Getting started in Aquaculture

FMAC

April 24th, 2024

Rainbow Trout (Steelhead)

Different Aquaculture Systems

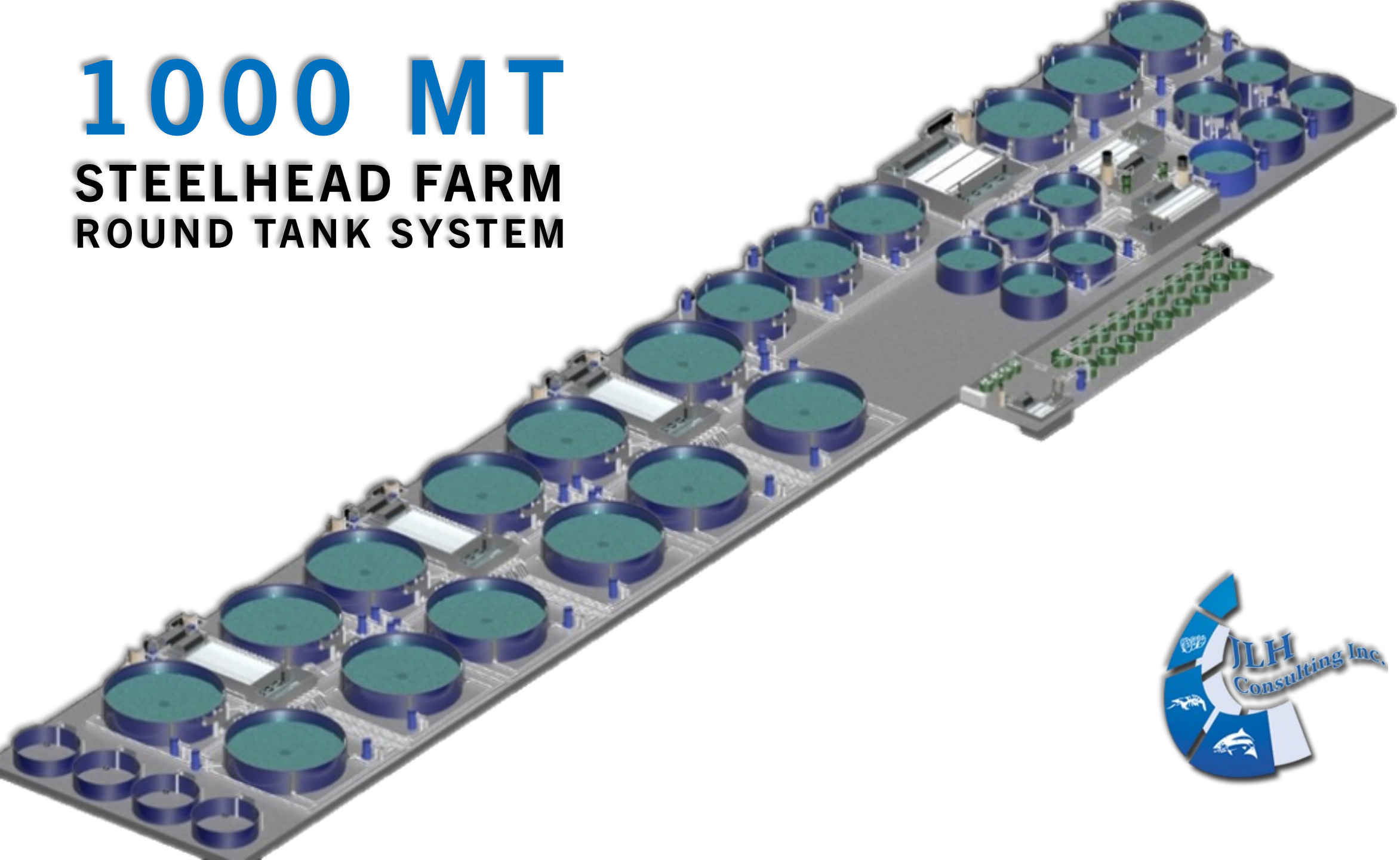
- Circular tanks
- Raceways
- Mixed cell Raceways
- Stacked troughs
- All of the above could be –
- 100% flow through
- Partial reuse – up to 75% reused water, no biofilter
- Full RAS (recirculating aquaculture system) - > 99.5% reuse, Biofilter
- All could be freshwater, marine water, brackish water, cool to tropical temperatures (10°C TO 30°C)

JLH CONVENTIONAL ROUND TANK SYSTEM

1000 MT

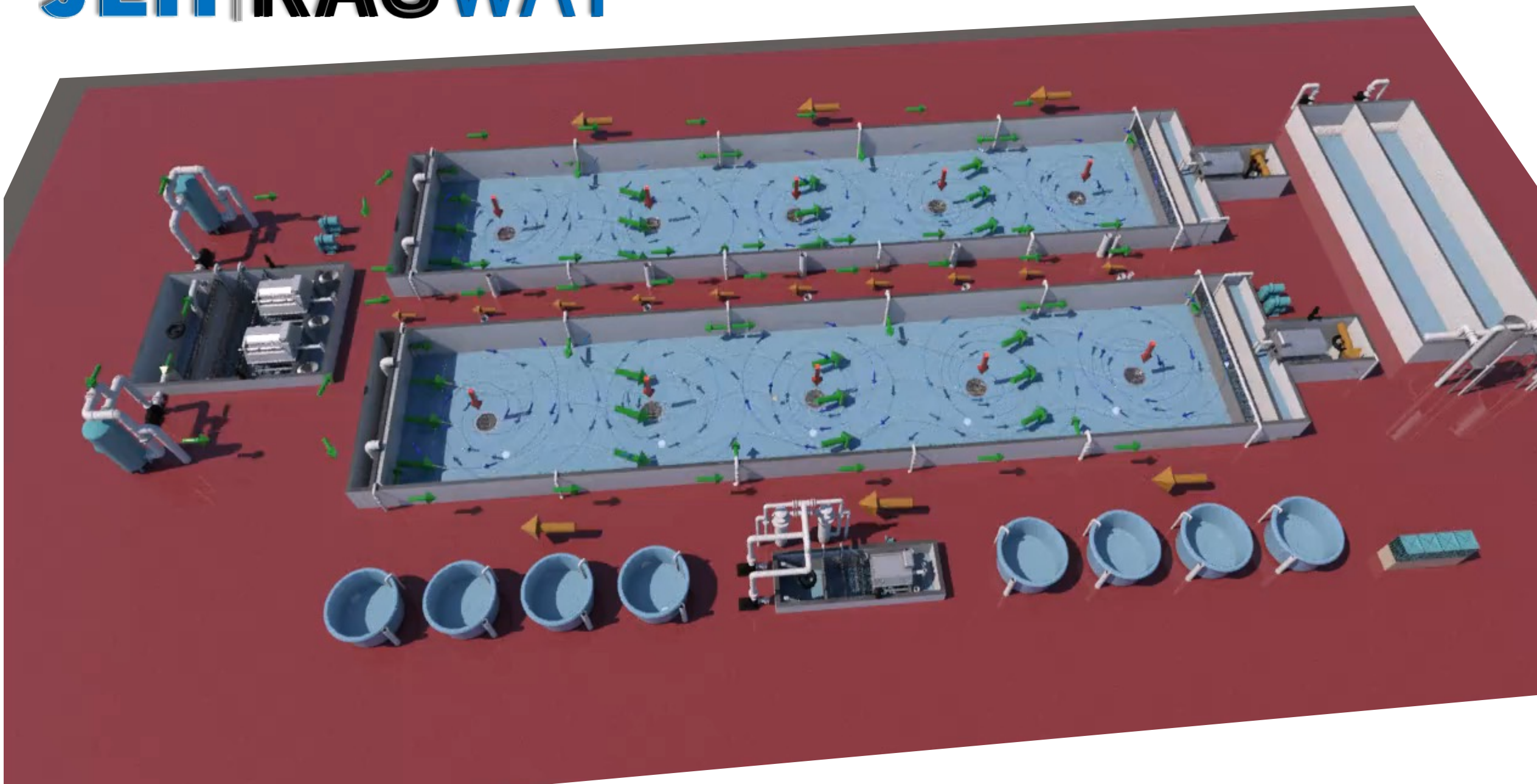
STEELHEAD FARM

ROUND TANK SYSTEM



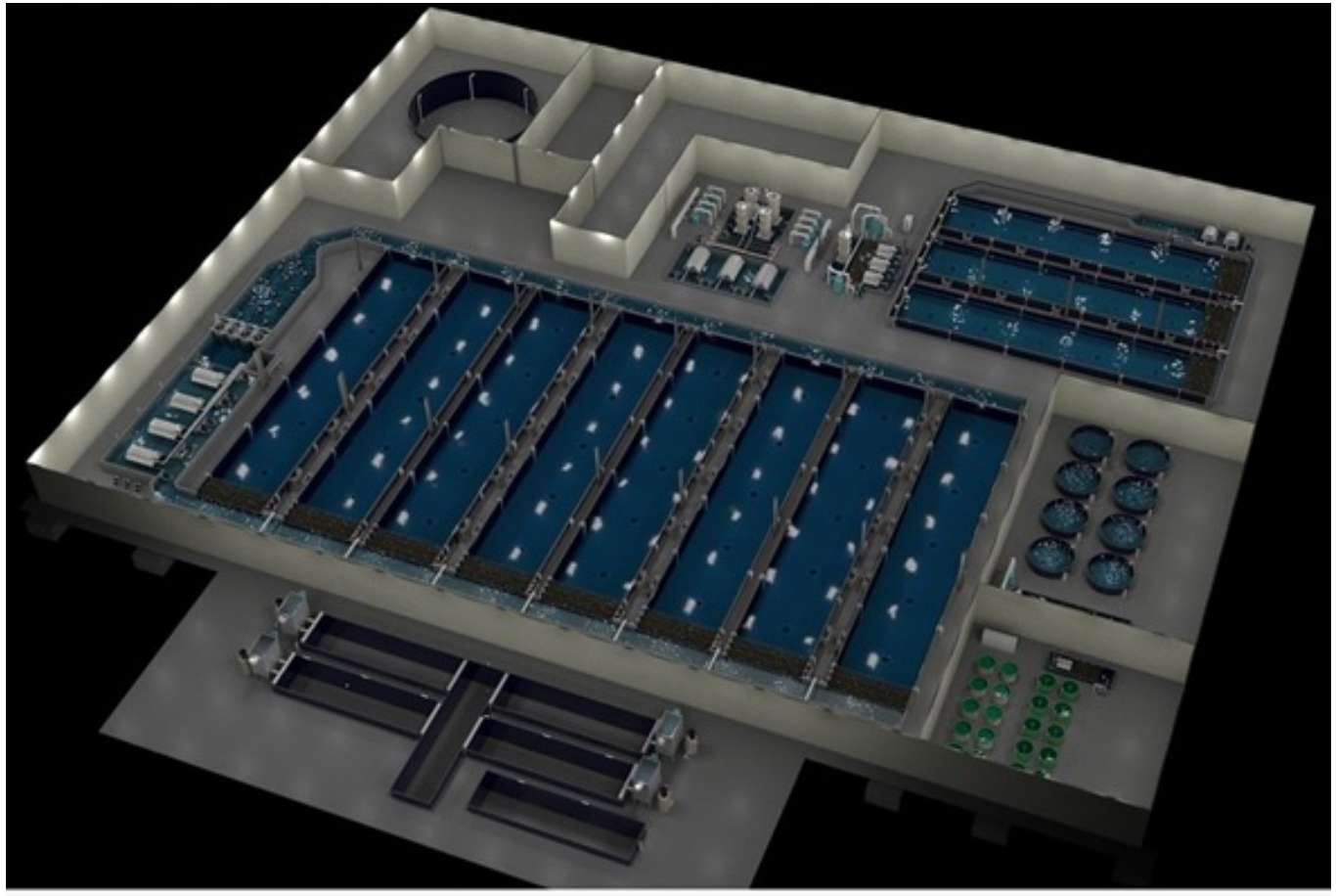
JLH Consulting Inc.

JLH | RASWAY®

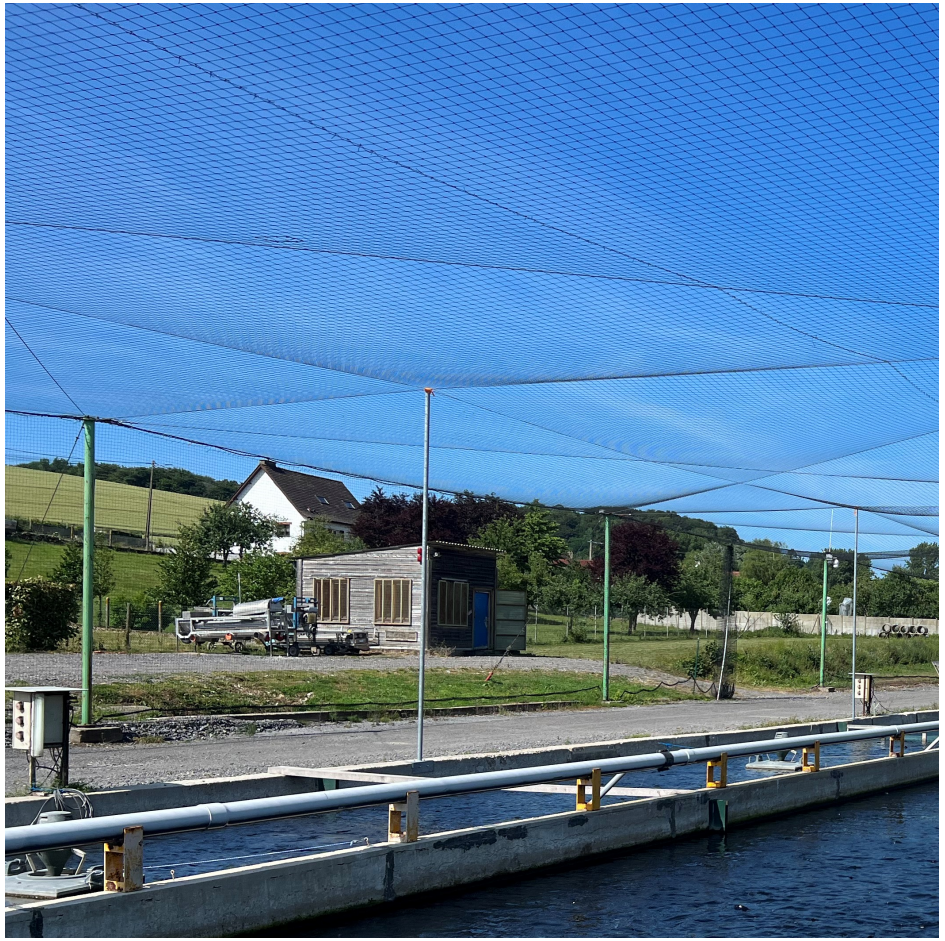


JLH | RASWAY®

- The Full Monty RASWay™

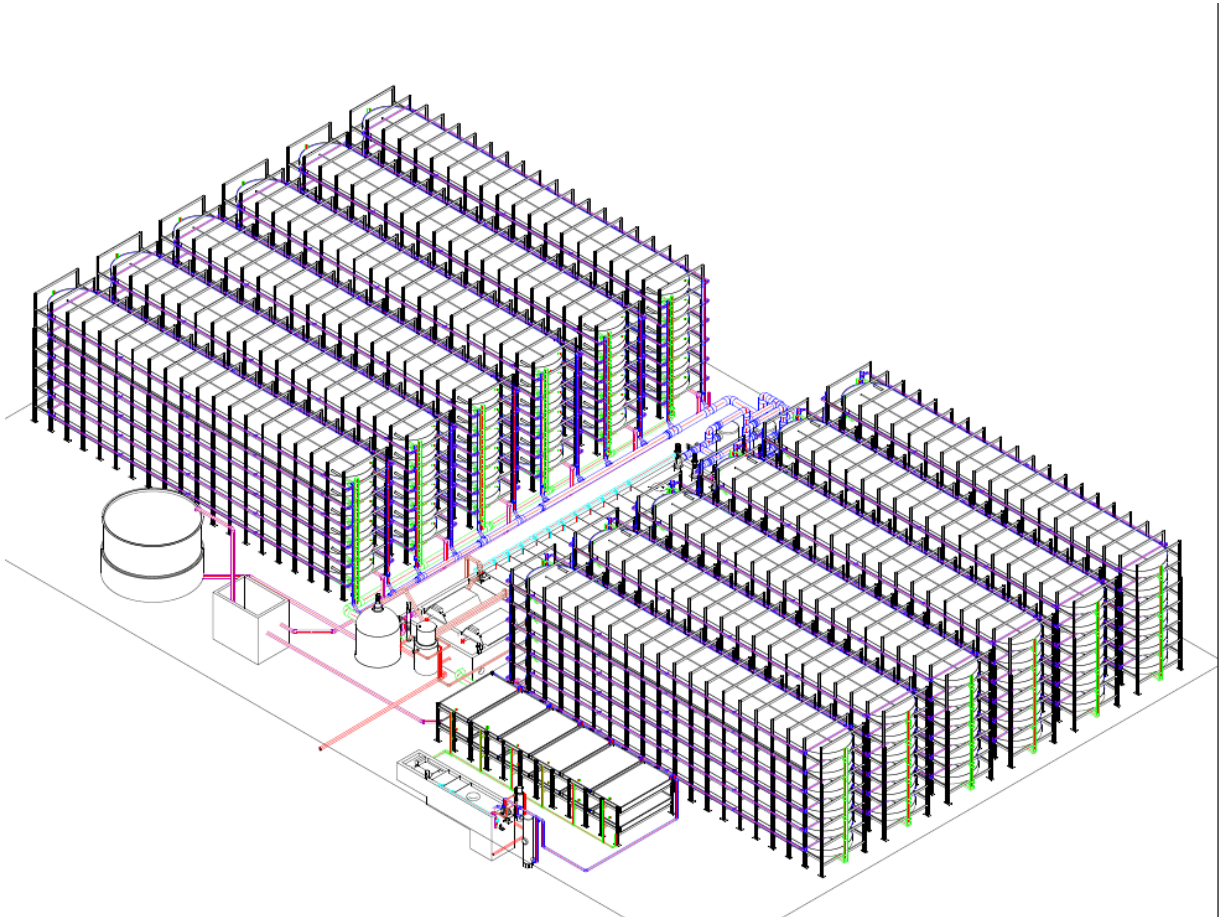


Raceways



Stacked troughs

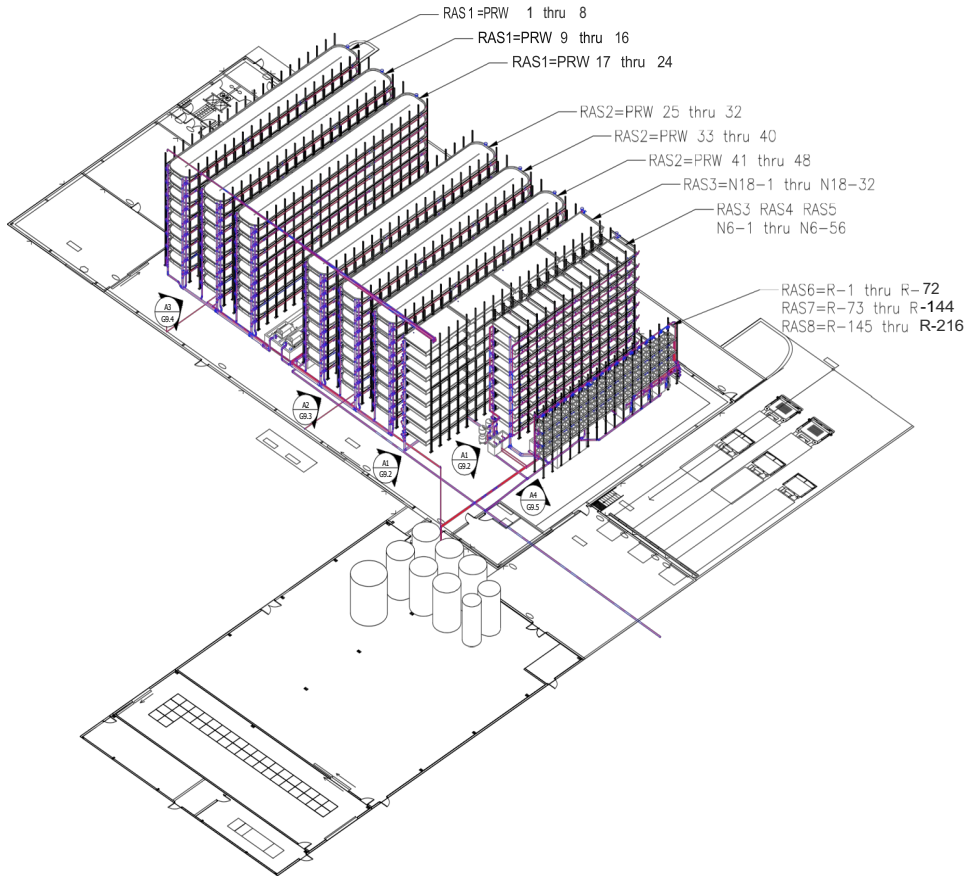
Shrimp – clear water RAS

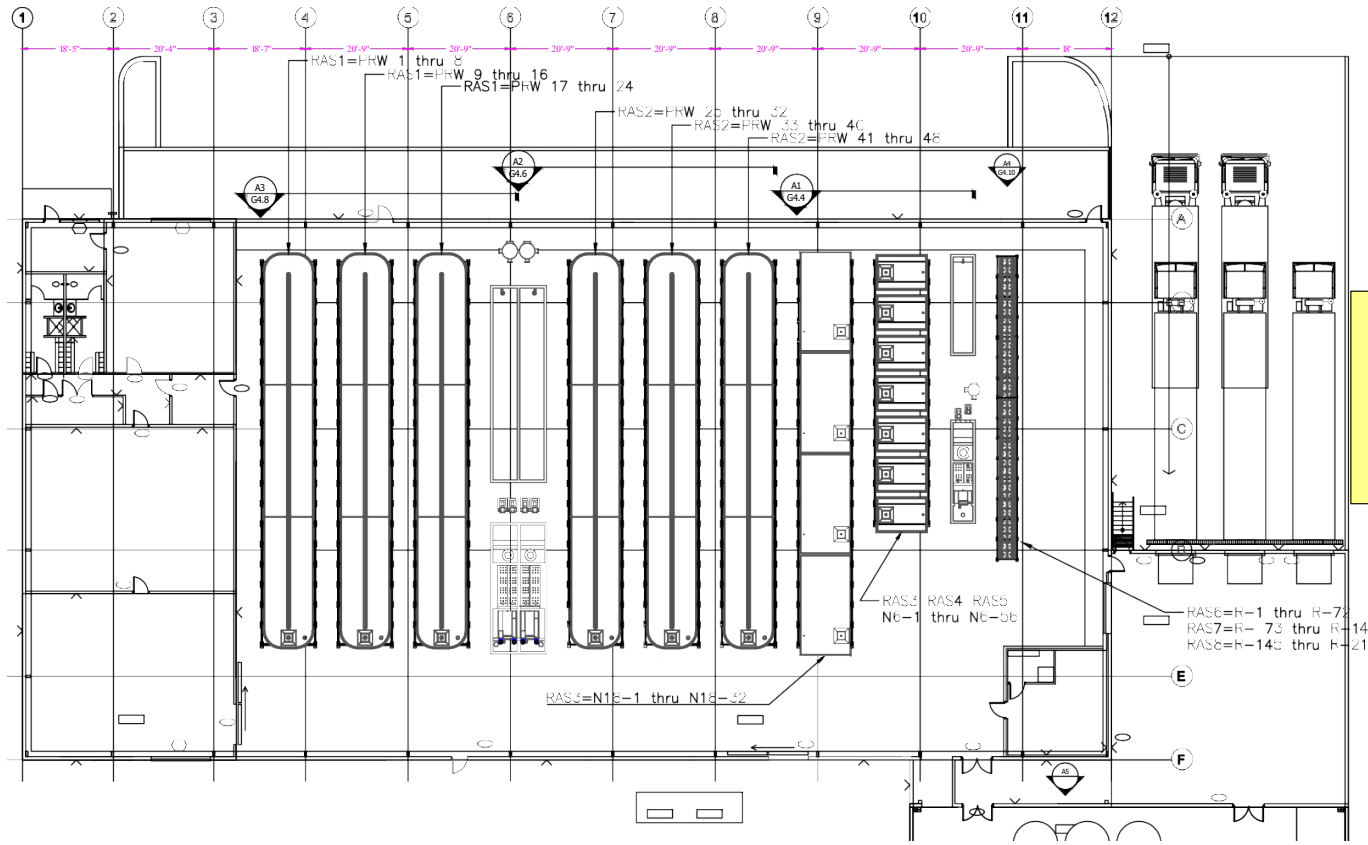


Stacked Troughs (2)

Shrimp

- Hybrid system, Bio floc and RAS nicknamed a “dirty RAS”





Equipment needed

- Tanks
- Oxygen delivery
- CO2 removal
- Pumping systems
- Foam fractionization (fine solids removal)
- Drum filters (solids removal)
- Biofilters
- Fish grading equipment
- Waste collection

Oxygen Delivery

- Dissolves 10 kg O2/h at 28°C into fresh water. Oxyflow® requires 6.2 kW while the Speece Cone requires 21.4 kW, a savings of 71% for the Oxyflow®.
- This translates into over $16,000 savings per year with electricity at $0.12/kWh. Savings increase at cooler water temperatures. Saving increase is due to the Oxyflow® operating at **0.25 bar versus 3.0 bar for the typical Speece cone.**
- The Oxyflow® and its related devices have been in use on fish farms in Europe since 1994. There is currently an installed base of over 200 units in Europe, 61 units in the US and Canada, and 33 in Australia.
- The Oxyflow® has a very reliable design, with no moving parts or restrictive passages.
- **OXYFLOW® IS A TRUE ENERGY SAVER.**

OXYFLOW®

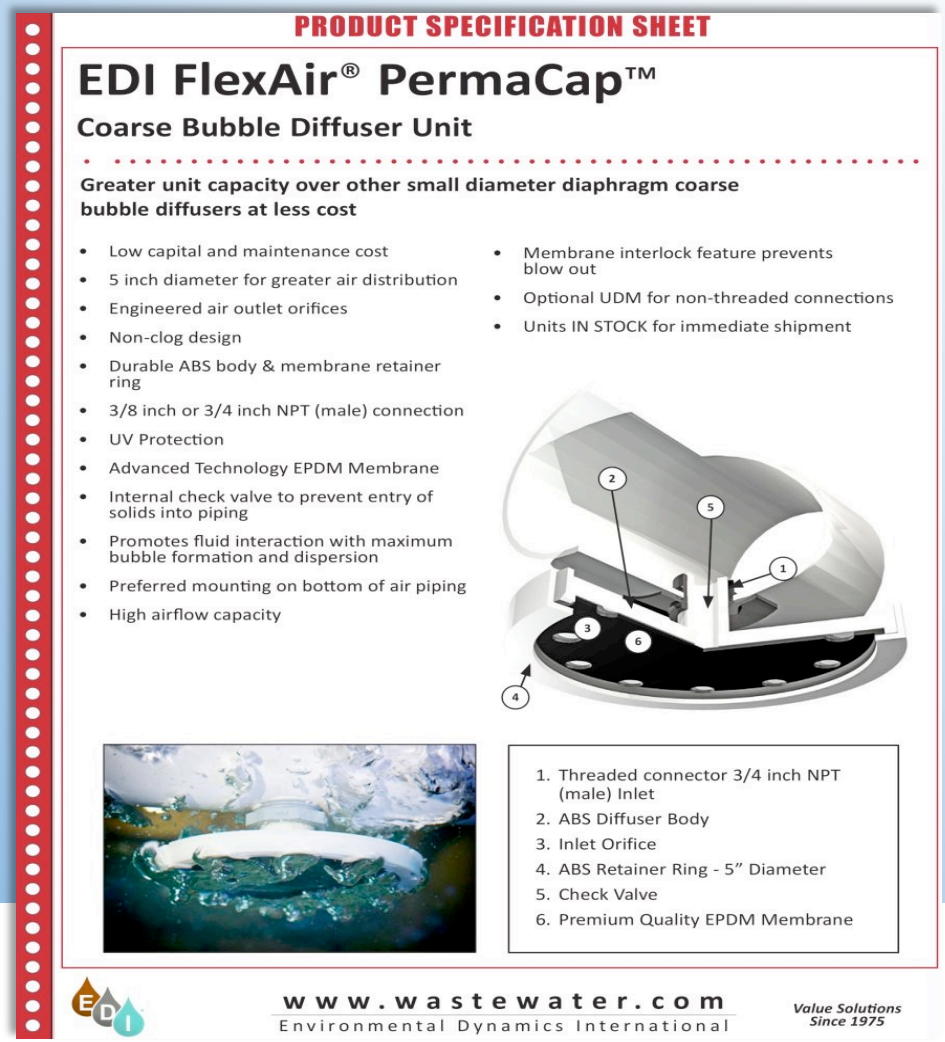
FOX

France Oxygénation

Foam Fractionation

VACUUM AIRLIFT™

CO2 Stripping



PRODUCT SPECIFICATION SHEET

EDI FlexAir® PermaCap™

Coarse Bubble Diffuser Unit

Greater unit capacity over other small diameter diaphragm coarse bubble diffusers at less cost

- Low capital and maintenance cost
- 5 inch diameter for greater air distribution
- Engineered air outlet orifices
- Non-clog design
- Durable ABS body & membrane retainer ring
- 3/8 inch or 3/4 inch NPT (male) connection
- UV Protection
- Advanced Technology EPDM Membrane
- Internal check valve to prevent entry of solids into piping
- Promotes fluid interaction with maximum bubble formation and dispersion
- Preferred mounting on bottom of air piping
- High airflow capacity
- Membrane interlock feature prevents blow out
- Optional UDM for non-threaded connections
- Units IN STOCK for immediate shipment

1. Threaded connector 3/4 inch NPT (male) Inlet
2. ABS Diffuser Body
3. Inlet Orifice
4. ABS Retainer Ring - 5" Diameter
5. Check Valve
6. Premium Quality EPDM Membrane

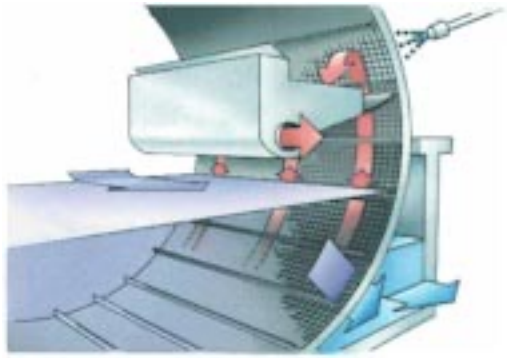
www.wastewater.com
Environmental Dynamics International
Value Solutions Since 1975

- In addition to surface aerators, we also use **PermaCap** coarse and fine bubble diffuser units to blow off CO2 and move the media in the MBBR's.
- The **JLH RASWAY®** system is essentially built on the same plane therefore energy costs are dramatically reduced because system water is only pumped once.

PERMACAP™

Drum Filters

Solids removal

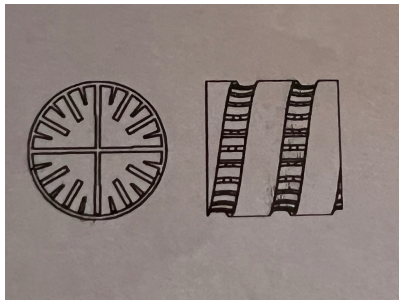


Fish Grading Equipment

Biofilter selection

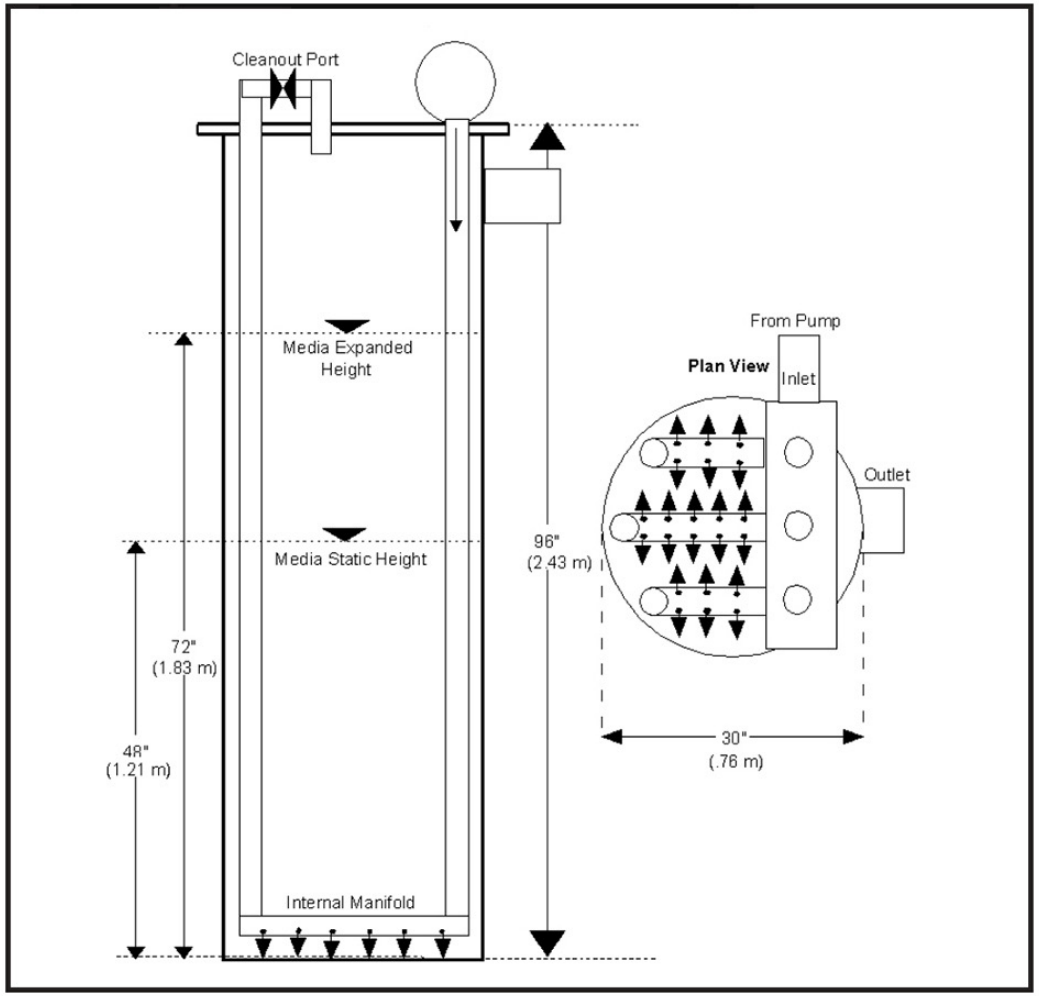
- I like MBBR's – moving bed bioreactor
- Pick a good reliable media which has a realistic m2/m3
- Give it enough air to agitate the media properly
- Always have a bit extra biomedia to be on the safe side

	Dia mm	Length mm	Surface (A) m2/m3	Surface prot. M2/M3
HXF13KLL+	13	13	955	806



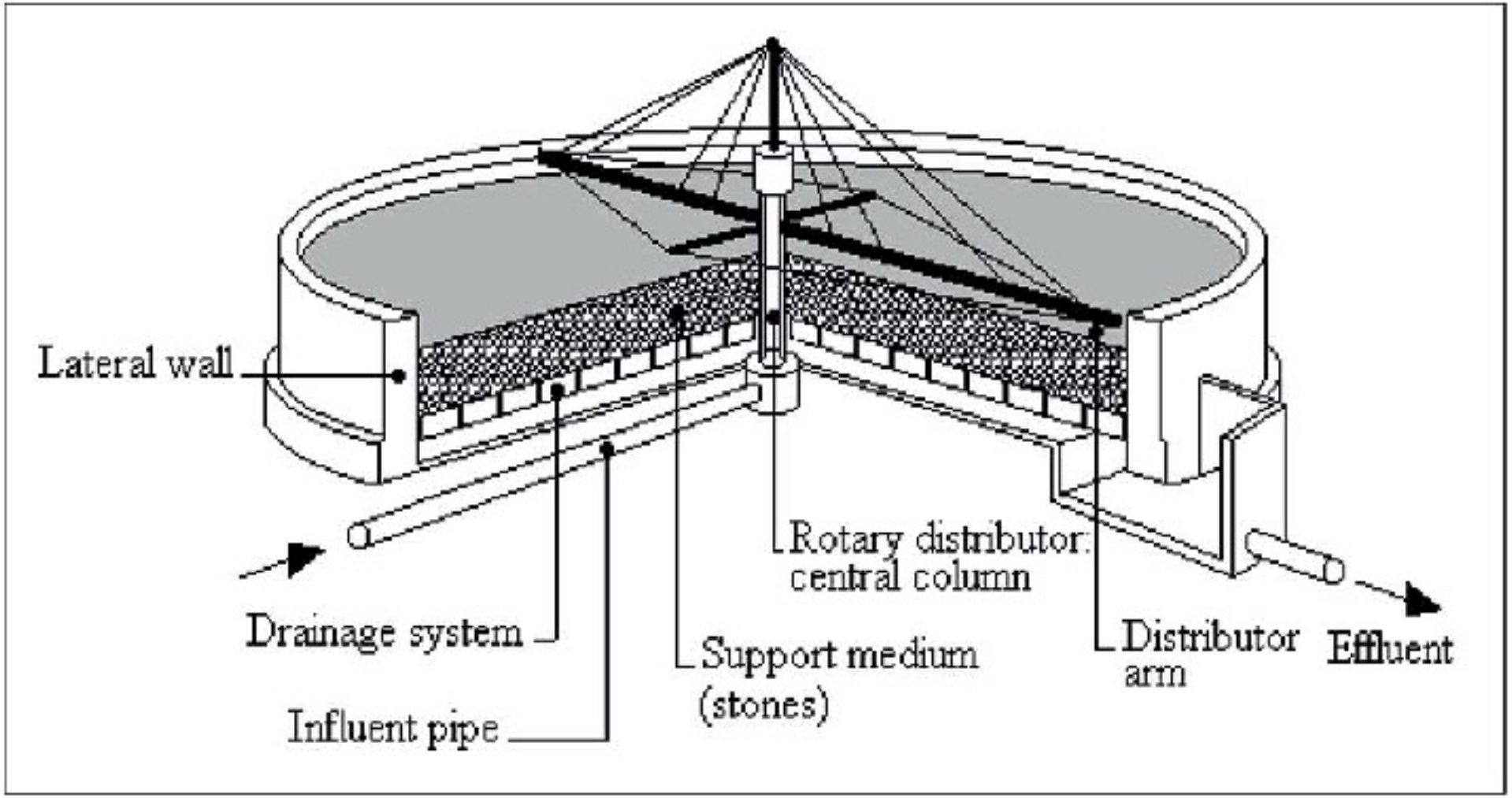
Biofilter selection (continued)

Fluidized sand filter

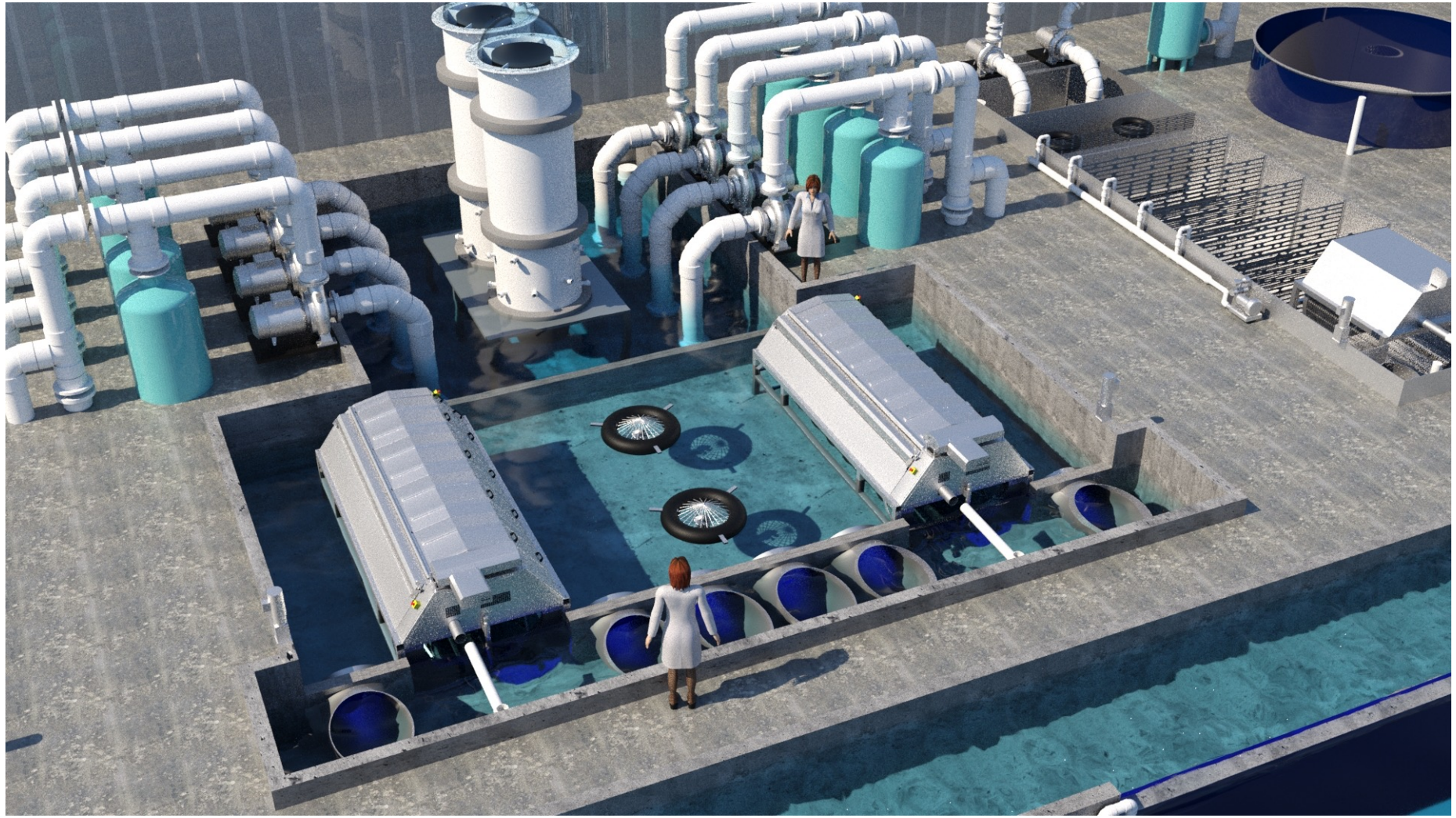


Biofilter selection (continued)

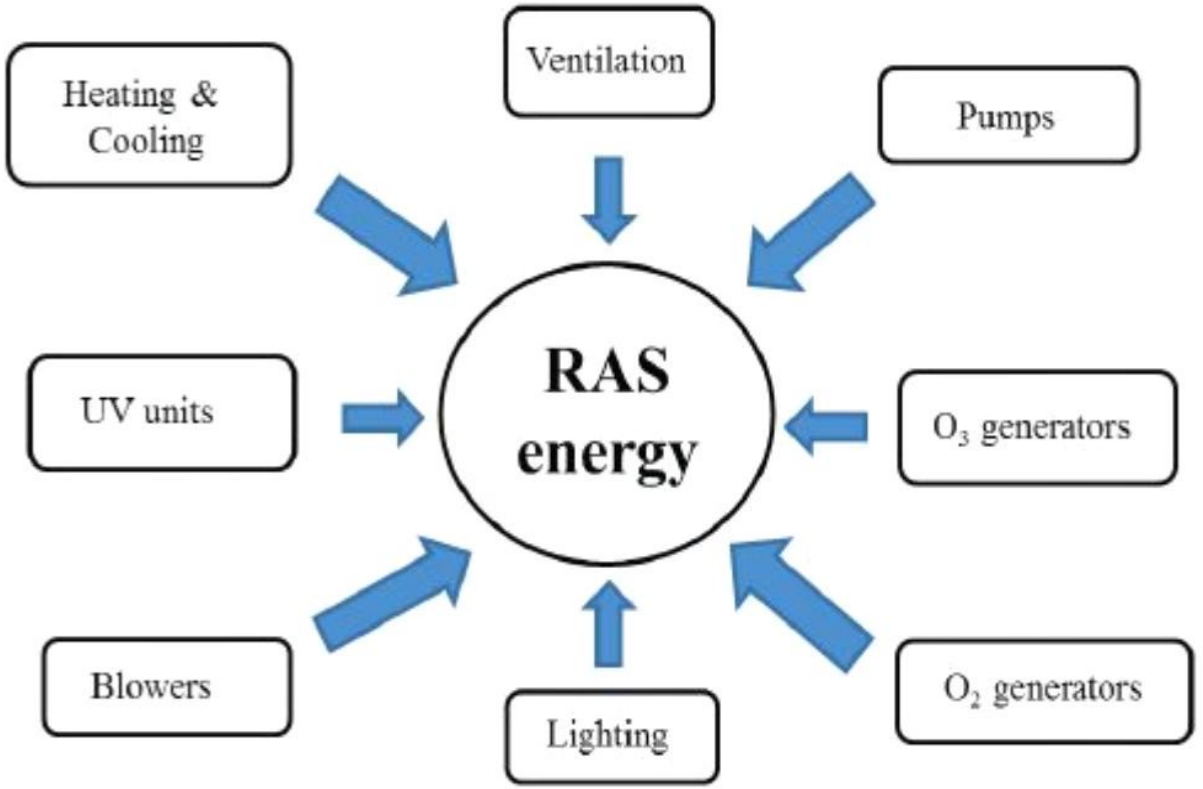
Trickling filter



RAS Equipment



RAS energy – courtesy of Paul Hundley



RAS Energy – diverse connected loads, many opportunities for optimization!

Power Use

- The amount of energy used in RAS varies considerably from 2.5 kW/kg produced up to >9 kW/kg produced (live weight).
- Try and get the most efficient design and most efficient equipment that your budget allows for power use is 24/7
- The table below is the connected load for a 3100MT steelhead facility. Works out to be 3.73 kW/kg produced
- All specie dependent and size of facility

	Power (KW)	Total Power (KW)		Horse Power
Total Connected Load - Equipment		1117.74	KW	1498.9
		1.118	MW	
plus lighting - 3000 lights, each light consumes 10 watts?	30	60		80.46
plus HVAC	43.96	87.92		117.91
plus heat exchanger/chiller	5	10		13.41
plus general 120V service	24	24		32.18
plus well pumps	11.19	22.37		30.00
plus ice machine	25.38	25.38		34.03
Total Connected Load - Other		229.67		307.99
		1322.03	KW	
Total Connected Load		1.32	MW	

Water Quality Parameters

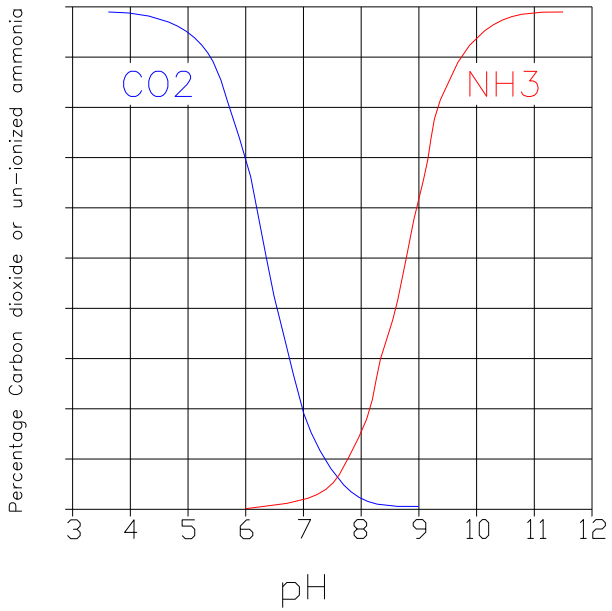
Water Quality Criteria

Chemical	Upper Limits for Continuous Exposure
Aluminum	0.01 ppm
Ammonia (NH_3)	0.0125 ppm (un-ionized form)
Arsenic	0.05 ppm
Barium	5.0 ppm
Cadmium	0.0004 ppm (in soft water < 100 ppm alkalinity)
Copper	0.006 ppm (in soft water < 100 ppm alkalinity) 0.03 ppm (in hard water > 100 ppm alkalinity)
Lead	0.03 ppm
Magnesium	15.0 ppm
Mercury	0.02 ppm
Nitrite (NO_2^-)	0.1 ppm in soft water
Potassium	5.0 ppm
Selenium	0.01 ppm
Sodium	75.0 ppm
Zinc	0.03 ppm
Carbon Dioxide	0 - 15 ppm
Total Alkalinity (as $CaCO_3$)	10 - 400 ppm
pH	6.5 - 8.0
Calcium	4 - 160 ppm
Manganese	0 - 0.01 ppm
Iron (total)	0 - 0.15 ppm
Ferrous ion	0 ppm
Ferric ion	0.5 ppm
Phosphorus	0.01 - 3.0 ppm
Nitrate	0 – 100 ppm
Hydrogen Sulfide	0 ppm

The above are the accepted guidelines.

Water Quality

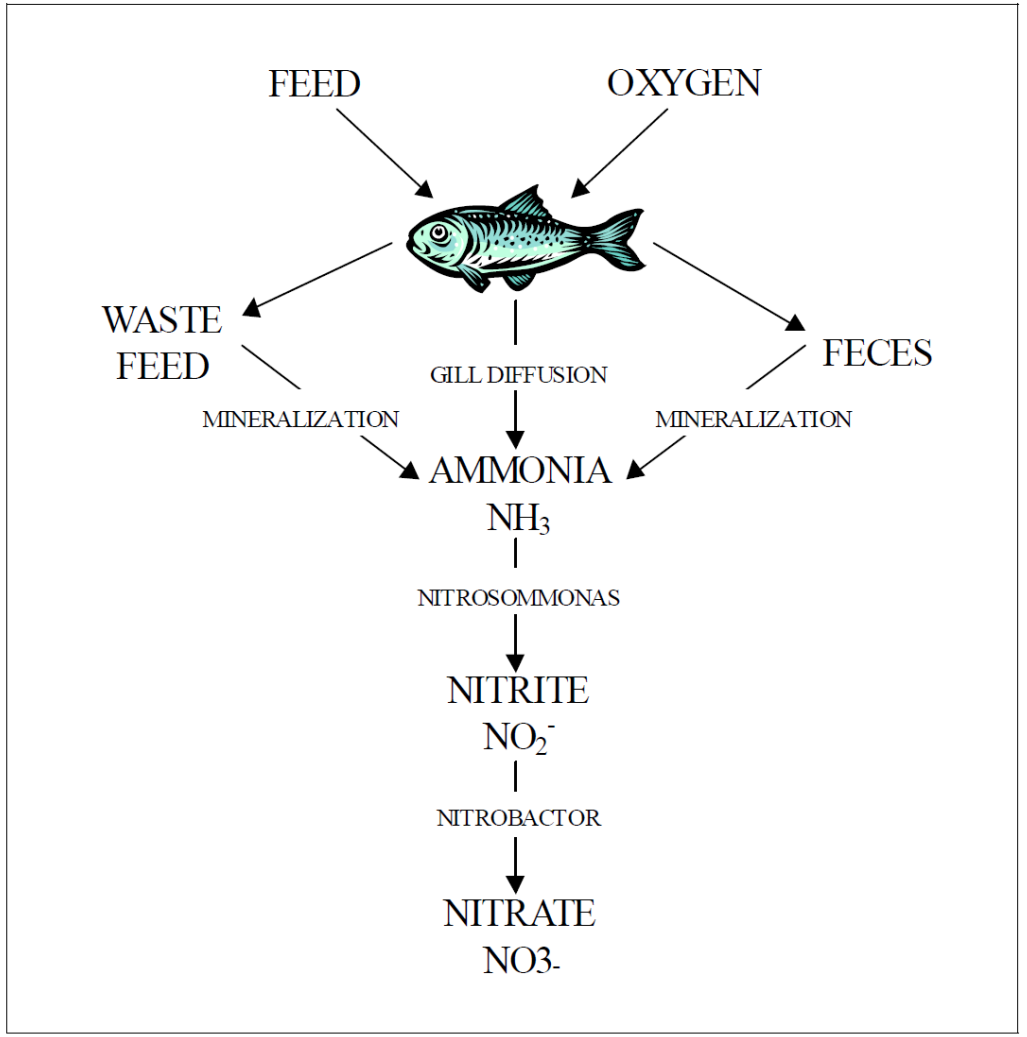
- Water quality determines not only how well fish will grow in an aquaculture operation, but whether or not they survive.
- Knowledge of testing procedures and interpretation of results are important to the fish farmer.
- pH, alkalinity, hardness and clarity affect fish, but usually are not directly toxic.
- The determination method and frequency of monitoring depends upon the type and rearing intensity of the production system used.



Water Quality (continued)

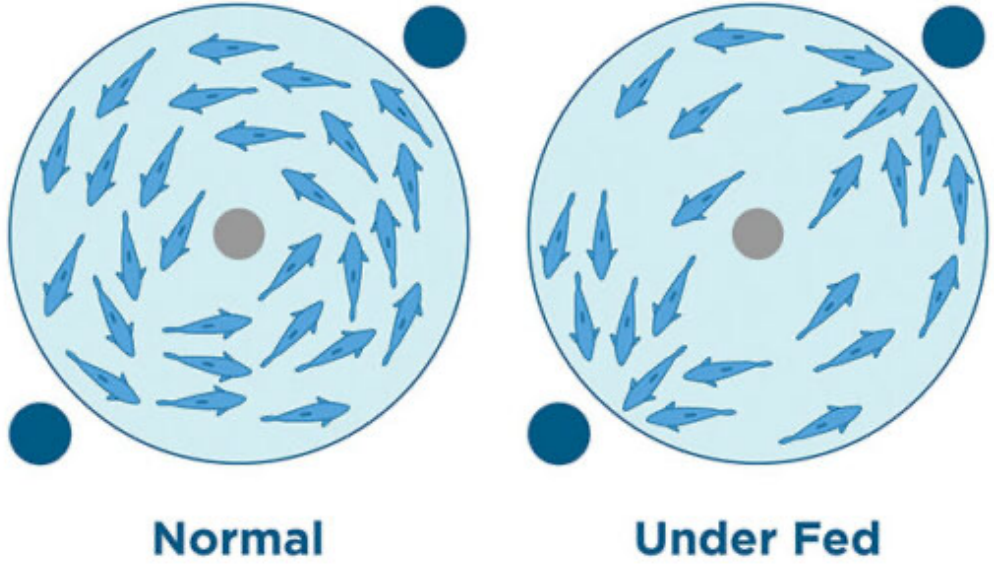
PARAMETER	Value
TAN (NH4)	**<2.0 ppm**
Nitrite (NO2)	**<0.1 ppm**
Nitrate (NO3)	**<100 ppm**
Carbon dioxide (CO2)	**<20 ppm**
Alkalinity (CaCO3)	**>100ppm**
pH	**6.8-7.2**
Temperature	**15°C**
Ozone (O3)	**<0.05**
Oxygen (O2)	**>80% sat.**
Ammonium (NH3)	**<0.0125 ppm**

Feed and oxygen = nitrate



Feed management = Healthy fish

- In a RAS your feed cost should be 50%+ of your overall budget
- Wasted feed is just not an extra cost burden but water quality could be severely affected
- Graphic from the Freshwater Institute

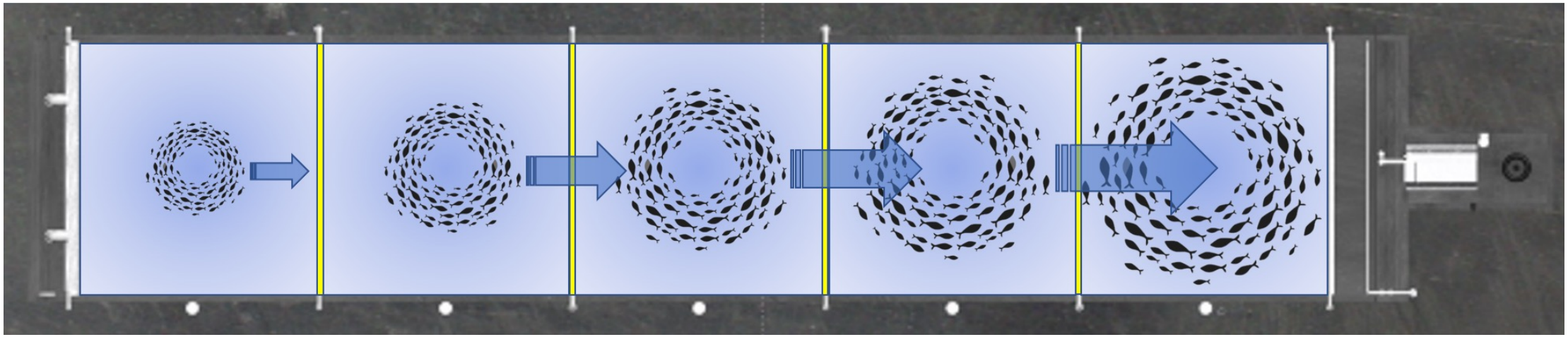


Happy well-fed Tilapia

Happy well-fed Trout

Maximum Biomass in RASWay™

Depending on the species you can reach a steady state biomass within the farm in 12-24 months



Density – keep it real !!!

- One of the first questions that must be answered in designing a RAS is the number of fish that can be carried in the tank.
- The number of fish and their mass will define the feeding rates from which the individual engineering components are designed.
- The number of fish that can be stocked per unit volume (kgs/M3) will depend on both the fish species and the fish size.
- Smaller fish should be less dense.
- Swim speed is important as well – swim lengths per second.
- Good management should produce a population that has a standard deviation that is less than 10% of the population mean.
- Feed size is important! There are only so many pellets in a kilo of feed.

Biosecurity

- The world's demands for high quality aquaculture products make control of diseases increasingly important. Good biosecurity programs are vital to maintaining healthy animals and to reducing the risk of acquiring disease in a facility.
    - Good biosecurity programs reduce the exposure to disease causing organisms with:

- **External barriers** – preventing the spread of disease organisms onto and off a farm
- **Internal barriers** – preventing the spread of disease organisms within a farm

Biosecurity (continued)

Disease causing organisms are often spread by vectors, such as fish, people or equipment. If the fish brought into the facility are disease-free, then the other vectors must be properly disinfected at defined critical control points so that exposure to disease causing organisms will be greatly reduced. An effective disinfectant is chosen based on:

- **Efficacy** - *Proven efficacy is of major importance, particularly as many disinfectants are ineffective against the full range of viral, bacterial and fungal disease-causing organisms. Particularly in aquaculture the viruses that cause diseases such as Infectious Pancreatic Necrosis are extremely persistent and difficult to destroy.*
- **Environmental impact** - *A good disinfectant must kill pathogenic organisms within a facility but must not harm organisms in the environment when released.*
- **Operator safety –** *Any products used must be safe for staff employing the product and all safety protocols must be strictly adhered to.*

Biosecurity (continued)

The principles of a good biosecurity program apply to all systems whether they be land based, flow through, recirculation or even sea cage systems.
External barriers – – preventing the spread of disease organisms onto and off a farm by focussing on:

- Pathogen-free water source at all times for land-based farms
- Total ban on movements of fish from other fish farms or at least a total ban on movements of fish from fish farm with older or fish of poorer health.
- Restrictions on movements of fish between farm sites of the same company
- Restriction on visits to the fish farm.
- Restriction on access to a farm site, i.e., fence around the site, locked doors, etc.
- Strict sanitary measures for any people entering the fish farm
  - protective clothing (washed regularly in hot water and disinfected)
  - foot dips and hand hygiene
  - cleaning and disinfection program
  - pest management control

Biosecurity (continued)

Internal barriers - preventing the spread of disease organisms within a farm by:

- Separation of each unit within a facility and isolation of these units from each other.
- Define sanitary units or areas on each farm site
- Define sanitary measures (i.e. cleaning & disinfection, pest control program) inside each unit or area.
- Define sanitary measures on movements between different units or areas i.e. total ban of movements from area X to area Z
- Restrict movements of tools and fish
- Strict sanitary measures for any workers entering the fish farm
  - protective clothing (washed regularly in hot water or disinfected)
  - foot dips and hand hygiene
  - cleaning and disinfection program
  - pest management control

Waste management

- Wet sludge – applied on farmers field (highly regulated and seasonal)
- Wet sludge taken to sewage treatment plant - $’s out
- Wetlands –no real return except they work well
- Actually, waste can be another source of revenue and can be handled in different ways
- Geotubes – can compost semi-dried sludge, not easy to work with
- Rotary Press – easy to handle but still highwater content
- Press with dryer – easy product to handle

Waste management (continued)

A Couple of Reminders

- 1st - Fish farming or Aquaculture to most is a way of life that we chose. BUT, we must remember it is a business and we must run it as such!
- 2nd – Create a good set of SOP's (Standard Operating Procedures) and adhere faithfully to them
- 3rd – NEVER quit looking at your fish for fish do fish things and they will tell you if something is going sideways way before any other thing you may have in your toolbox
- 4th and last – never kill fish the same way twice – learn from your mistakes

Global Activity – JLH & Rational Designs and Projects

This business can take you to different places!!!

Thank you!

FISH ARE EASY

PEOPLE ARE HARD.

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