Introduction to Aquaponics

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Special Thanks to
Andrew S. McArdle, Aquaponics Specialist
for his original work

What is Aquaponics??

Aquaculture + =

Recirculating Aquaculture

Raises fish in densely stocked tanks

Drawbacks:

- High amounts of waste produced
- Extensive Filtration Required

Aquaculture + **Hydroponics** =

Hydroponics

Farming of plants in a soil-less environment.

Drawbacks:

- Chemicals and fertilizers are provided in a nutrient solution (many of which are petroleum derived and can be expensive)

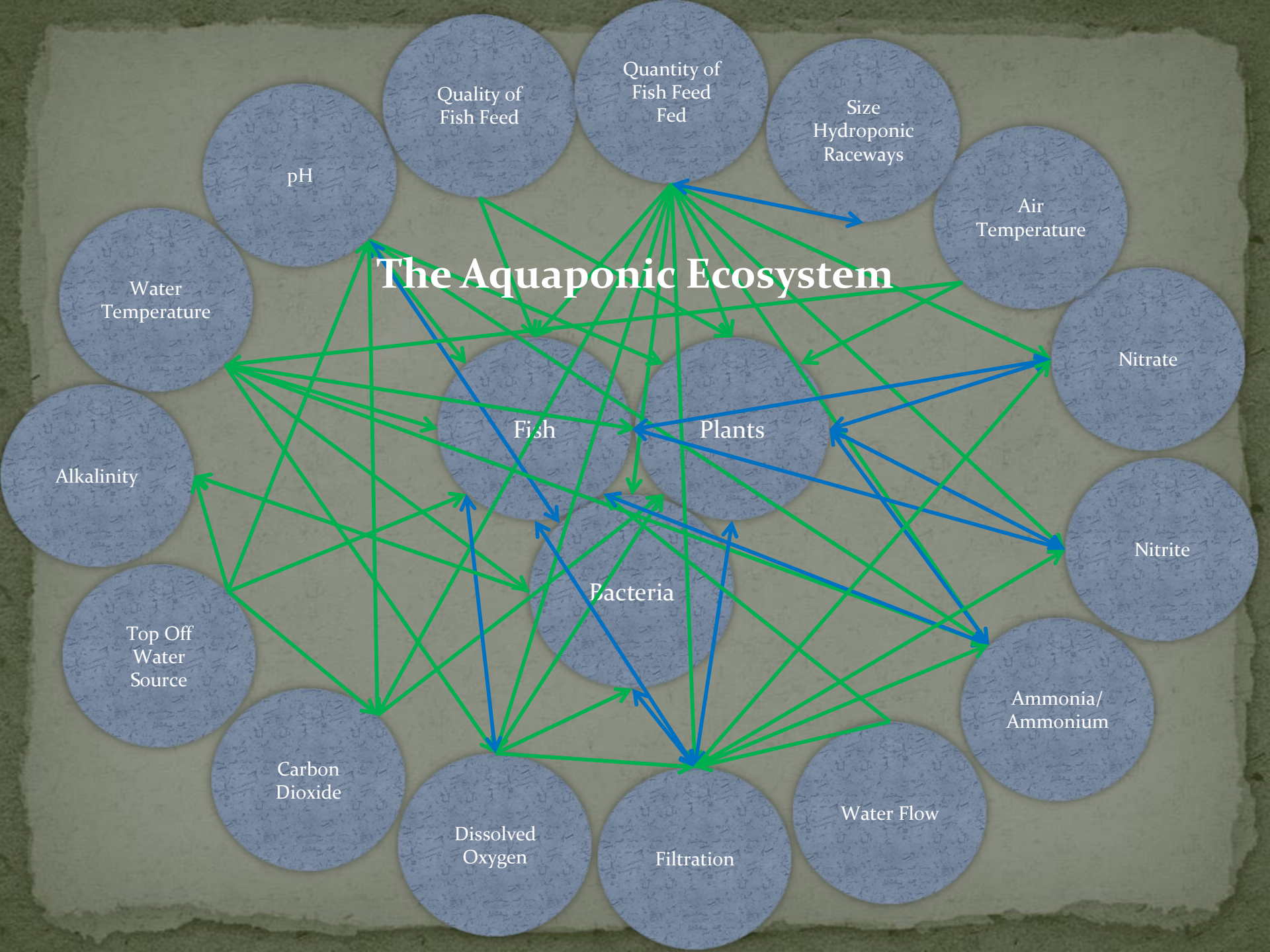
Aquaculture + Hydroponics = Aquaponics

Aquaponics

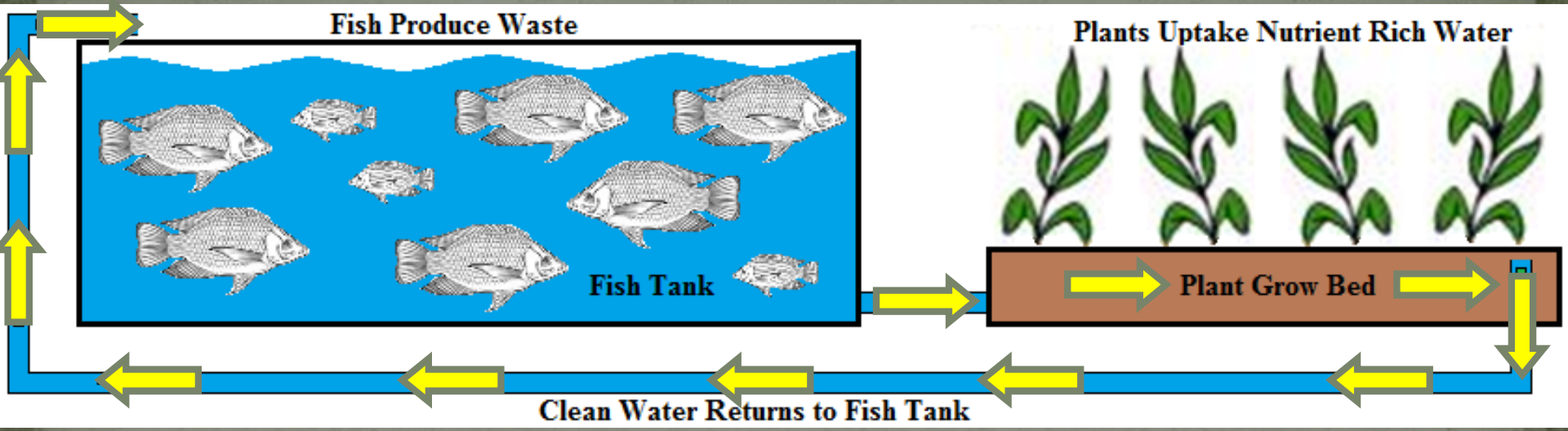
Culmination of both intensive aquaculture and hydroponic technologies in a recirculating system.

-Reduced Waste

-Hydroponic Fertilizers No Longer Required


The Aquaponic Ecosystem
Quality of Fish Feed
Quantity of Fish Feed Fed
Size Hydroponic Raceways
pH
Air Temperature
Water Temperature
Nitrate
Fish
Plants
Alkalinity
Nitrite
Bacteria
Top Off Water Source
Ammonia/ Ammonium
Carbon Dioxide
Water Flow
Dissolved Oxygen
Filtration

The Idea


Fish Produce Waste
Fish Tank
Plants Uptake Nutrient Rich Water
Plant Grow Bed
Clean Water Returns to Fish Tank

Types of Aquaponic Systems

Media Bed

- Flood and Drain System
  - Media filled grow bed
    - pH neutral rock or expanded clay
    - Either continuously flooded
      OR flooded and drained

NFT – Nutrient Film Technique

- Nutrient Film Technique (NFT)
  - Suitable for smaller plant varieties – Leafy Greens
  - Larger plants clog gutters
  - Thin film of water
  - Can heat up very easily so chiller may be required
  - Good potential for commercial operation

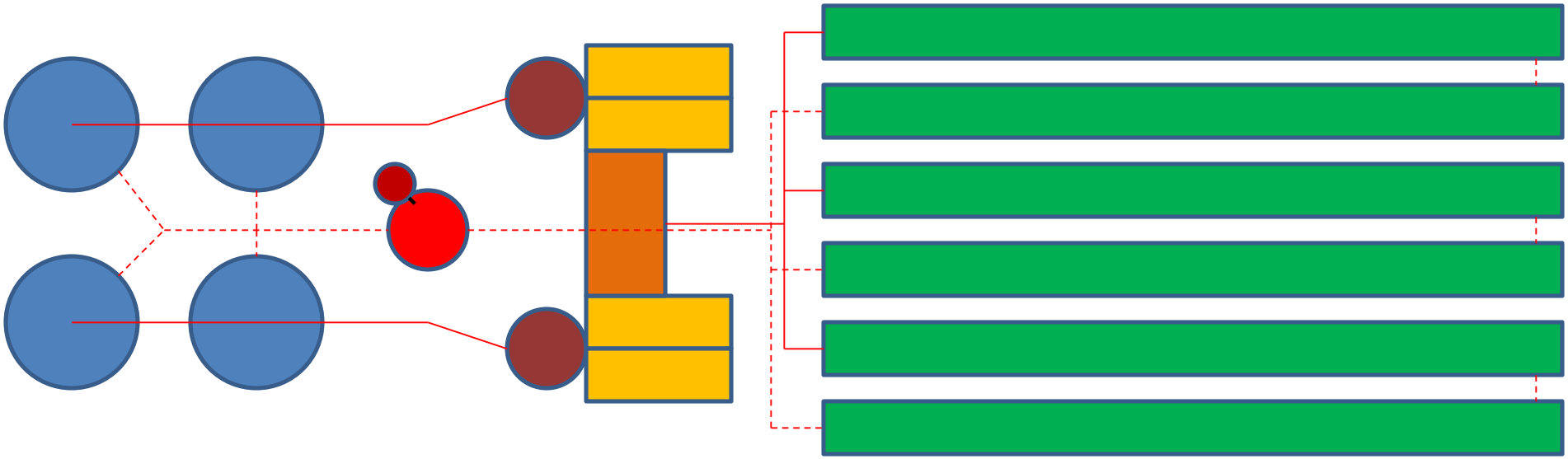
DWC – Deep Water Culture Raft Method

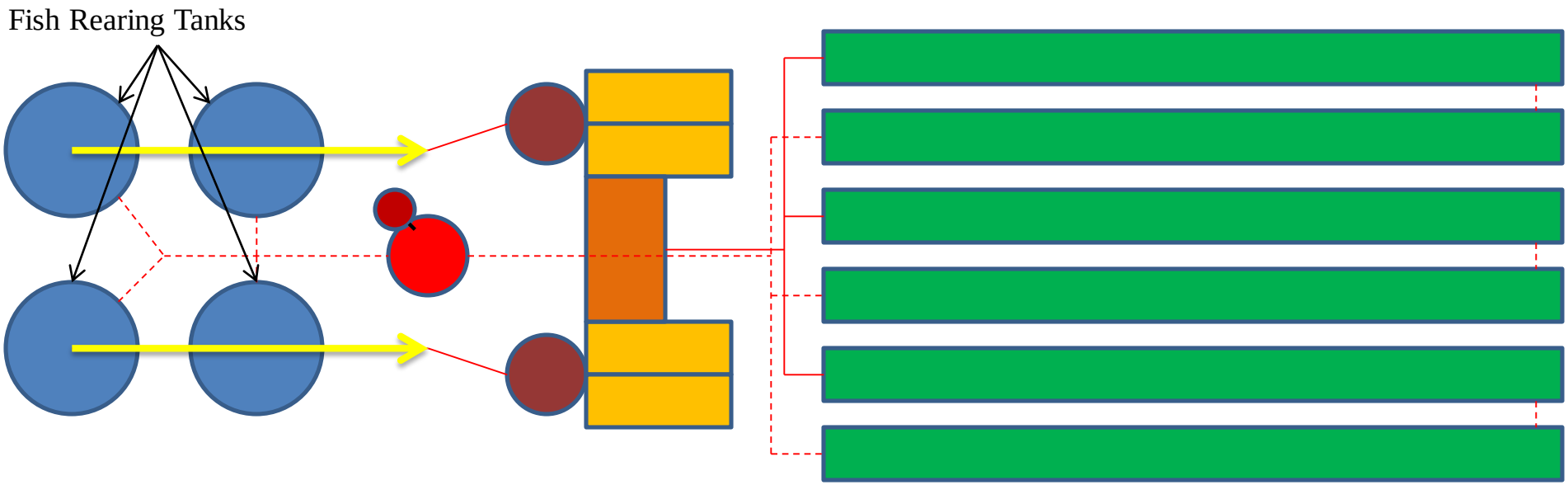
- Raft System
  - Floats plants on top of water with roots suspended in the water column
  - Most practical commercial application

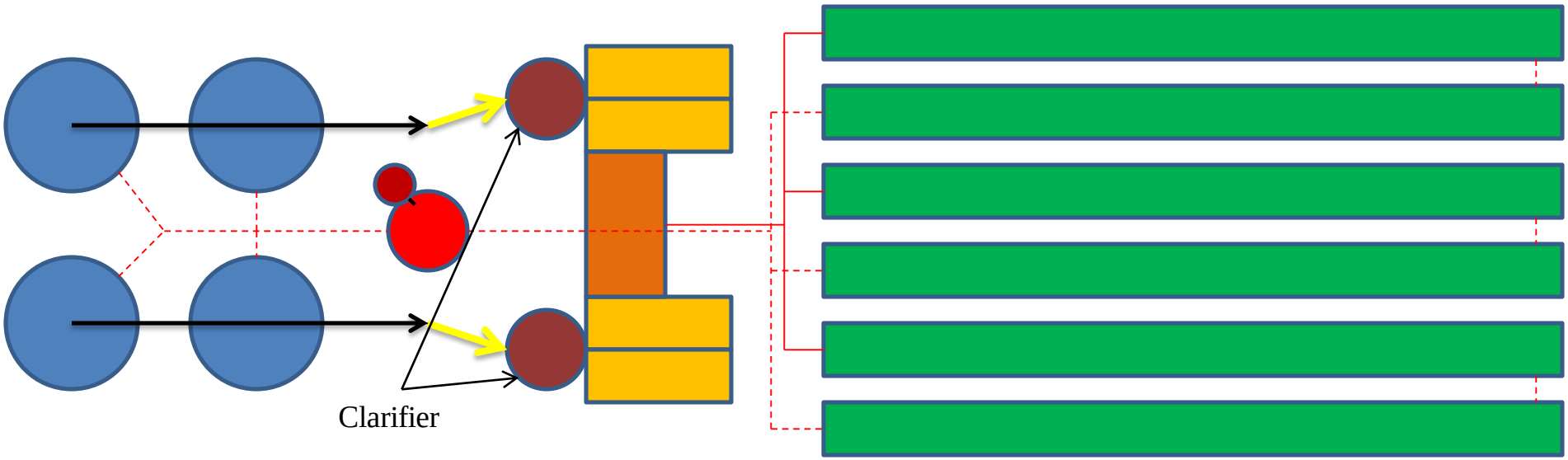
Key Elements

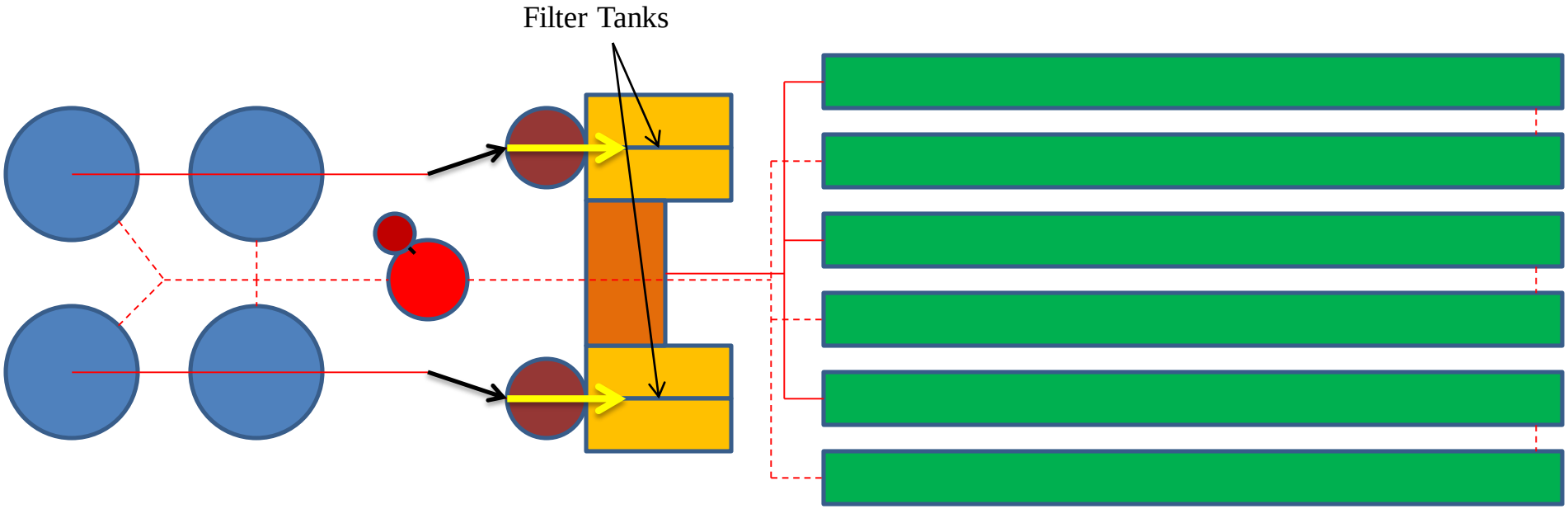
- Fish Culture Tanks
  - Size and number varies among systems
- Clarifier
  - Solids removal
- Filter Tanks
  - Depends on Size of system if required
- Degassing Tank
  - Vents out excessive amounts gases
- Biofilter
  - Nitrification process
  - Varies depending on system
    - Can be in own tank or within growbed for some systems
- Water Pump
  - Want to use no more than a single pump in your system
- Air blowers
  - Provides sufficient dissolved oxygen levels required by fish and plants
- Grow Beds
  - Primary difference between system designs
- Primary System Designs
  - Raft System
  - Nutrient Film Technique (NFT)
  - Flood and Drain System
- Water Flow
  - Gravity Fed – Typically from fish tanks to a sump with a pump.

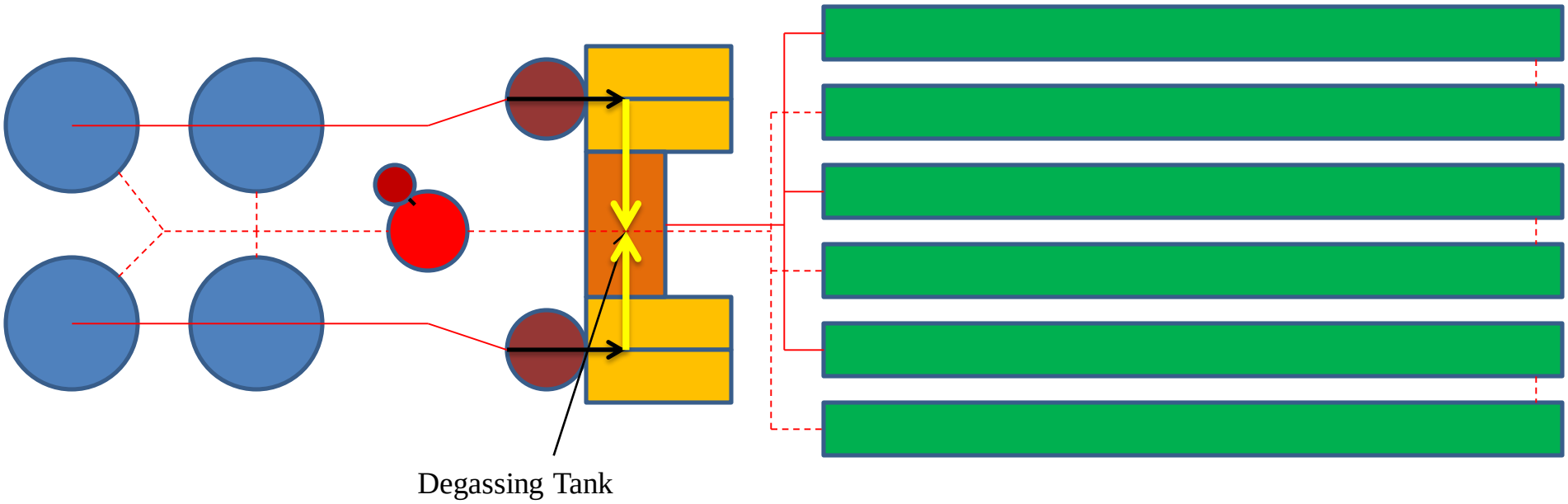
The System

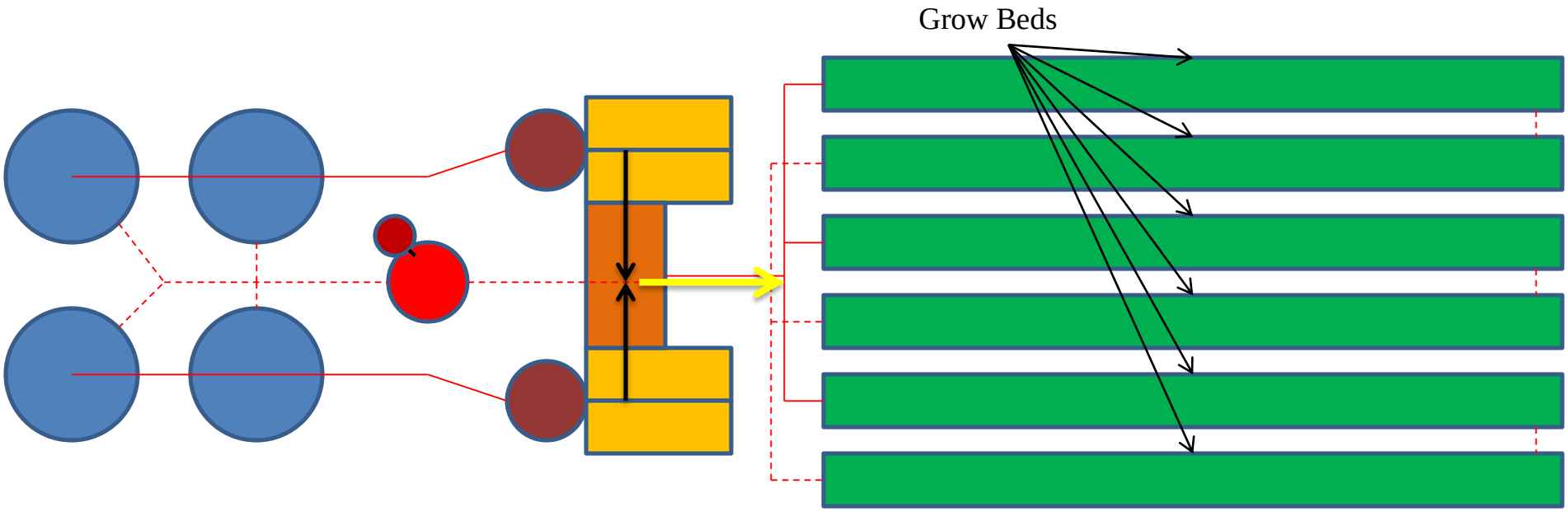


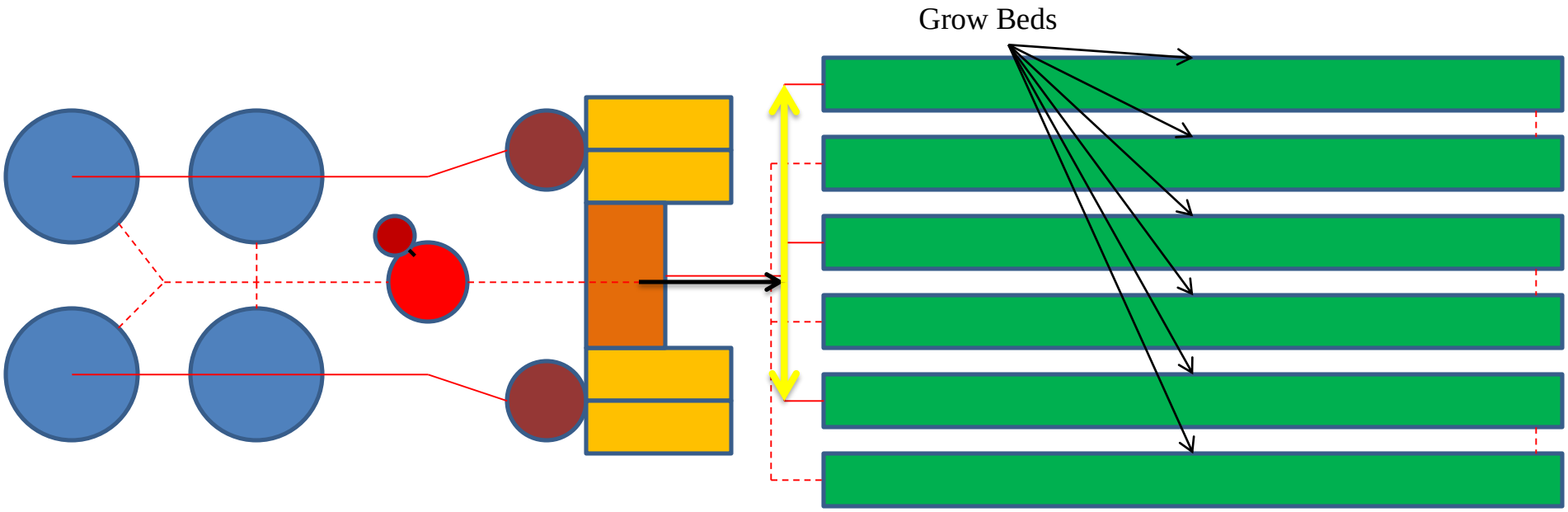

Fish Rearing Tanks

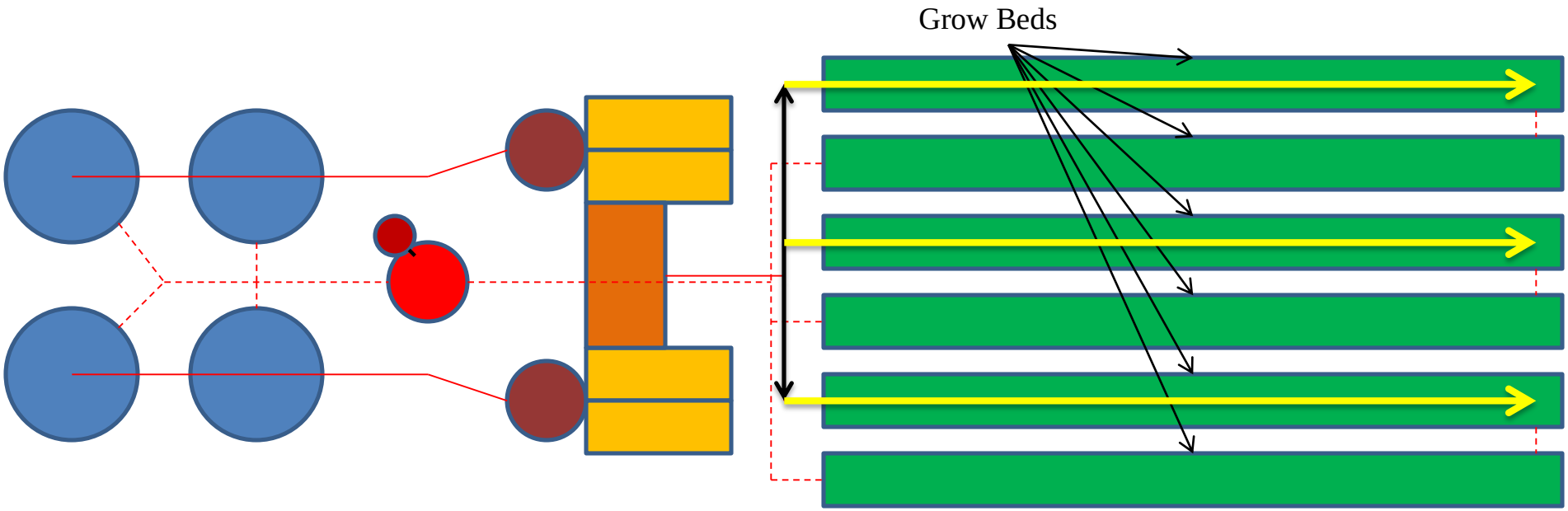

Clarifier

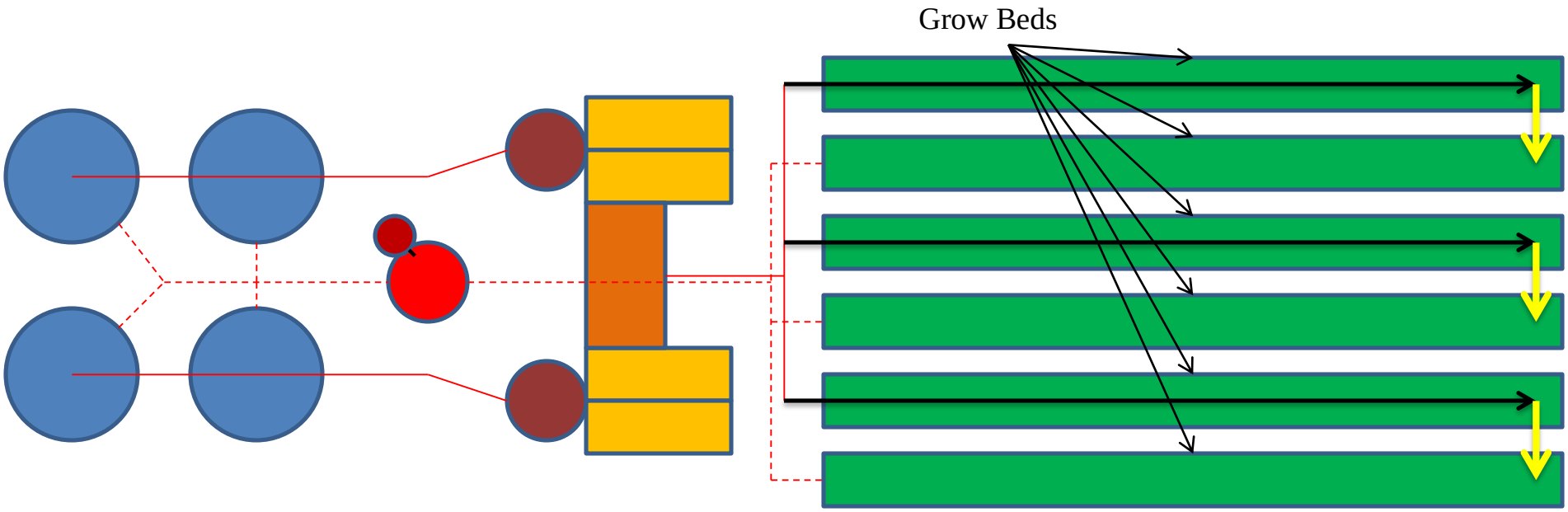

Filter Tanks

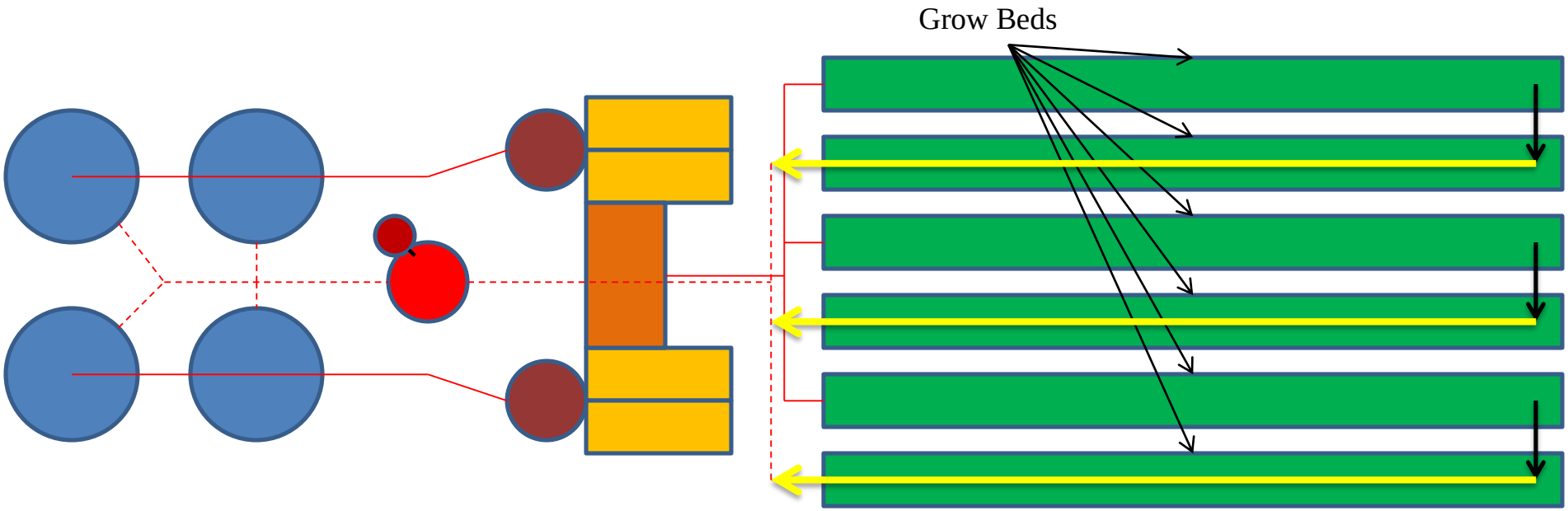

Degassing Tank

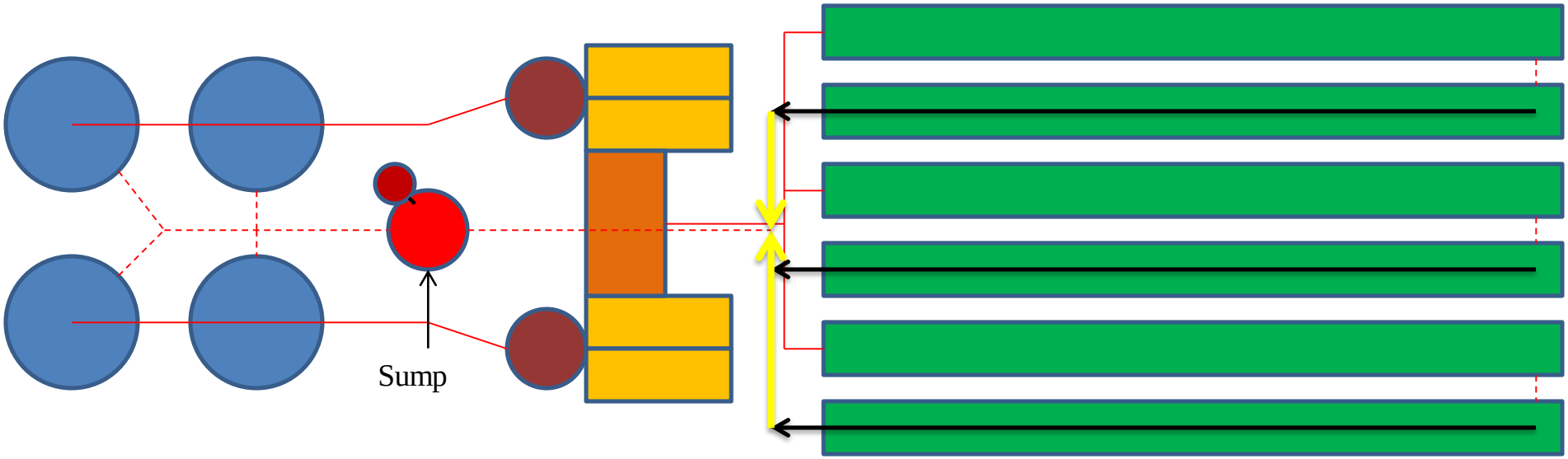

Grow Beds

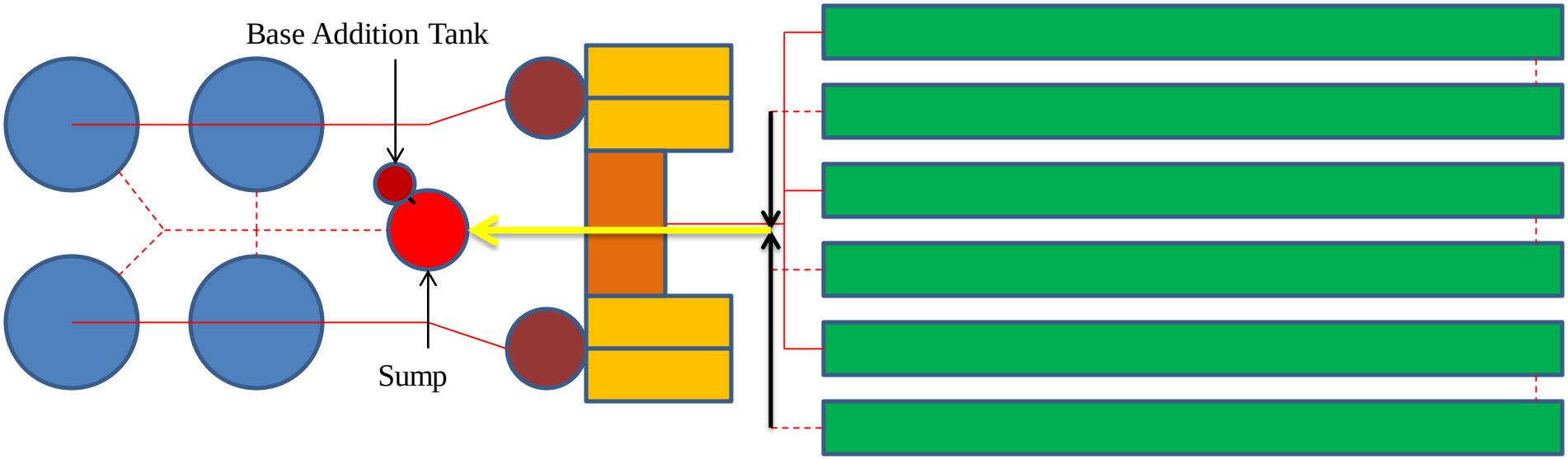

Grow Beds

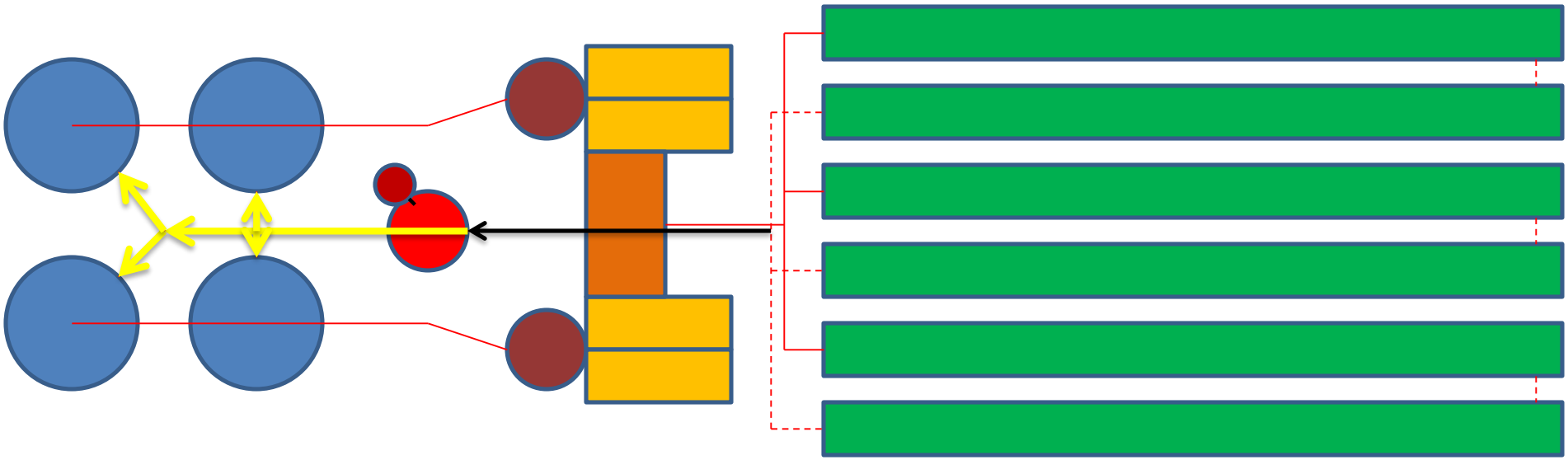

Grow Beds

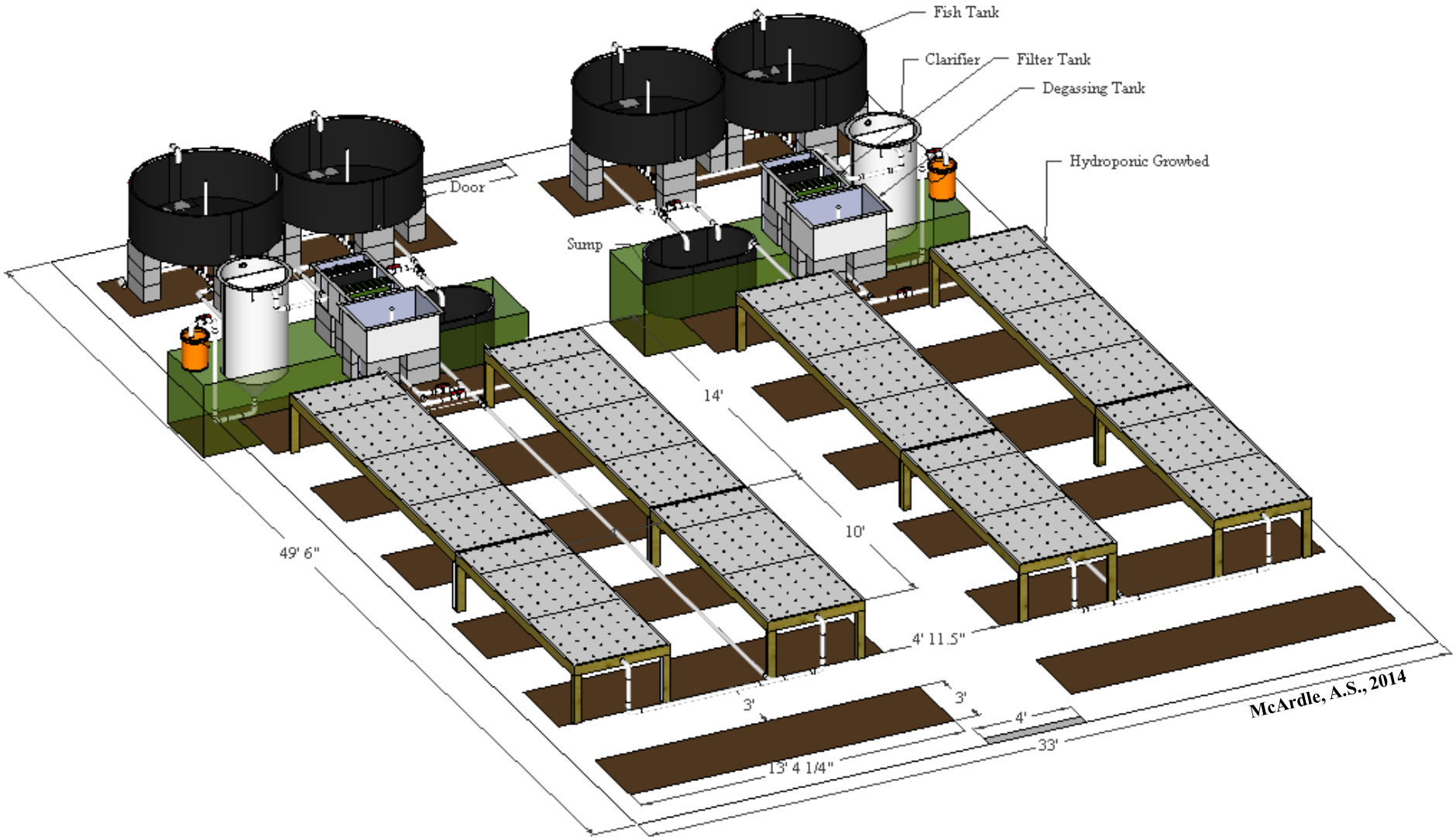

Grow Beds

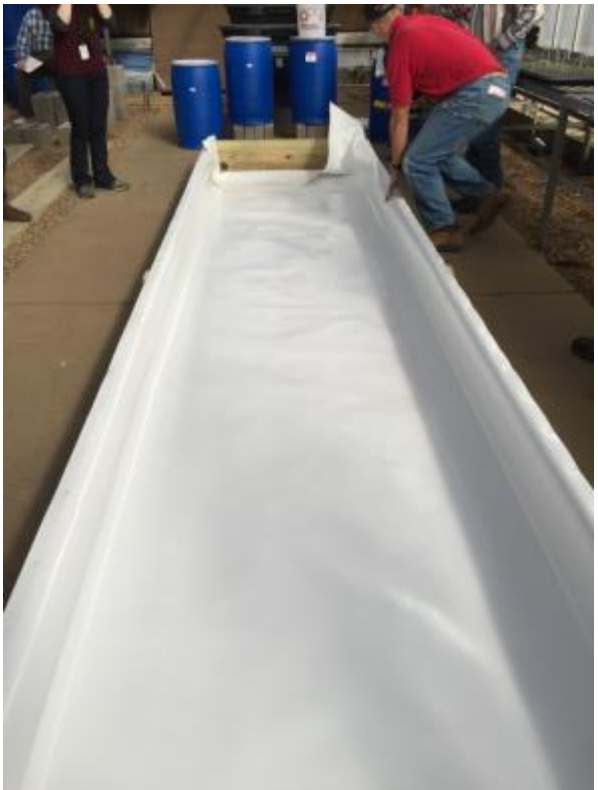

Grow Beds

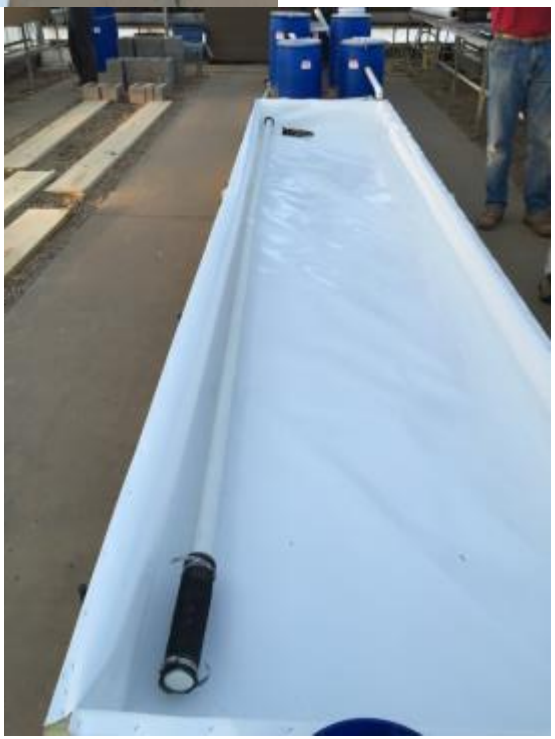

Sump

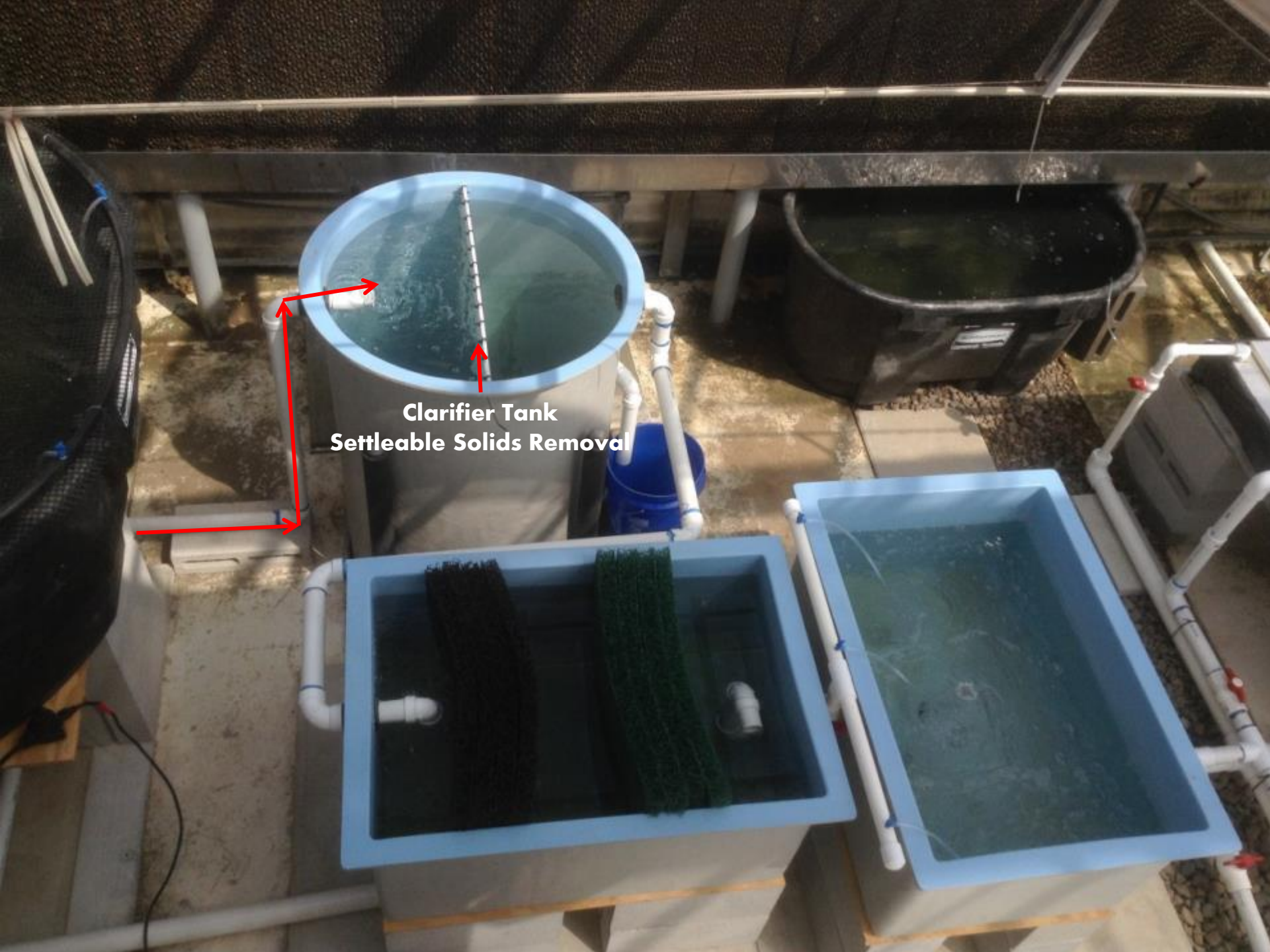

Base Addition Tank
Sump

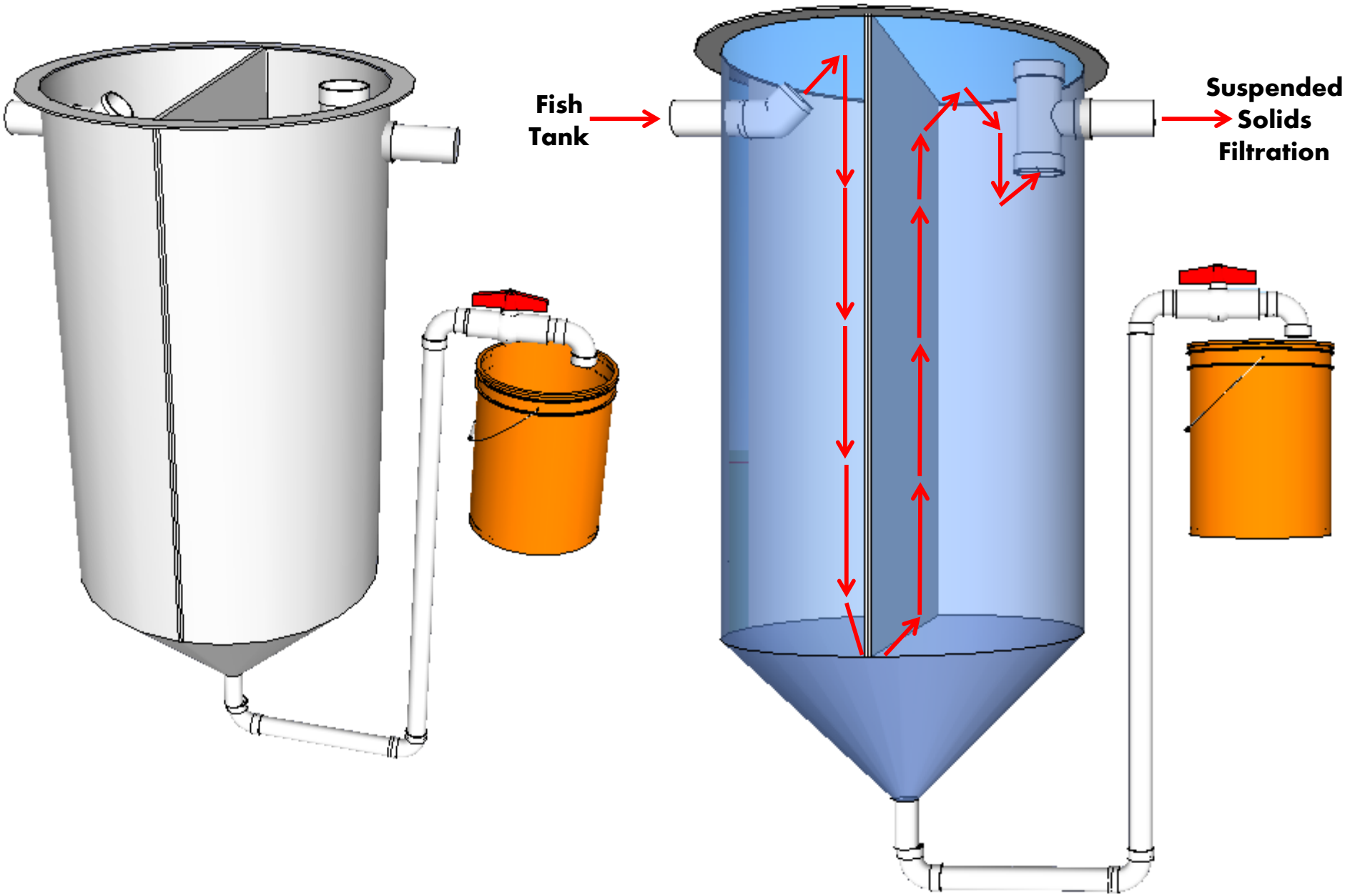


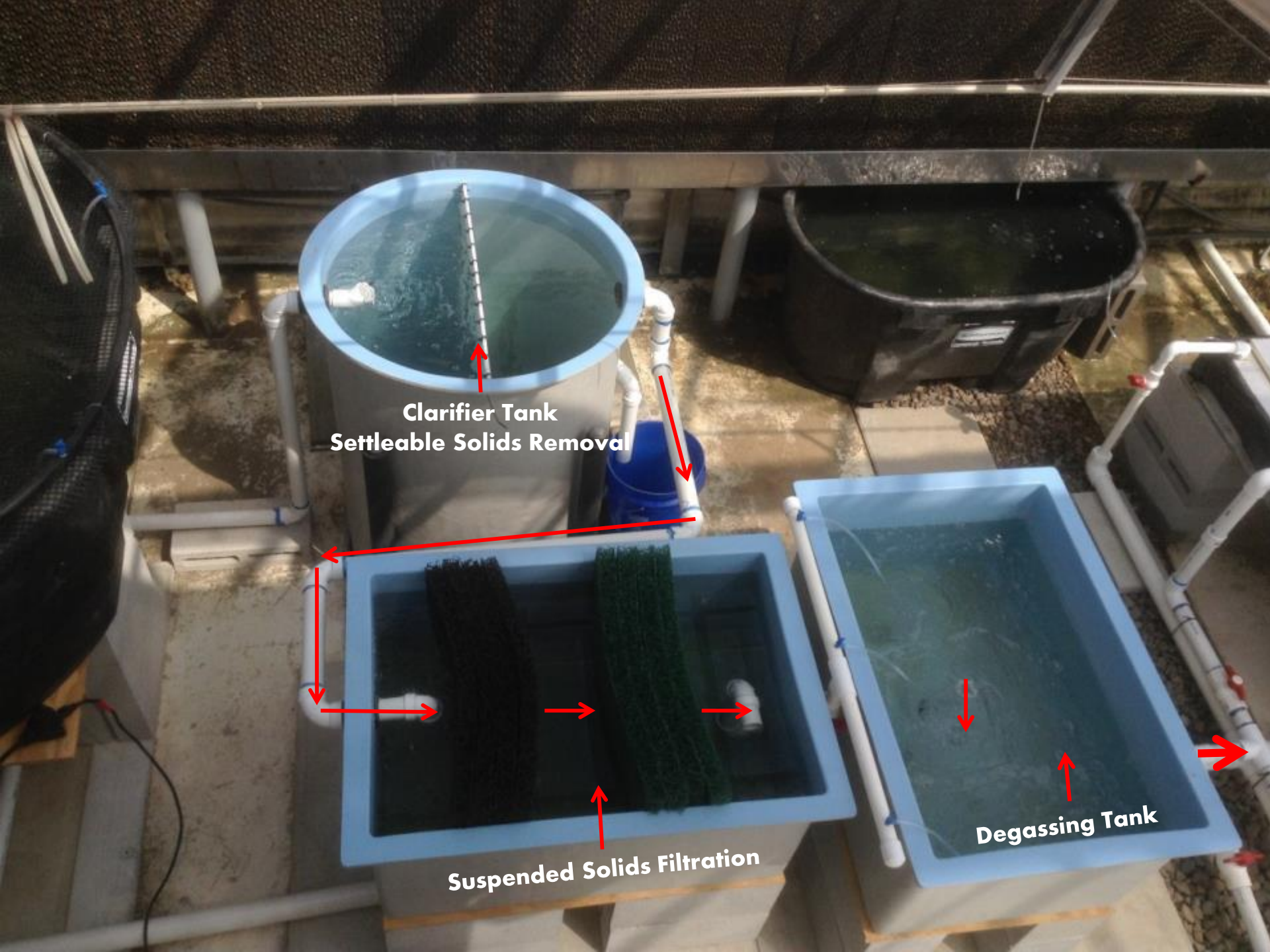

Fish Tank
Clarifier
Filter Tank
Degassing Tank
Hydroponic Growbed
Door
Sump
14'
10'
49' 6"
4' 11.5"
3'
3'
4'
13' 4 1/4"
33'
McArdle, A.S., 2014



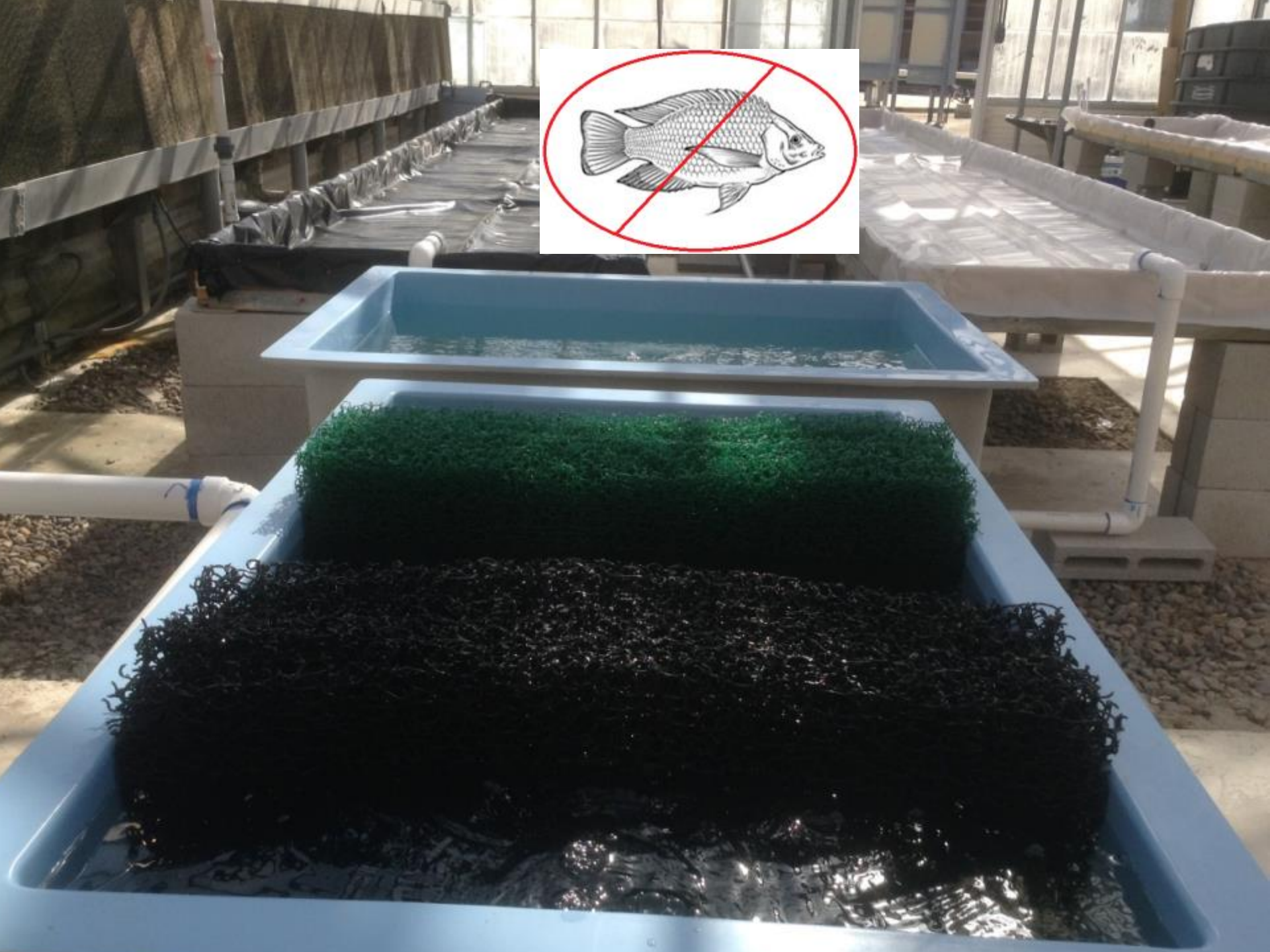



Clarifier Tank
Settleable Solids Removal

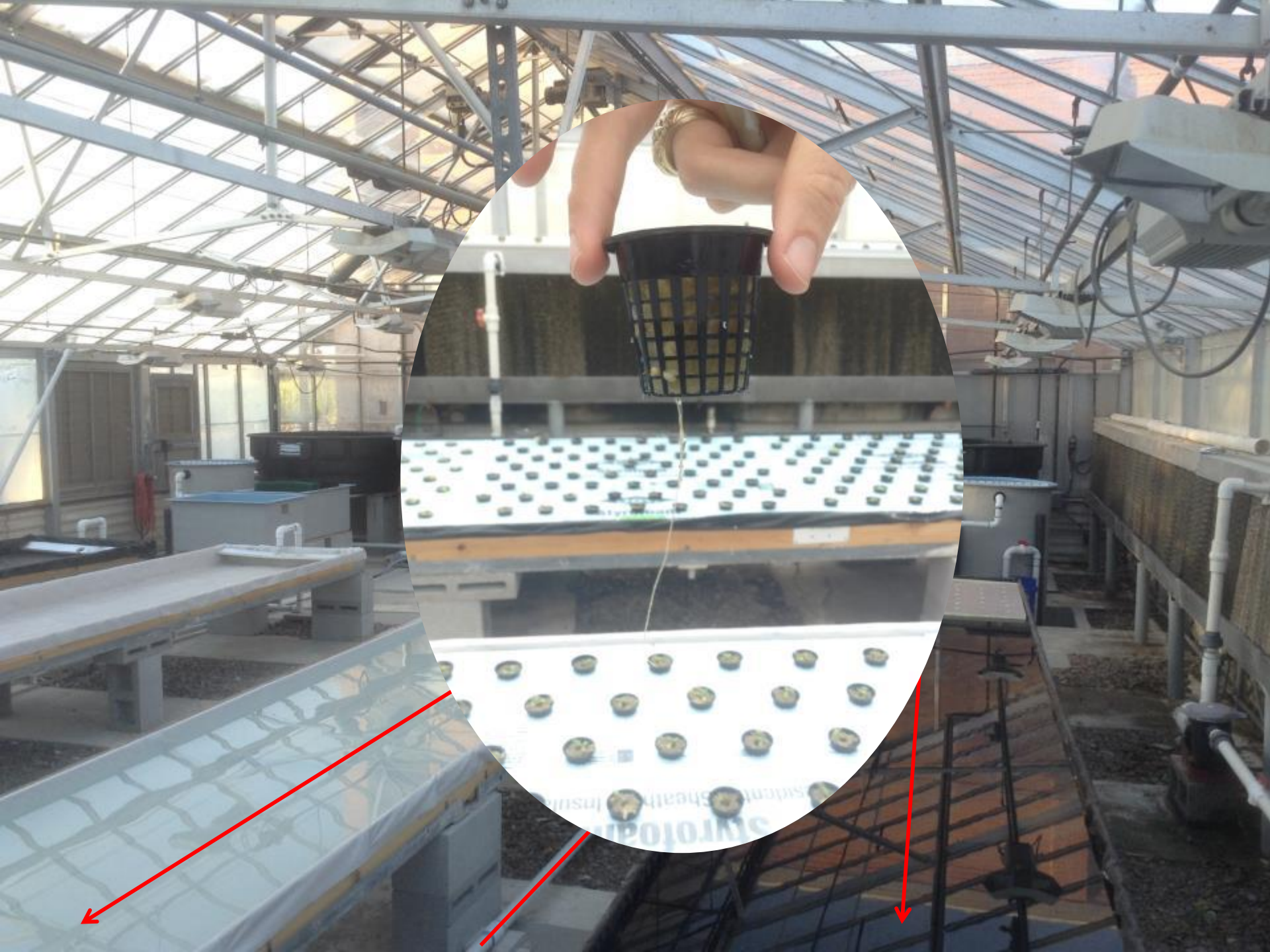

Fish
Tank
Suspended
Solids
Filtration


Clarifier Tank
Settleable Solids Removal
Suspended Solids Filtration
Degassing Tank


1,000 Eggs every 4 Weeks





~1/3hp

Flow Rate: 10 gallons/minute

*Allows fish tanks to retain the water for 60 minutes.

Regenerative Air Blower:
2hp

Water Pumps!

Backup Generator!

Air Blowers!

Backups! Backups! Backups!

Bacteria

You are actually farming one more thing along with the fish and vegetables…

Fish Excrete Ammonia Through Waste & Gills

Plants Uptake Nutrients from the Water Filtering it for the Fish

The Aquaponic Nitrogen Cycle

Ammonia

nitrosomonas sp.

Nitrite

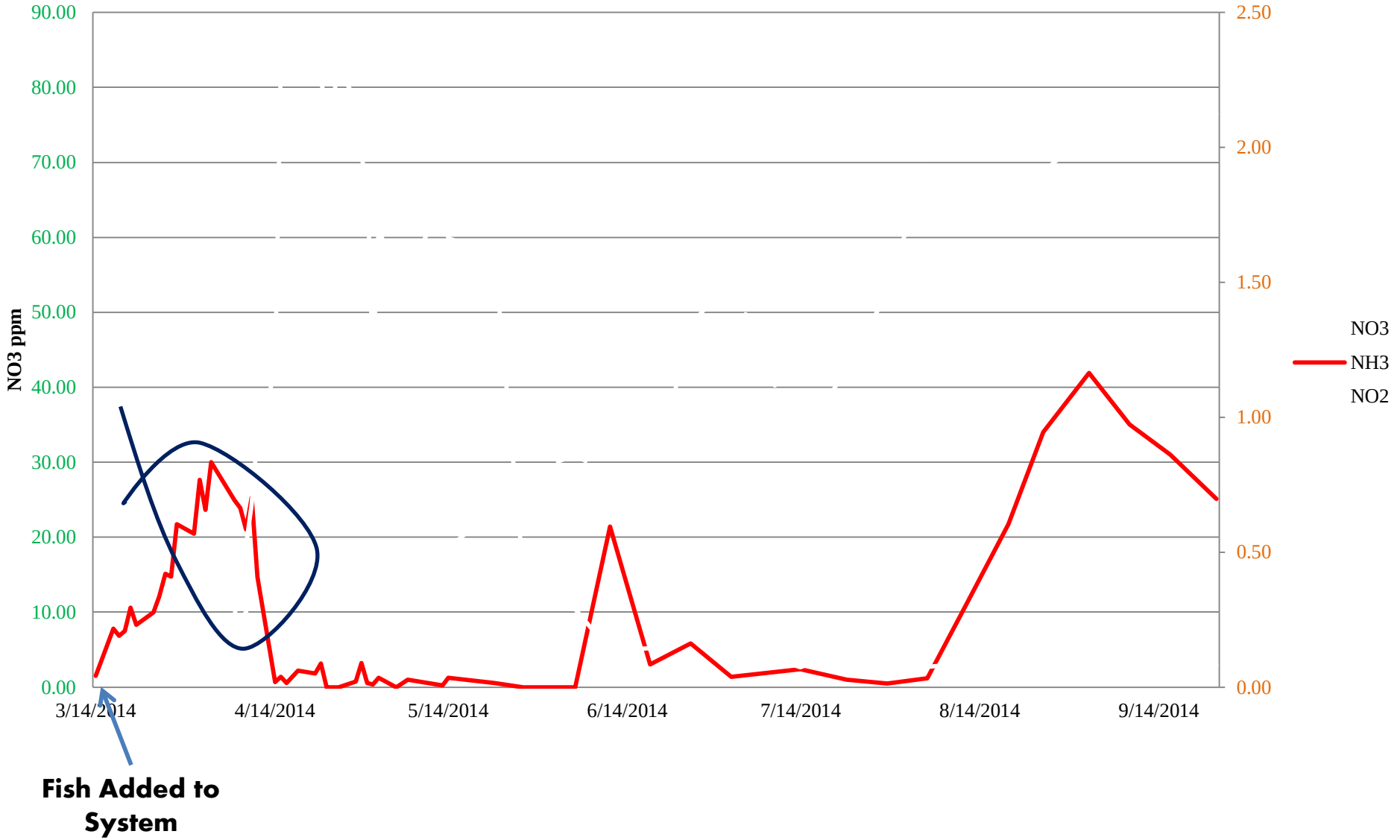
nitrobacter sp.

Nitrate

Bacteria Convert Waste to Usable Nutrients for Plant Growth

System Cycling

Start-Up Phase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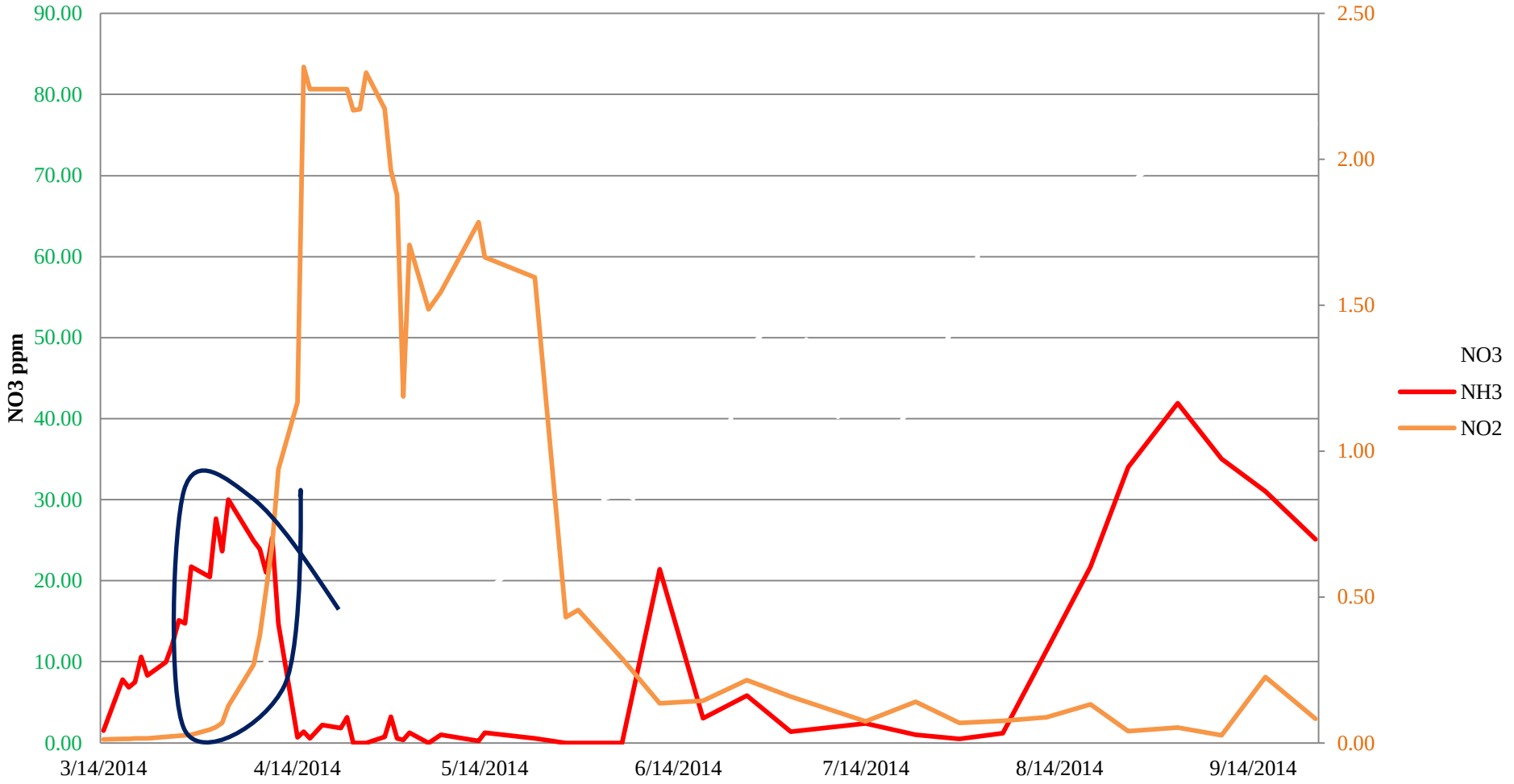
NO3
NH3
NO2
Fish Added to System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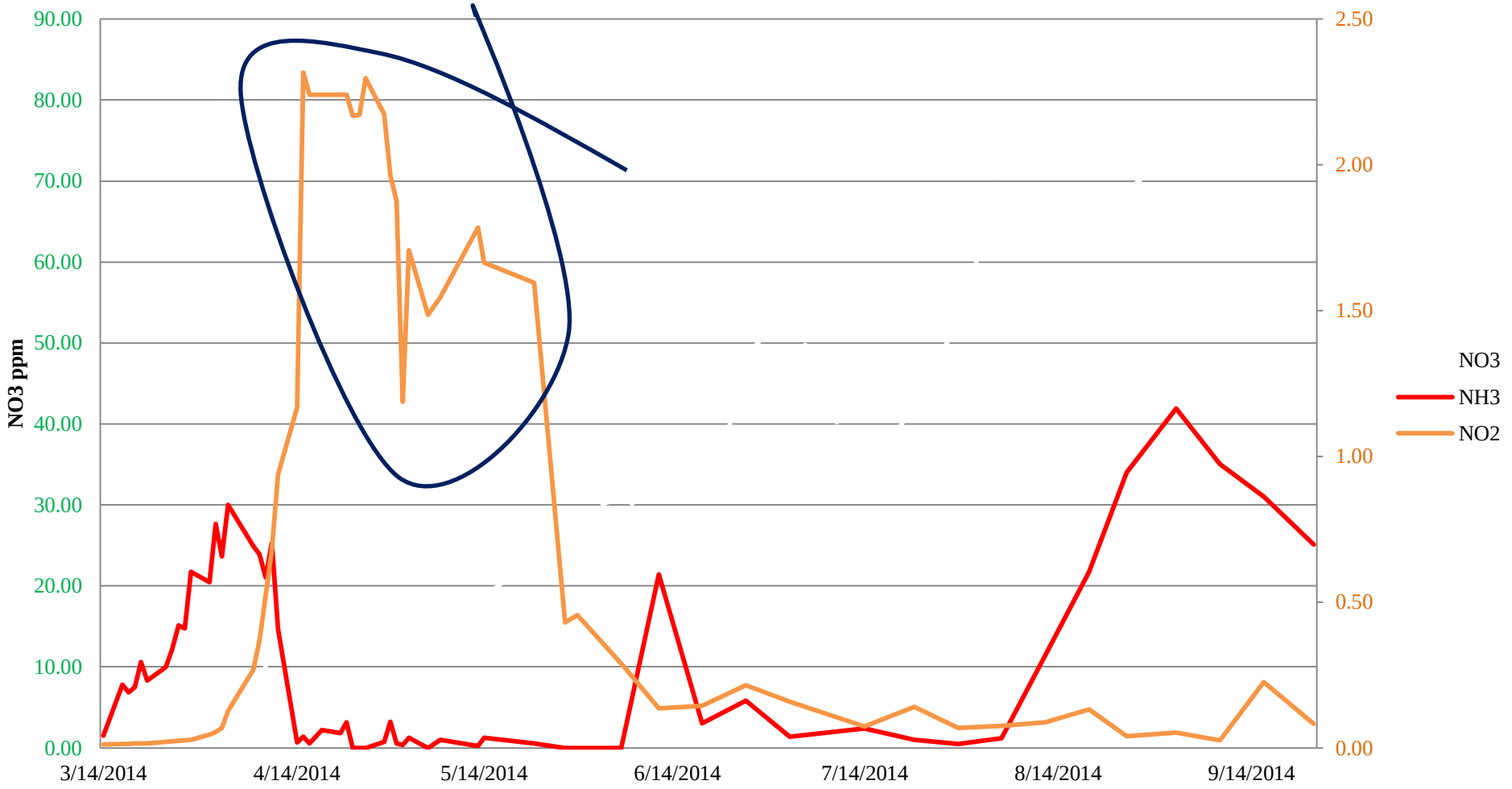
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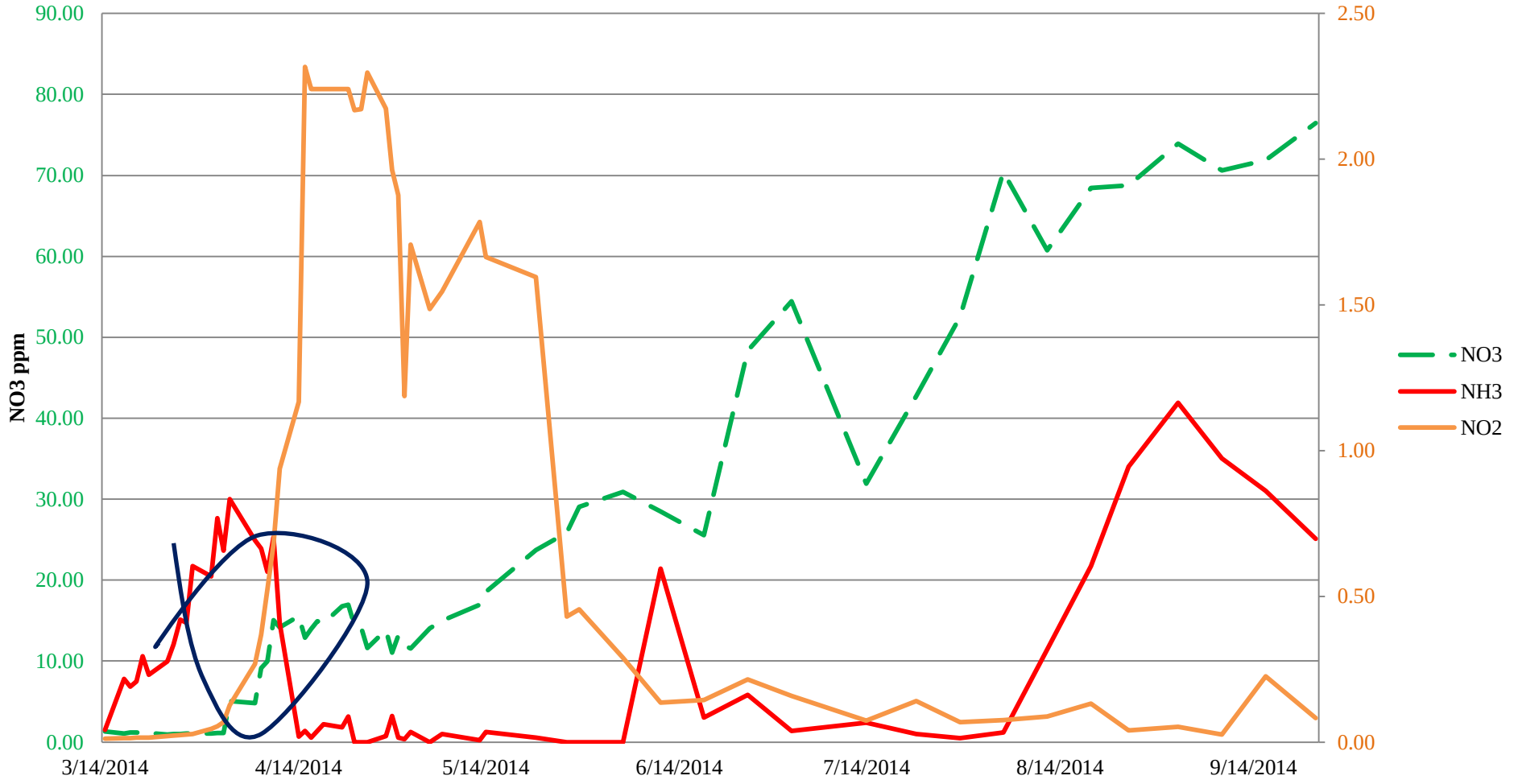
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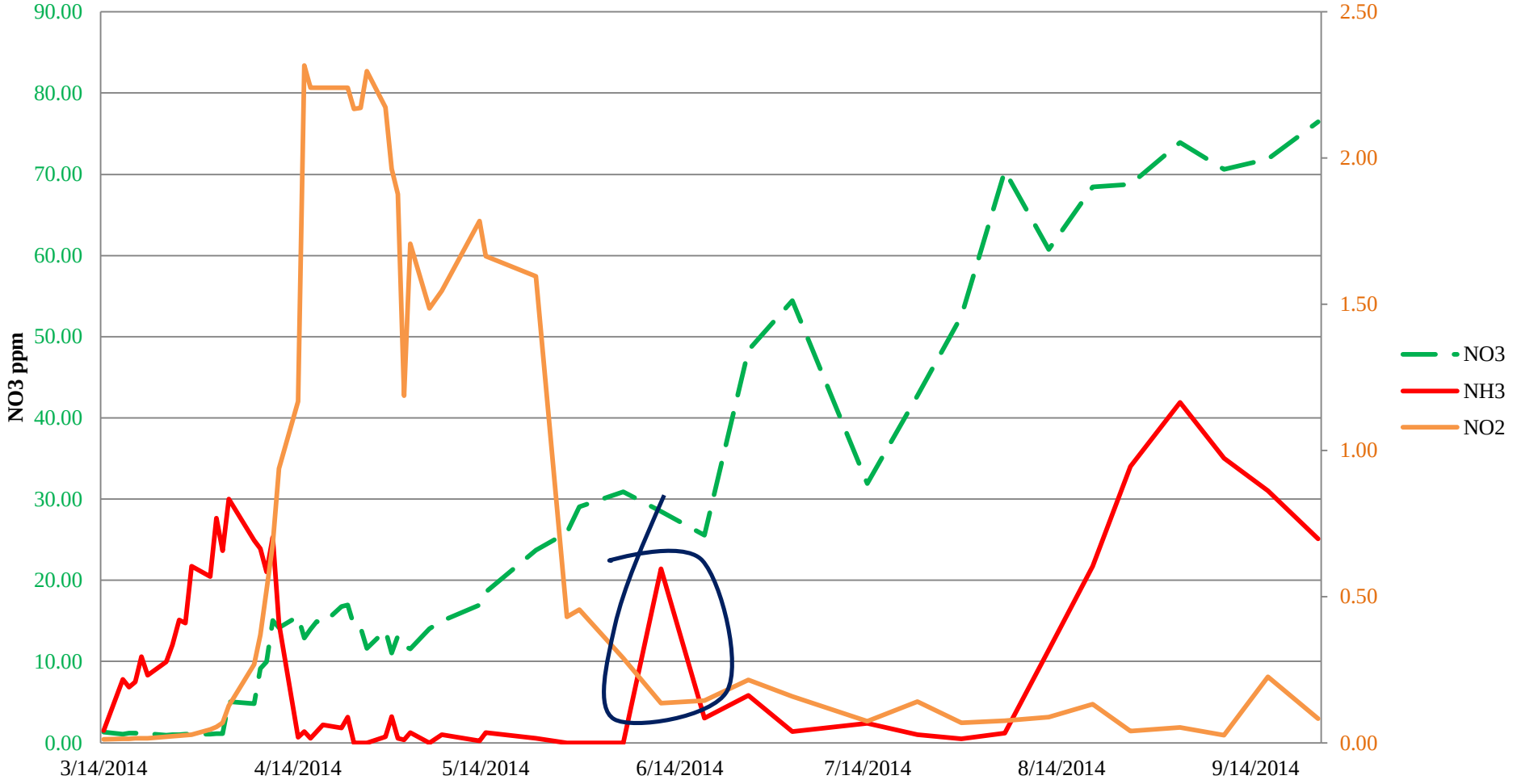
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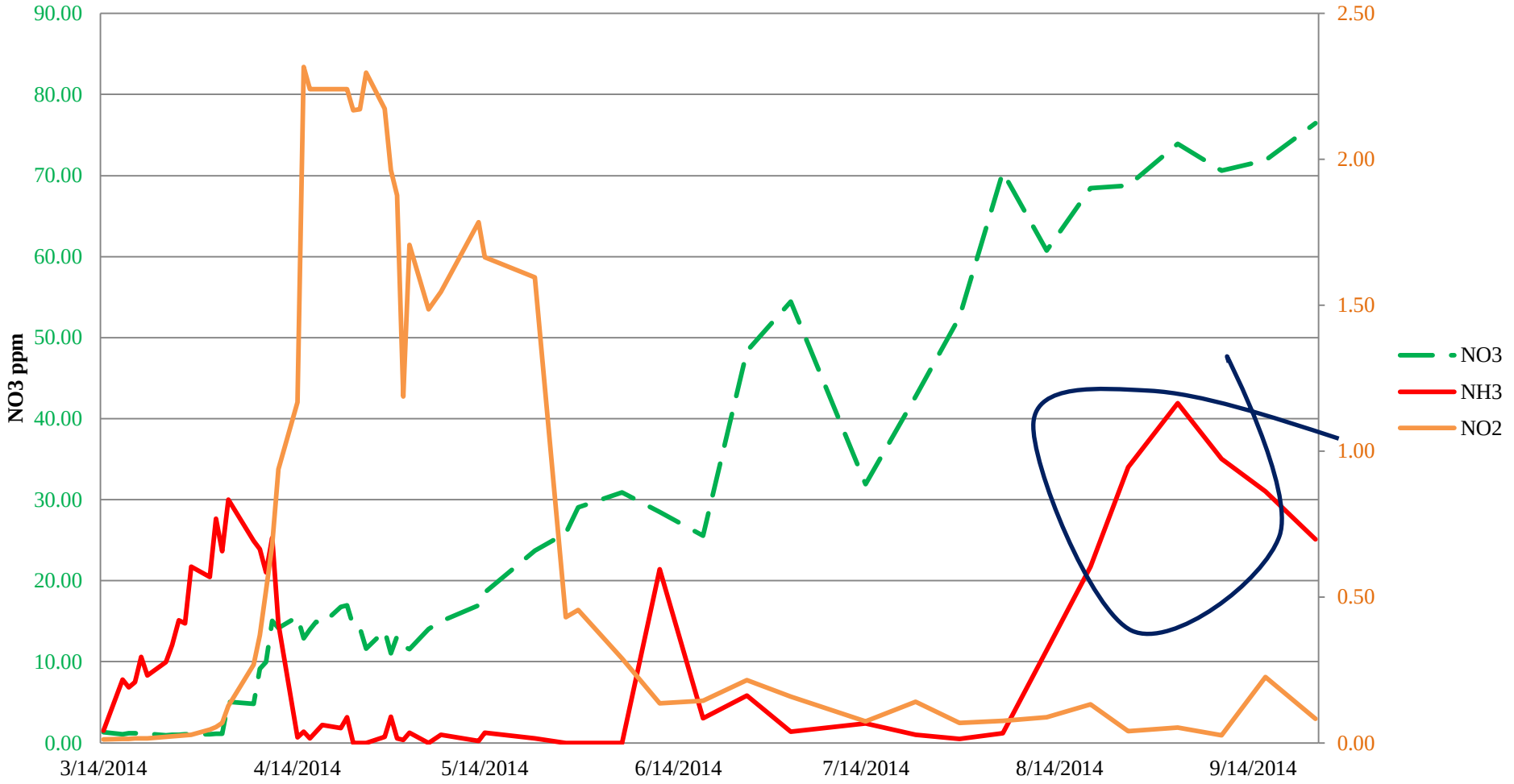
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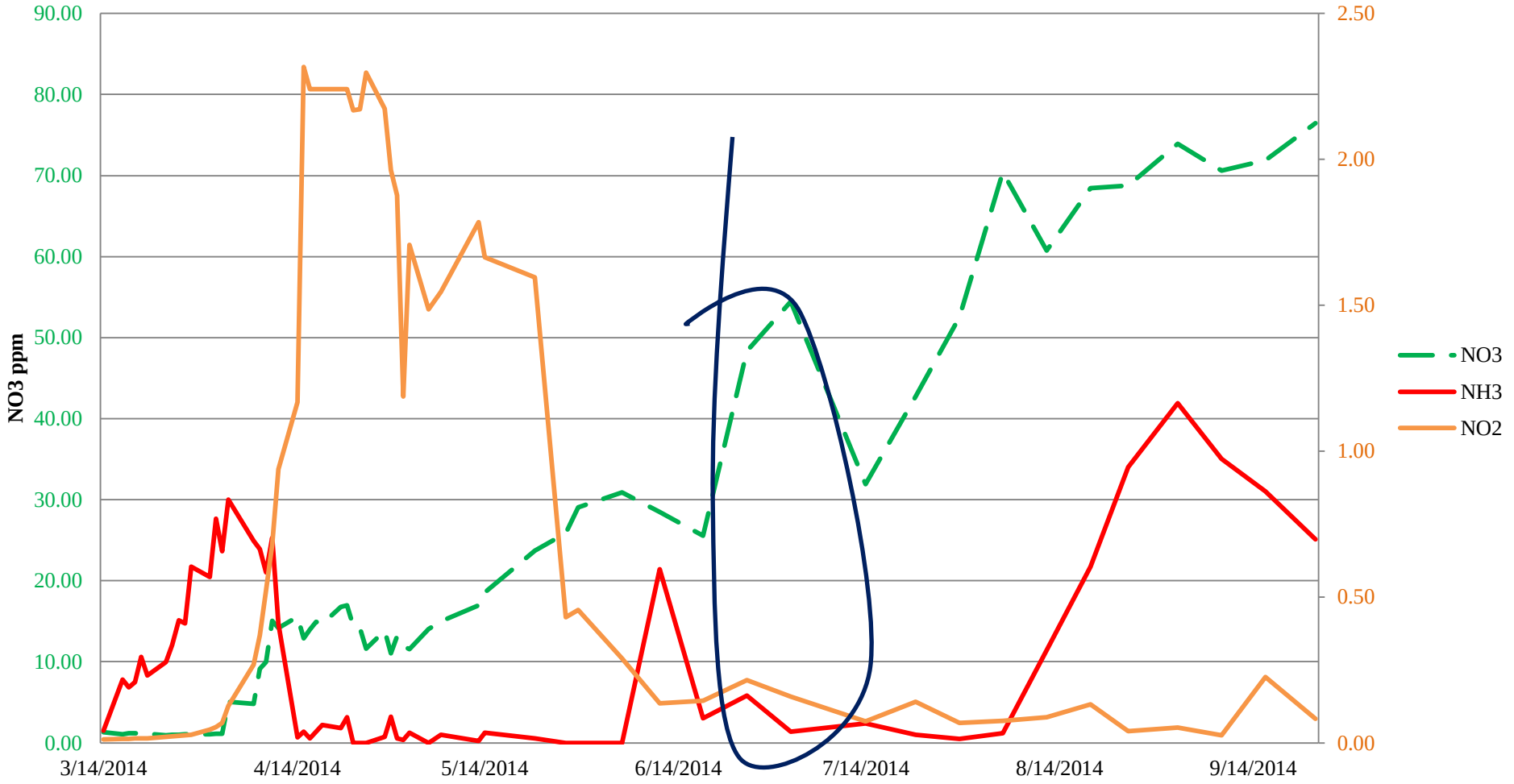
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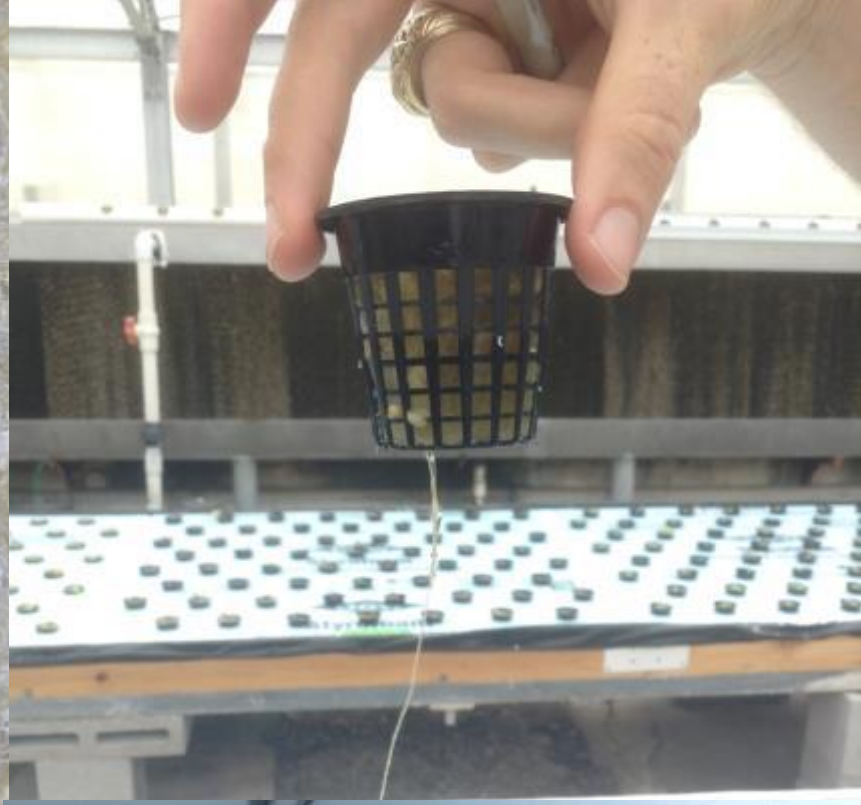
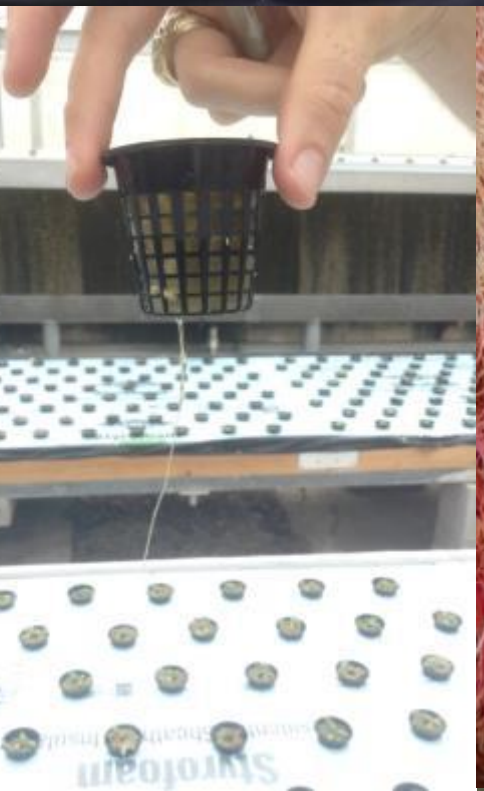
NO3
NH3
NO2

Nutrient Dynamics

Nitrate Levels





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7/25

7/28

14 days
Sowing/Germinating/Initial Seedling Growth
+
20 days in the system
=
34 day grow out from Seed to table

Romaine - DRAGOON

The

- Two sc
  - fish
- Soil-bo
- Fish ar
- CO2 p
  booste
- No her
- Plants
- Nutrie
- Little t
- Can be
- Allow
- 95% le

Disadvantages??

No Pesticides / Insecticides

Electrical Costs

Extensive Knowledge

System Inputs

Nutritionally Complete Fish Feed

&

pH Adjusters

- Calcium Carbonate ($CaCO_3$)
- Potassium Bicarbonate ($KHCO_3$)

PLANT : FISH Ratio

- Ratio of 4.13:1
  - Total plant growing area: 384 ft^2
  - Total fish-rearing surface area is 95.2 ft^2
- ~480 g of fish feed / day
  - ~30 g of fish feed/m^2 of plant growing area per day

Production Potentials

- Fish
  - Harvest every 6 weeks with the use of four fish tanks.
  - 8.7 harvests / year
  - 150 lbs / harvest
  - 1,305 lbs / year

Based on growing **tilapia to 0.5 lbs / gallon**

Ornamental fish such as Koi are different as they can be sold anywhere along the growth cycle depending on desirable size.

Production Potentials

- Vegetables
  - Mini Lettuce Heads
    - 4 to 6 week growth period from transplant to harvest
    - 232-348 heads of lettuce / week
    - 12,064-18,096 heads of lettuce / year
  - Full Size Lettuce Heads
    - 4 to 6 week growth period from transplant to harvest
    - 144-216 heads of lettuce / week
    - 7,488-11,232 heads of lettuce / year

Item	Cost
Tanks	$ 3,824.96
Hydroponic Raceways	$ 1,403.26
Waterline Plumbing	$ 839.46
Airline Plumbing	$ 1,299.15
other	$ 3,750
Total	**$ 11,116.83**

Permits, Licenses, Certificates .....

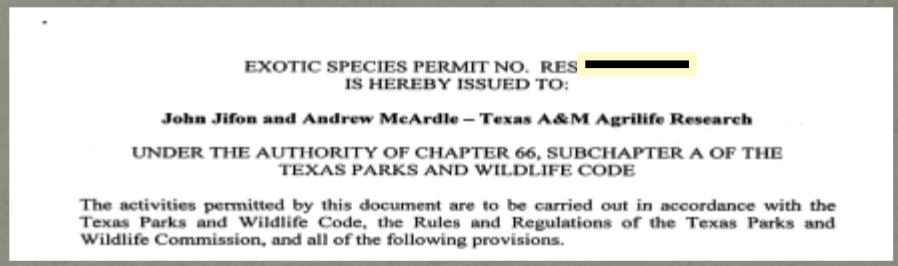
Aquaculture License

TEXAS DEPARTMENT OF AGRICULTURE
TODD STAPLES, COMMISSIONER
P. O. BOX 12847 AUSTIN, TX 78711-2847
(877) LIC-AGRI (877-542-2474)
For the hearing impaired: (800) 735-2989 TDD (800) 735-2988 VOICE
www.tda.state.tx.us

AQUACULTURE LICENSE

This is to certify that the person listed below is licensed to operate a fish farm or cultured fish processing plant in accordance with Texas Agriculture Code Chapter 134.

Exotic Species Permit



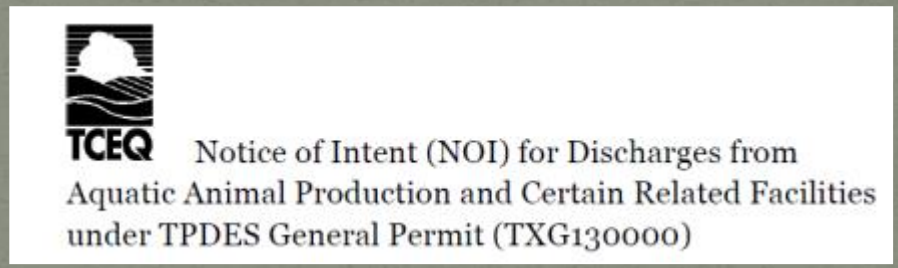
EXOTIC SPECIES PERMIT NO. RES [redacted]
IS HEREBY ISSUED TO:

John Jifon and Andrew McArdle – Texas A&M Agrilife Research

UNDER THE AUTHORITY OF CHAPTER 66, SUBCHAPTER A OF THE TEXAS PARKS AND WILDLIFE CODE

The activities permitted by this document are to be carried out in accordance with the Texas Parks and Wildlife Code, the Rules and Regulations of the Texas Parks and Wildlife Commission, and all of the following provisions.

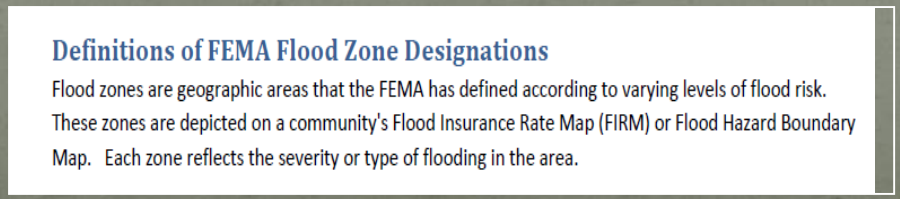
Waste water discharge permit



TCEQ

Notice of Intent (NOI) for Discharges from Aquatic Animal Production and Certain Related Facilities under TPDES General Permit (TXG130000)

Flood zone declaration



Definitions of FEMA Flood Zone Designations

Flood zones are geographic areas that the FEMA has defined according to varying levels of flood risk. These zones are depicted on a community's Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map. Each zone reflects the severity or type of flooding in the area.


Questions