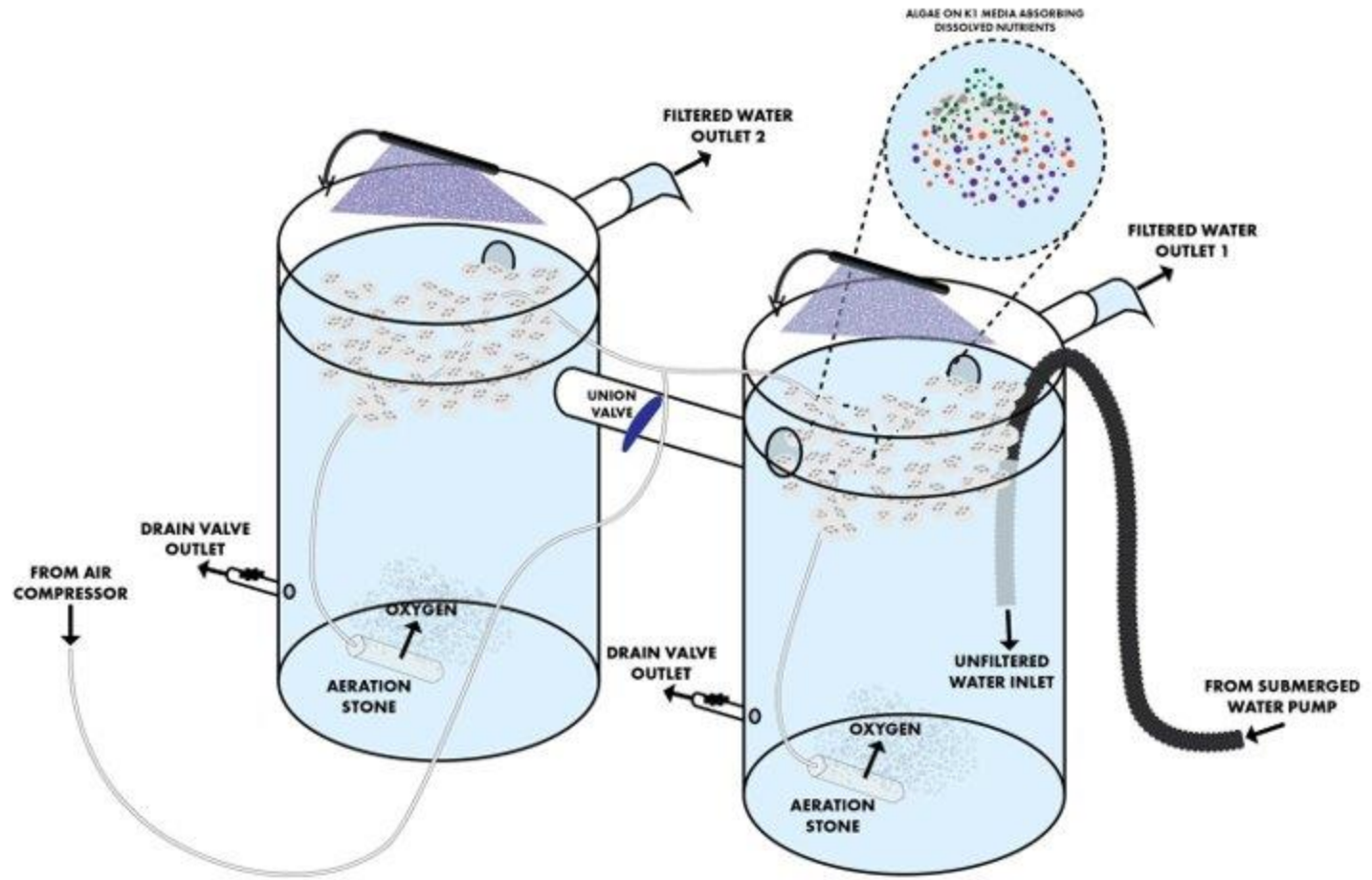


HRT (HYDRAULIC RESIDENCE TIME)

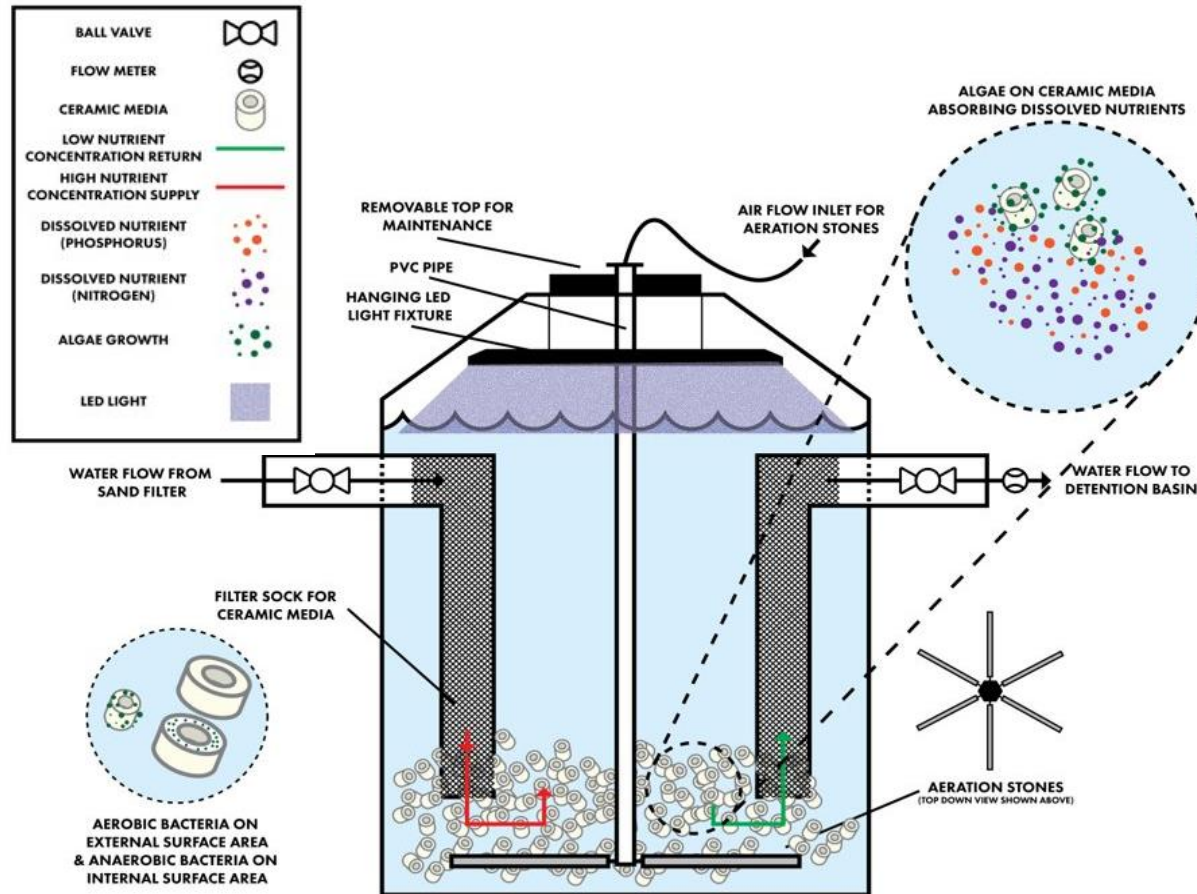
- Desired HRT of 2 days
- Prototype Methods:
 - Pump voltage
 - Pipe diameters (1.5" to ¾")
 - Head loss calculations (17 GPM to 2.0 GPM)
 - HRT 6 minutes

Discharge Height Above Pumping Level	5 ft (1.5 meters) 1,800 gallons/hr (6,814 liters) 10 ft (3.0 meters) 1,320 gallons/hr (4,997 liters) 15 ft (4.5 meters) 720 gallons/hr (2,725 liters) 20 ft (6.0 meters) 120 gallons/hr (454 liters)
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CURRENT PROTOTYPE



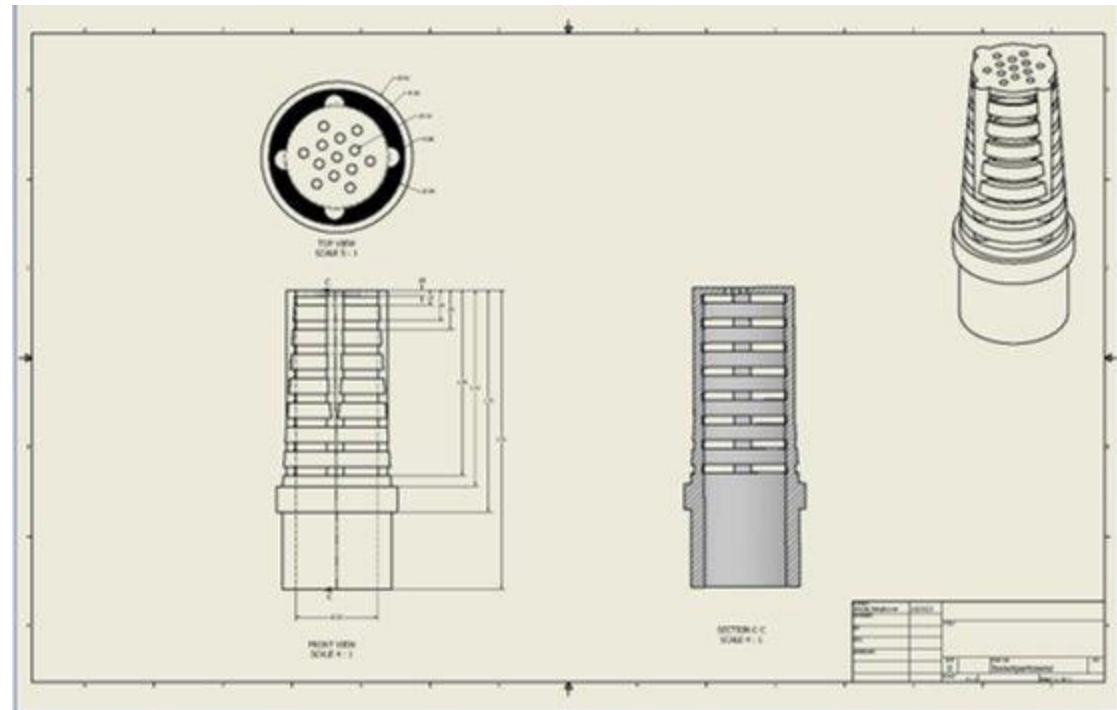
RECOMMENDED OF ACTION



- Install 500-gallon tank with blue LED
- 422 units of ceramic media (double surface area)
- Year-long duration
- HRT of 2 days

RISK MANAGEMENT

- Algae growth
- Light
- Media spillage



COST ANALYSIS



Over 8 months of cleaning from 32 to 16 water changes

- Labor: \$3,072
 - \$32/6 hours to drain and refill
- Water : \$8,432
 - \$0.0062/gallon
- Total: \$11,504

REFERENCES

- Zhe Sun. ATTACHED-GROWTH SYSTEM FOR NITRIFICATION AT LOW TEMPERATURE Zhe .Sun Purdue University. 2014.
https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1293&context=open_access_theses



Preparing people to lead extraordinary lives