Silbiger Lab Mesocosm User Manual

Dr. Nyssa Silbiger and Danielle Barnas

2020-10-14

Contents

Chapter 1

Summary

This manual describes the design, operation, and maintenance of the Silbiger Lab mesocosm system, located in the loading bay between Citrus Hall and Eucalyptus Hall at California State University, Northridge, funded and operated by Dr. Nyssa Silbiger.

Requests for use of the mesocosm system can be made here

Chapter 2

Contacts

Name	Involvement	Contact Information	Notes
Nyssa Silbiger	System Design Asst. Professor, CSUN	nyssa.silbiger@csun.edu 818-677-4427	
Danielle Barnas	System Installation and Maintenance Silbiger Lab Tech, CSUN	danielle.barnas@csun.edu	
Louis Dang	Systems Engineer	louis@aqualogicinc.com	www.aqualogicinc.com
Bill Krohmer	Administrative Operations	william.krohmer@csun.edu	
Science Shop	CSUN College of Science and Math Machine Shop	818-677-3055	Location: EH 2014 Available M-Th 0600-1630 www.csun.edu/Science-Shop
Wendy Dunbarr	Support Technician, CSUN Stockroom	wendy.dunbarr@csun.edu 818-677-2056	Location: CH 5108
Perry Martin	Supervising Plumber, PPM	perry.martin@csun.edu 818-677-2222 (PPM) 818-677-2237	
Will Moran	Network Engineer, CSUN IT	will.moran@csun.edu 818-677-6273	
Willy Martinez	Lead Electrician, PPM Electric Shop	willy.martinez@csun.edu 818-677-6273	

Name	Involvement	Contact Information	Notes
Neptune Systems	Apex Support Team	support@ neptunesystems.com	www.neptunesystems.com
Dickson Lab	Seawater CO2 CRMs	co2crms@ucsd.edu, 858-534-2582	Certified Reference Materials Laboratory Scripps Institution of Oceanography University of California, San Diego Andrew Dickson 2350 Downwind way Room 15 La Jolla, CA 92037

Chapter 3

System Details

Contents
- **Aquaria System**
- **Filtration and Recirculation System**
- **System Operational Parameters**
- **Apex Connection Series**
- **EB832 Outlet Connections**
- **Water Flow Operation**

Aquaria System Component List

- Experimental Tanks (21.25” x 12.5” x 13.5”H, 14.37 gal) - Per tank:
- 1 Submersible powerhead pump (Hydor Nano Koralia 240 powerhead)
- 1 200 W Heater (Hydor aquarium heater)
- 1 Light (Halo Basic M-110)
- 1 Temperature probe (Apex)
- 1 pH probe (Apex)
- 1 Solenoid valve for pH (Apex)
- 1 air stone and tubing to bubble CO2
- 3 Flow sensors (Apex, FS-25 1/4” fitting, flow rates from 3-12 GPH (12-45 LPH))

- 1 Main Supply line: “N”
- 1 Solenoid Supply line: “S”
- 1 Drain line: “D”
- 1 Overflow drain port
- 1 Controlled drain port
- 1 Gate valve (solenoid for water inflow)
- 1 VDM (Apex Variable Dimming Module, 1 unit for 2 tanks)
- 1 FMM (Apex Fluid Metering Module)
- 1 PM1 (Apex Probe Module 1)
- Experimental Tanks - Per Apex, Rack of 4 tanks:
- 1 Base Unit (Apex processing unit, 1 unit for 4 tanks)
- 2 EB832 (Apex 8-outlet EnergyBar, 1 unit for 2 tanks)
- 1 Conductivity probe (Apex)
- 1 CO2 regulator valve (Tunze pH Controller Set, pressure reducing valve 7077/3)
- 1 Industrial Grade Carbon Dioxide, 50 pound cylinder

Filtration and Recirculation System Component List

- Sump (66.25” x 31.5” x 21”H)
- Chiller and Heat Pump (AquaLogic Multi-Temp and Titan Series)
- 1 PM1 (Apex Probe Module 1)
- 1 Temperature probe (Apex)
- 1 pH probe (Apex)
- Water pump (PerformancePro Cascade pump)
- UV Sterilizer (Comet Series 95 Watt Lamp)

- 2 PhosBan chemical filter (PhosBan Reactor 550)
- 2 Air compressors
- 10 Airstones and tubing (4 units on one phosban reactor, 6 units on the other)
- 3 Mesh filters (AquaLogic, 50 microns mesh size)
- 3 Carbon filter cells with mesh casing (AquaLogic, CF28AC,28in, ActC)
- 4 Blue high density mesh filters (Matala Filter Media)
- 4 Black low density mesh filters (Matala Filter Media)

System Operational Parameters

- This is a closed loop system where water from each individual tank will recirculate back to a main holding reservoir (sump).
- Normal High Tide operating water level is approximately 12.5“H for a total water volume of 14.37 gal per tank (total of 287.4 gal to fill the available 20 tanks).
- Normal Low Tide operating water level is approximately 4“H for a total water volume of 4.60 gal per tank (92.0 gal total for the 20-tank-system).
- Excess water drained to the sump at low tide is 9.77 gal per tank (195.4 gal total for the 20-tank-system).
- Normal sump operating water level is 7” water in the filter cell compartment, which has an approximate volume of 82.32 gal. Sump freeboard volume (max before overflow) is 107.39 gal.
- Secondary sump available volume is 250 gal. To operate from a High Tide water level to a Low Tide water level, excess water must be redirected to the secondary sump to accomodate the excess volume (see below).
- Aquaria drain pipe is in line with a 30 gal sump pump, which will draw water from the aquaria drain line and pump water to the sump.
- Sump is in line with a secondary holding tank for sump overflow at Low Tide.
  - 195.4 gal returning to sump in a Low Tide scenario will be split between the main and secondary sumps so that water level is the

same in each.

- **Total system water volume should not exceed 390 gal - ideal water volume for this scenario is 375 gal total throughout the system**
- Flow rate for each tank can be maintained at ~2-6 GPH (See Tidal Manipulation for specific flow rates).

- Chiller is plumbed inline with the filtration skid, which includes mechanical/biological filtration as well as UV sterilization (chemical filtration).

- One main pump recirculates the water flow throughout the experimental tanks and the main holding reservoir.

- Each tank has an immersion heater that allows tank temperatures to be set ~15 degF (8.3 degC) above the main holding tank reservoir.
  - **Note: The tank needs to have low flow or be static in order to initially heat up to desired temperatures much higher than the sump. Once the temperature has been reached in the system, then flow can be set to the normal operating rate.**

- A small sumbersible powerhead in each tank provides water circulation throughout the tank.

- Each tank has (2) water supply lines, each with (1) Neptune Systems flow sensor and (1) needle valve for manual flow rate control, and (1) gate solenoid valve in line with (1) supply line for programmable tidal effect. Each tank also has (2) drain lines with (1) flow sensor in line with (1) needle valve for outgoing flow rate control, and (1) 'overflow' line for maintaining maximum tank volume. Incoming and outgoing flow rates have to be manually adjusted for tidal effect.

- Flow metered water lines
  - N: Main supply
  - S: Solenoid-controlled supply
  - D: Drain

- Tidal effect
  - outgoing tide: incoming flow rate (N + S) is lower than outgoing flow rate (D).
  - incoming tide: incoming flow rate (N + S) is greater than outgoing flow rate (D).

  - Note: The tank will not be completely empty during low tide events to prevent the recirculating powerhead from running dry.

- Each tank has (1) CO2 supply line with an airstone connected to (1) Neptune Systems solenoid valve to control the lowering and maintenance of pH in tanks.

- CO2 scrubber comprised of (1) or (2) air compressors connected to (1) or (2) Phosban Reactors will bubble out CO2 from the sump water to bring up pH to ambient or near-ambient conditions in the holding reservoir to supply to the tanks.

- Each tank has individual LED lighting, which can be controlled for white or blue light for natural daily light cycles or some other program.

- Certain tank conditions can be controlled via Neptune Systems Apex Controllers. Each Apex controls (4) tanks.

- Controllable parameters are: pH, temperature, tidal effect (S flow into the tank), and lighting.

- Certain tank conditions can be monitored via Neptune Systems Apex Controllers. Each Apex monitors and records data for (4) tanks.

- Monitored parameters include: pH, temperature, salinity, flow rates, relative light intensity, and the status of any set program (whether a unit is On of Off at any given time based on the program set)

Apex Connection Series

- Each EnergyBar connects to the Base Unit with an AquaBus cable via the AquaBus Ports for power. (2) EB832 units connect to (1) Base Unit.

- Each CO2 Solenoid valve connects to the EnergyBar via the DC24 Accessory Port on the side of the EB832. (2) Solenoid valves connect in (1) EB832.

- (1)PM1 connects to (1) EnergyBar with an AquaBus cable via the AquaBus Ports, and all PM1 modules connect in series with each other for power.

- VDM connects to the last PM1 in series with an AquaBus cable via the AquaBus Ports for power.

- Temperature probes connect to the PM1 Temp Port or the Base Unit Temp Port. (1) Temperature probe in each PM1, and (1) Temperature probe in the Base Unit.

- pH probes connect to the PM1 pH/ORP Port or the Base Unit pH/ORP Port. Push the BNC female connector of the probe on to the male connector and turn 1/4 turn clockwise to lock the connector in place. (1) pH probe in each PM1, and (1) pH probe in the Base Unit.

- Halo light connects to the VDM or Base Unit via the V1/V2 or V3/V4 Port. (2) Light connections in the VDM and (2) Light connections in the Base Unit.

- (1)FMM connects to (1) EnergyBar (whichever EB832 is not powering the PM1 modules) with an AquaBus cable via the AquaBus Ports, and all FMM connect in series with each other for power.

- (3)Flow sensors connect to each FMM via (3) of the numbered ports.

EB832 Outlet Connections

Note: Each horizontal row on an EB832 corresponds to one tank, yielding 4 outlets per aquarium. Current outlet order, left to right:

1. 200W Heater
2. Hydor Powerhead
3. Water supply line “S” Solenoid
4. Halo Light

Water Flow Operation

- Flow from the filtration sump to the mesocosm tanks
  - Water from the chiller can be directed either back into the sump or to the mesocosm tanks or both simultaniously.
  - The bypass valve is used to regulate the line pressure going back to the mesocosm tanks. The more closed, the higher the pressure in the line, and the more open, the lower the pressure.
  - It is recommeded you maintain partial flow to the sump to maintain circulation within the sump and to not overwhelm the tanks with more water pressure than they can handle, depending on your flow rates in.

  - Multiple valaves in line can be used to regulate the flow through the filtration system, though the chiller has a safety flow switch that requires a minimum flow rate for the chiller to operate.

  - Minimize flow through the filtration system if you want to increase residence time of water through the UV sterilizer.

- Flow from the mesocosm tanks to the filtration sump
  - Water from the tanks drains to an outdoor underground 30 gal compartment, which will automatically pump water out when a certain water level is reached (about 15 gal). This water can be directed either back into the sump, or if you intend to drain water in the event of a water change or the end of an experiment, water can be directed to a drain port.
- Overflow from sump to secondary containment
  - When mesocosm water level falls from a high tide to low tide sequence, more water will drain to the sump than what the main sump can individually hold. Excess water can be redirected from the sump (S1) to the secondary containment (S2) by opening the S2 inflow t-valve (allows simultaneous flow of filtered, chilled water to both S2 and the mesocosm tanks), and an exchange t-valve (allows for continuous flow between S1 and S2).

Chapter 4

Inventory

Contents
- **Mesocosm Tanks**
- **Filtration**
- **Additional Items**

Mesocosm Tanks

Item	Quantity	Purchase Replacement
Experimental Aquarium	20	
Aquarium Lid	20	
Lid Holding Pegs	80	
200W Heater	20	$24.99 Amazon
Suction Cup Heater Holder	40	
Halo Light	20	$299.99 Amazon
Halo Light Power Cords	20	
Hydor Powerhead	20	$34.99 Amazon
Apex Temperature Probe	20	$29.95 Bulk Reef Supply
Apex pH Probe	20	$74.95 Bulk Reef Supply
Apex Conductivity Probe	5	124.95 Bulk Reef Supply
Suction Cup Probe Holder	40	
Apex CO2 Dosing Solenoid	20	$29.95 Bulk Reef Supply
Neptune FS-25 1/4” Flow Sensor	60	$19.95 Bulk Reef Supply
Flow Solenoid/Gate Valve	20	$16.99 Electric Solenoid Valves
Polyethylene Tubing 1/4” OD (water input)	40	$15.71 for 100’ Amazon
Vinyl Tubing 1/4” OD (CO2 input)	20	$3.92 for 20’ Home Depot
Airstone	20	$5.99x10pack Amazon
Apex VDM	5	$99.95 Bulk Reef Supply
Apex FMM	20	$99.95 Bulk Reef Supply
Apex PM1	15	$84.95 Bulk Reef Supply
Apex Display Module	1	$99.95 Bulk Reef Supply

Item	Quantity	Purchase Replacement
Apex Base Unit	5	$399.95 Bulk Reef Supply
Apex EB832	10	$249.95 Bulk Reef Supply
Tunze CO2 Regulator Valve	1	
Bluelight Glasses	6	

Filtration

Item	Quantity	Purchase Replacement
107 gal Sump	1	
250 gal Secondary Sump	1	
Chiller	1	
Apex Temperature Probe	20	$29.95 Bulk Reef Supply
Apex pH Probe	20	$74.95 Bulk Reef Supply
Apex PM1	1	$84.95 Bulk Reef Supply
PhosBan Reactor 550	2	$85.14 Bulk Reef Supply
PhosBan CDX Carbon Dioxide Absorption Media 3L	0	$44.38 Bulk Reef Supply
Cascade Water Pump	1	
UV Sterilizer	1	
UV Light (UV-BULB-095W-1)	1	$110 AquaLogic
Air Pump	2	
Air Pump tubing to Phosban Reactor 3/8” ID	2	$4.93 Home Depot
Airflow Tubing 3/16” ID	4	$2.69 Petsmart
Airstone	10	
Bag Filter, 50um	3	
Carbon Filter Cell	3	
Matala Filter, High Density (Blue)	4	
Matala Filter, Low Density (Black)	4	

Additional Items

Item	Quantity	Purchase Replacement
Apex pH 7 Calibration Pack	5	Bulk Reef Supply
Apex pH 10 Calibration Pack	5	Bulk Reef Supply
Apex 53,000 uS Conductivity Calibration Pack	5	Bulk Reef Supply

Chapter 5

Start-up Guide

Contents
- **Basic Operation**
- **Filtration**
- **Sump Flow**
- **Mesocosm Tank Flow**
- **CO2 Scrubber to Elevate pH**
- **Draining the Meso and Sump**

Basic Operation

1. Operating water level in the filtration sump should be at least 7" in the filter cell compartment, about 2 inches above the three carbon filters.
2. Outflow water from the tanks feeds down to the outside underground sump pump, then into to the filtration system inside the Citrus Hall Field Room.
3. Water pumped into the Field Room flows through three 50um bag filters and eight matala mesh filters before overflowing into the main holding reservoir. Reservoir water is pumped through three carbon filters, a UV sterilizer, and chiller, then either back into the holding reservoir or to the tanks.
4. Water directed toward the tanks has two potential inflow ports (one constant flow and one controlled by a solenoid) and two potential outflow ports (one overflow port and one controlled by a manual open/close needle valve to adjust tank volume)

Filtration

- Biological and Mechanical Filtration: Water from the Mesocosm tanks is pumped into the sump while passing through three 50um bag filters and

eight matala mesh filters (high and low density) to pick up debris. These filters have an accumulated biofilm to biologically filter the water before entering the sump and returning to the tanks.

- Chemical and Mechanical Filtration: Water in the sump is pulled through three carbon filters with mesh filter sleeves and pumped into a UV sterilizer before entering the sump and returning to the tanks.

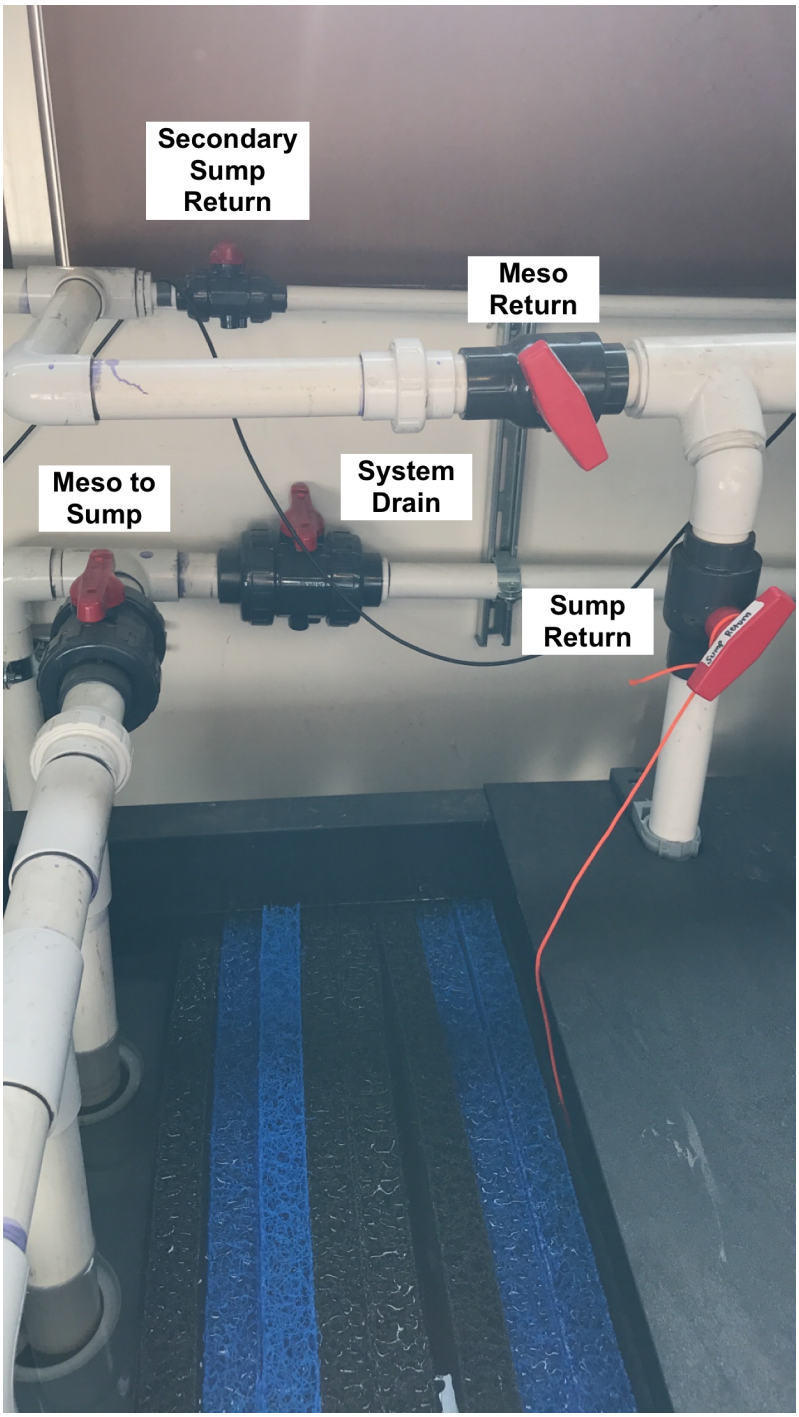
Sump Flow

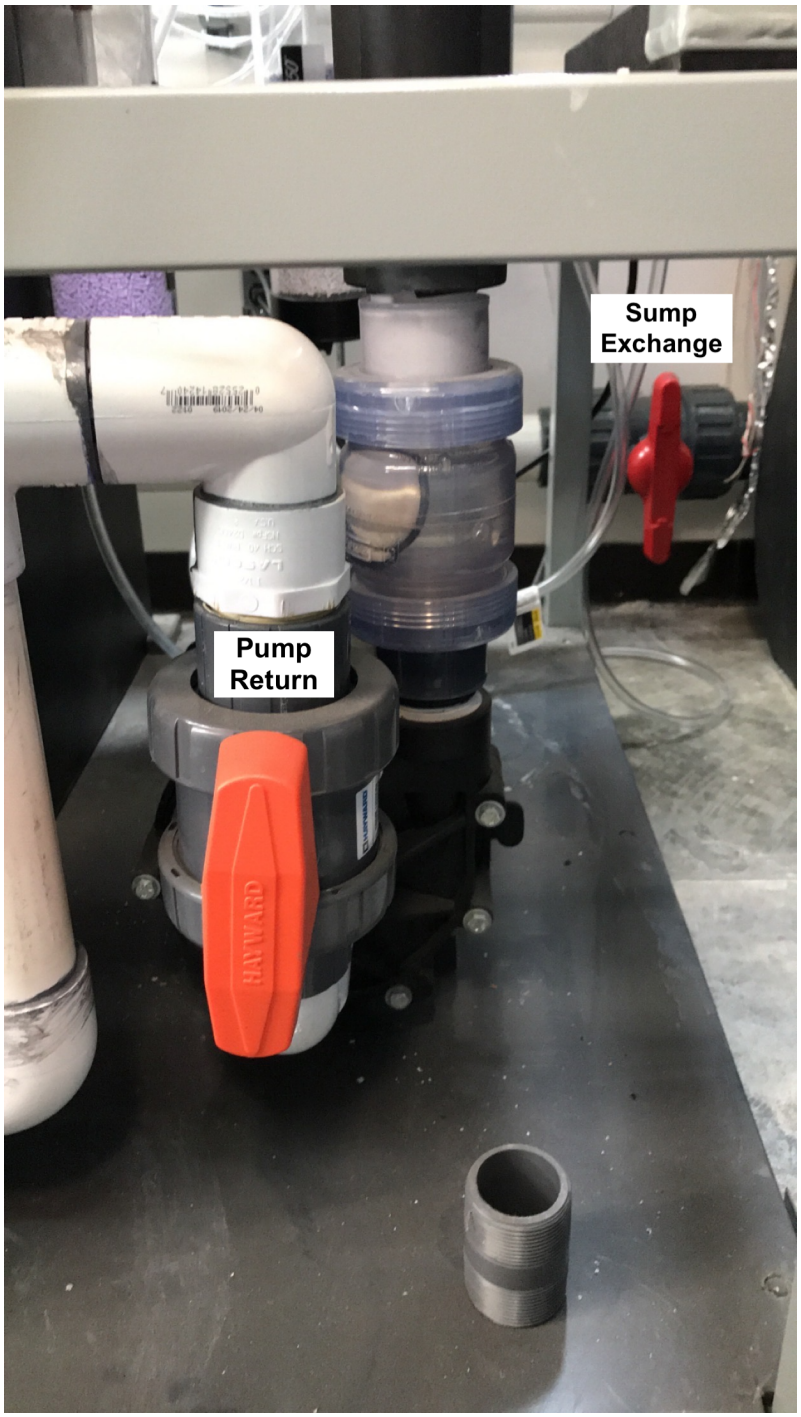
1. Preparing flow in the sump

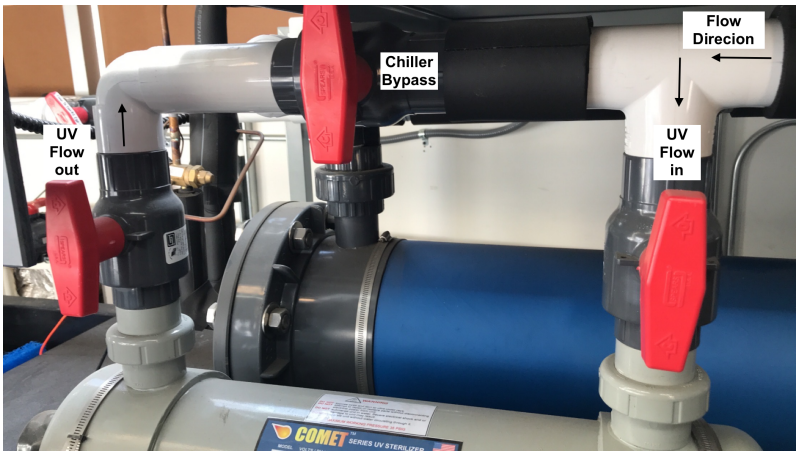
    1. Before turning on the pump, make sure the correct channels of flow are opened to direct the water where it needs to go.
    2. The Meso Return valve should be vertical in the “closed” position (perpendicular to the PVC), and the Sump Return valve should also be vertical in the “open” position (in line with the PVC). See Figure 1 to identify valves.
    3. The Pump Return valve should be veritcal in the “open” position to allow flow from the sump through the pump to the UV filter and chiller compartments. See Figure 2.

        1. If you do not intend to utilize the Secondary Sump at this time, close the Sump Exchange valve (as shown in Figure 2)

    4. The two UV Flow valves and the Chiller Bypass valve should all be vertical. This directs flow down through the UV light chamber before pushing through to the chiller compartment. See Figure 3.


Secondary Sump Return
Meso Return
Meso to Sump
System Drain
Sump Return


Sump
Exchange
Pump
Return
HAYWARD



2. Turning on sump flow
    1. Once all the valves are properly opened/closed as described above, plug in the Cascade Pump and make sure water is running through the system properly without any leaks. There may be some initial sputtering while air is pumped out of the pipes, but that should stop within a couple minutes.
    2. Look at the pump and make sure you can see water being pushed through the clear junction.
        1. If it looks like water is not running through the pump, **unplug the pump immediately**. Running the pump dry can burn out the motor.
    3. If everything seems to be stable, plug in the UV light.
    4. To stabilize the pH in the system, fill the PhosBan Reactors with CO2 absorption media and plug in the air pumps as detailed below.

Mesocosm Tank Flow

1. Filling the mesocosm tanks
    1. Make sure the drain valve located under each tank is closed (turned clockwise all the way, finger-tight).
    2. Fill each rack one at a time (only open the N flow valves for one set of 4 tanks at a time) and make sure rack and filtration skid flows are balanced before moving on to the next rack.
        1. Open the N flow valve for each tank (and S flow valve if you plan to turn on the solenoid [SOL-TNK-#] to help fill the tanks).
    3. To open flow from the sump to the tanks, first make sure the circular flow within the sump itself is stable. Then slowly open the Meso Return valve (turn counterclockwise) until the t-valve is sitting about

45 degrees to the PVC pipe. This configuration splits flow to both the sump and the mesocosm. You can further adjust water pressure to the tanks by slightly closing the Sump Return valve to direct more flow to the meso, less flow to the sump, while always keeping the line to the sump partially open.

4. Once all tanks are filled, make sure the whole system is stable in standard recirculation mode before setting up a tidal cycle, if desired.

2. Set flow in tanks

    1. Calculate your desired residence time. When full, each tank holds 55 liters, so divide 55L by your desired residence time and use that estimated value as your flow rate. Example: for a RT of 4 hours: 55L/4hr = 13.75 L/hr
    2. Use the Neptune Systems flow meters as a guide for setting the flow, but for the most accurate flow rates, use a graduated cylinder to estimate flow into each tank.
        1. Using the example above: 13.75 L/hr = 229.2 mL/min = 38.2 mL/10 seconds to efficiently check each tank's flow using a graduated cylinder
    3. While higher flow is more stable, lower flow may change slightly throughout the day, so it is recommended to check and set flow twice per day: once in the morning and once in the afternoon/evening.

CO2 Scrubber to Elevate pH

1. Filling/Replacing media in the Phosban Reactor

    1. Unplug the airpump connected to the Phosban Reactor and disconnect both sets of tubing going into/out of the Reactor to easily handle it.
    2. Unscrew the lid of the Reactor, take off the red cap and black mesh, and pour out the used up media (purple if freshly used, grayish white if used and stale) into a bag or some other containment. Used media can be deposited in a standard trash receptacle.
    3. Use tape or parafilm to cover the hole of the small tube inside the Reactor before pouring in the new media (stark white pellets). Fill to **an inch below** the top of the small tube, so no media falls into the tube. Remove the covering from the small tube and replace the black mesh and red cap, aligning the red cap so it encapsulates the top of the small tube.
    4. Screw the lid back on, finger tight, and replace the Reactor on the side of the sump. Reconnect the tubing from the airpump to the side of the Reactor and from the air splitter to the front of the Reactor. Submerge the airstones connected to the air splitter tubing in the holding reservoir of the sump.

5. Once you're sure everything's securely placed, plug in the air pump.
6. Listen and feel for any air leaks and adjust tubing as necessary.

Draining the Mesocosm and Sump

1. The first step before draining any water is to turn off the powerheads, heaters, and CO2 solenoids in all mesocosm tanks. **The powerheads and heaters cannot be ON when dry or they may be damaged**.
2. You must also place caps on each pH probe filled with either DI water for temporary storage or KCl storage solution for long-term storage. **The probe tips cannot dry out or they will be damaged**.
    1. Remove the probe from its holder in the tank, rinse in DI, then carefully slide the DI-filled cap on the probe tip until the diode is fully submerged.
3. Divert flow from the mesocosm tanks to the drainage port
    1. There is a drain in the Mechanical Room behind the Field Room with PVC pipe facing downward inside. This PVC is connected to our system and is the location for all system drainage.
    2. Refer to Figure 1 for the following t-valve identities.
    3. **First open the System Drain Valve** by turning the valve so it aligns parallel to the PVC. This opens flow to the drainage port in the back room. Always open an avenue of flow before closing an avenue of flow to avoid back pressure build up.
    4. Second, Close the Meso To Sump valve by turning the valve so it sits perpendicular to the PVC. This will divert flow from the mesocosm tanks out of the system.
4. Fully open (parallel to the PVC) the Sump Return valve of the filtration system, then turn off the flow of both the N and S valves for each tank, turning the valves clockwise until finger tight.
5. Unplug the UV light and air pumps, but leave the water pump on for now.
6. When draining the tanks, drain one tank at a time, to not overflow the drainage system.
    1. **Unscrew** the larger outflow pipe until it is fully removed and cover the top opening with your hand to avoid water splashing upward when you remove the pipe.
    2. Under each tank is a needle valve controlling drain flow through the smaller outflow pipe in each tank. Fully open this valve by turning the needle counterclockwise until partially open.
    3. The smaller outflow tube can simply be pulled out from its slot, sometimes needing to be twisted to be unwedged.
7. The underground sump pump located between the Mesocosm container and the Field Room will continue to push water from the tanks to the Field Room system.

    1. **Do not allow salt water to overflow the drainage port of the Mechanics room.** Periodically check the drainage port to make sure the water pumped from the tanks is not overflowing onto the floor of the Mechanical Room.
    2. By only draining one tank at a time, overflow should not be an issue.
    3. If you notice water is overflowing, slightly open the Meso To Sump valve to divert some water back into the sump and reduce the water volume diverted to the drainage port.

8. Once the mesocosm tanks are all drained, unplug the sump's main pump.
    1. **Alternatively**, to drain the sump partially, leave the main pump plugged in, open the N flow valves for mesocosm tanks, then slightly open the Meso Return valve, and slightly close the Sump Return Valve.
    2. Water will flow from the sump to the tanks, then out through the drainage port.
    3. Once the water level in the sump is 1-2 inches above the three carbon filters, open the Return Sump valve, then close the Meso Return valve, then unplug the sump's main pump.
9. Remove filters from the sump
    1. To access the bio-filtration reservoir, remove the black and blue matala mesh filters, and clean them by hosing them down with freshwater (available just outside the Field Room door).
    2. To remove the 50-micron mesh filters, remove the PVC pipe located directly after the Meso To Sump valve (see Figure 1) by unscrewing the PVC at the junction (unscrew away from you if standing at the head of the sump). This PVC pipe with three outports can be temporarily removed, so the mesh can be taken out and also sprayed down with fresh water to clean.
    3. Remove the three carbon filters from the main reservoir by gently twisting and tugging until they come away, and hose them down outside with fresh water.
10. To drain the sump, use a small aquarium pump to pull water out of the sump into buckets that can be drumped down the drainage port in the back room
    1. Attach tubing to the aquarium pump and place both the pump and tubing end into the main reservoir of the sump.
    2. Plug the aquarium pump into the quad outlet behind the sump (where the sump pump and UV light had previoiusly been plugged in).
    3. Use the tubing to fill up a bucket with remaining sump water, and place the tubing end back into the sump when dumping the bucket.
    4. Do this until the water level is such that the aquarium pump is no longer a viable option. 1. **Do not let this pump run dry, or it may be damaged**

11. Place the tubing and aquarium pump in the bio-filtration reservoir and continue the process, stopping before the pump runs dry.
    1. Any additional water can be removed with a small bucket or large sponge.
12. Once the system is drained of seawater, place the filters back into the sump (3 50um mesh, 8 bio-filters, and 3 carbon filters).
13. Clean the mesocosm tanks thoroughly.
    1. Remove any debris or algal grwoth
    2. Wipe off all probes (avoiding sensitive tips), tubes, heaters, and sides of the tanks
    3. Use a brush to clean inside the large and small outflow pipes
    4. Thoroughly clean the powerheads (remove the plastic head and magnetic turbnine within to clean all areas of each unit, removing algal growth and debris)
14. Screw back on the PVC pipe with three outports at the junction by the Meso To Sump valve.
15. Fill the sump with fresh water.
    1. Follow the instructions in the Water Collection Guide for filling the sump with fresh water (attach a hose to the water pipe next to the Field Room door and fill the sump from the hose) and the order of operations for turning flow back on through the sump and tanks.
    2. You will not have to plug in the UV light or air pumps since you are not maintaining any water chemistry, but rather just flushing the system.
    3. Place the hose in the front most compartment of the sump (where the three 50um mesh filters sit, to let the fresh water go through this compartment, into the second compartment and then overflowing into the main reservoir.
    4. While the sump main reservoir fills to about halfway, open the N and S flow valves for all the tanks.
    5. Once the sump is halfway full, partially open the Meso Return valve and partially close the Return to Sump valve.
    6. Plug in the sump main pump.
        1. Fresh water from the sump will flow through the sump pipes and into the mesocosm, flushing out the internal plumbing, and then from the tanks, into the underground sump, and out through the drainage port. Flush the system in this way for ~ 20 minutes, leaving the hose on to continuously refill the sump.
        2. Make sure the sump is not filling up too quickly (avoid overflowing) or draining too quickly (avoid the water level dropping below 1-2 inches above the three carbon filters)
    7. After the system has flushed through, re-place each mesocosm tank's outflow pipes (screw in the large pipes and wedge in the small pipes), and then close the D valve below each tank.

    8. Open the Meso to Sump valve and close the System Drain valve.
    9. Allow all tanks to completely fill with fresh water, and once the tanks are full and the sump is filled halfway, turn off and remove the freshwater hose.

16. Let fresh water run through the system for one to two days before following these same steps for draining the freshwater.
17. End of experiment

    1. Remove the water inflow tubes from each tank's N and S ports to be acid washed and rinsed in DI water before next use.
    2. Rinse all pH, conductivity, and temperature probes in DI water.
    3. Use a KCl storage solution for capping the pH probes, ensuring the probe tips are fully submerged in the solution.

Overflow into Secondary Sump

1. If you need to contain more water in the system than the tanks and main reservoir can hold at one time (ex. during a "low tide event" when half of the tank water is drained into the sump), then you will need to incorporate flow to and from the secondary sump.
2. First unplug the sump's main water pump to make sure the pump will not run dry if the water level drops too low (see details below).
3. To direct some flow from the mesocosm system into the secondary sump, partially or fully open the Secondary Sump Return valve (Figure 1), so that the t-valve runs parallel with the PVC. Filtered sump water will then be simultaniously directed into the mesocosm and the secondary sump, via PVC tubing that diverts water into the top of the secondary reservoir.
4. To then open flow between both the main holding reservoir and the secondary sump, open the Sump Exchange valve (Figure 2), so the t-valve runs parallel with the PVC.

    1. Because this flow-through connection will allow water to flow between both reservoirs to establish water level equilibrium, make sure the water level in the main reservoir is still about 2 inches above the carbon filters after this water exchange has occurred. If not, add more seawater to the system until the carbon filters are once again submerged **to avoid the pump running dry**.
    2. Once the carbon filters are appropriately submerged (seawater just two inches above the filters, not much more), turn the main pump back on.
    3. The full system requires ~ 400 gallons of sea water to maintain tank volume and submersion of carbon filters while including use of the secondary sump.

Chapter 6

Water Collection Procedures

The water collected for the mesocosm system is filtered (100um mesh filter) unbuffered seawater from the Southern California Marine Institute (SCMI) located at 820 S Seaside Ave, San Pedro, CA 90731.

Contents
- **SCMI Packing List**
- **Pre-Collection Check List**
- **Water Flow Procedure**
- **Water Collection**
- **Filling the Sump**

SCMI Packing List

1. Items to bring to SCMI for collecting water
    1. Two large water storage bins and lids
    2. Pool hose (stored inside one of the water bins)
    3. Standard garden hose (from Field Room)
    4. Triple filter and locking ring
    5. Banjo attachment (PVC to pool hose adaptor)
    6. Two ratchet straps or sets of rope

Pre-Collection Check List

1. Before traveling
    1. Sign out the Ford 450 truck at the Bio Stock Room for your desired day (Biology Department Vehicle ID 440).

    1. Before driving a univeristy vehicle, be sure to complete the Defensive Drivers course. Email Wendy Dunbarr (wendy.dunbarr@csun.edu) for details.
    2. At least 24 hours before collecting water, email Mark Loos (mark.loos@csulb.edu) of your intent to get water, and give him an estimated time of arrival. Check in with him or his appointed staff member upon arrival.
    3. Check that all three o-rings of the triple filter are in place and that the filters are placed in order (left to right following direction of flow: 20um, 5um, 1um) before twisting the filters onto the base rack. Use the locking ring to ensure a tight seal of the filter compartments onto the rack.
    4. Ensure that all components of the sump are prepared for water:
        1. Three bag filters are in place
        2. Eight matala filters are in place
        3. Three carbon filters are in place, the open PVC end wedged into the holes of the PVC located in the back of the holding tank
        4. If you do not intend to use the secondary sump, close the Sump Exchange valve (see image below)
        5. Check that all power cords are away from areas with possible water exposure

2. Once you pick up the truck from behind Chaparral Hall, back it up to the large stacked square bins in the same parking lot, near the side of the building on the grass.
    1. With the help of at least one other person, lift and slide the top bin into the bed of the truck. Take off the lid of the second bin and lift the second bin onto the bed of the truck. Once in place, put the lid back on (lids weight an additional 15-20lbs).
3. Make sure you have all the items listed above laoded in the truck to bring to SCMI.
4. Plan to leave CSUN for SCMI after 9am to avoid major traffic, and wear or bring closed toed shoes to wear once you arrive.
5. When you arrive at SCMI, back into the employee lot (the parking lot to the left of the building when looking on from the street), back through the lot and behind the building parallel to the wire fence.
    1. Move the cone before backing into the lot behind the building and replace the cone when you leave.

Water Flow Procedure

1. Near the wire fence, there is a large pool hose with a pvc loop attachment. Remove the banjo attachemnt comprising of the PVC “U” on the pool hose and attach the banjo adapter that connects to the triple filter. Before

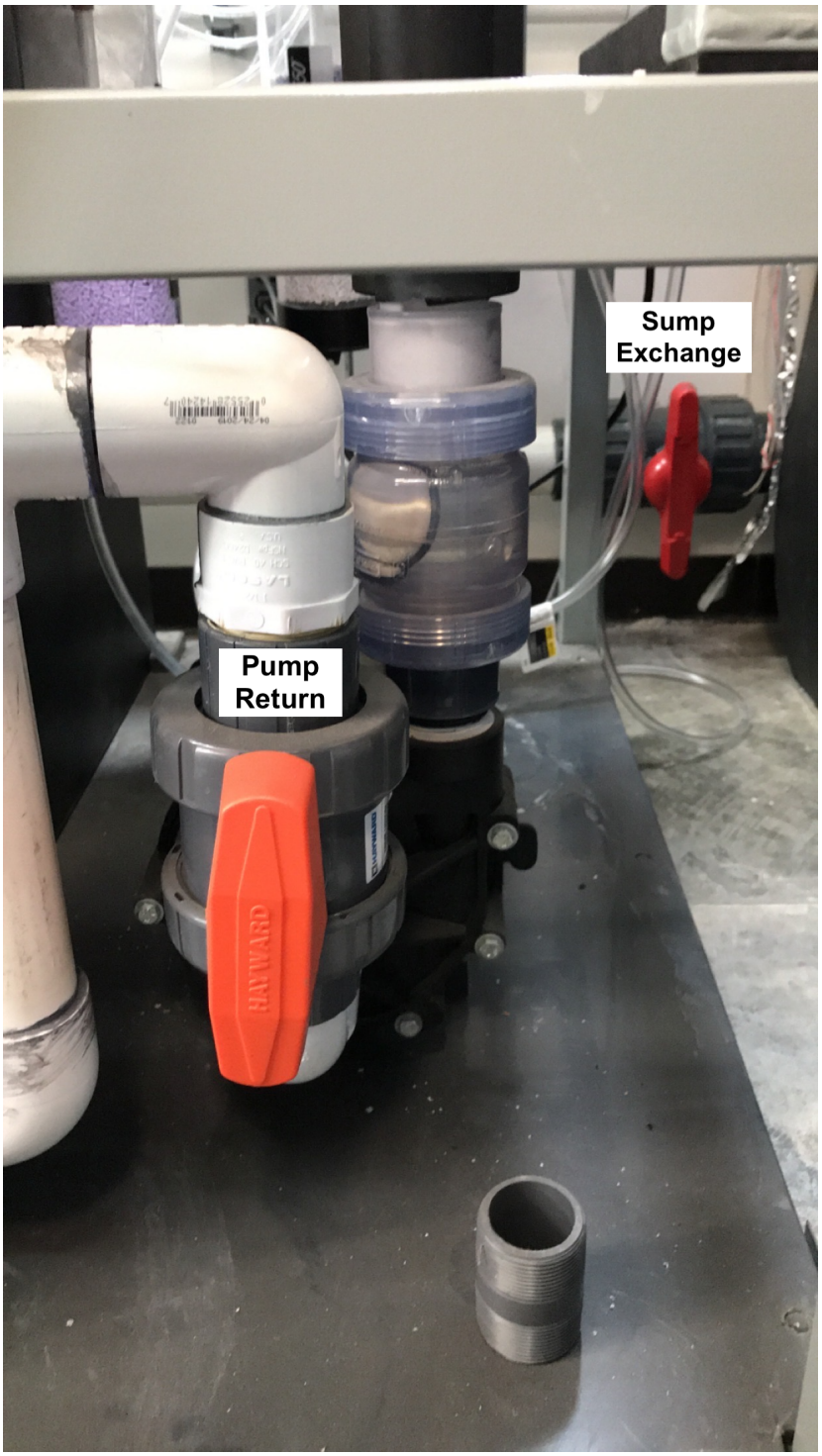


Figure 6.1: Figure 1. Sump Exchange valve

connecting it to the filter, move this end of the hose to the drain port (hole in the concrete flowing under the walkway).

2. Unwind the SCMI garden hose enough to also place the outflow end at the drain port.
3. Open the t-valve at the base of the pool hose **half-way (at a 45 degree angle)** and fully open adjacent garden hose (t-valve parallel to the PVC).
    1. Refernce image for t-valve alignment:
4. Walk over to the filtration area in the corner of the back lot (near the fish pens) and locate the filter chamber (tall teal cylinder with rounded top). Open the t-valve for the PVC pipe running from the base of the filter chamber toward the wire fence (see image below).
5. There is a power switch on the fence across from the filter's PVC (second power unit from the right). Turning this switch ON will initiate flow from the marina, through the filter, and out the end of the pool hose.
    1. **Do not turn on the power supply until you have opened the other t-valves.** Doing so could cause pressure buildup in the piping and damage the system.
6. Flip the switch ON and leave the water running for 30 seconds to 1 minute to flush out any standing water in the system.

Water Collection

1. Connect the male end of the garden hose to the outflow end of the triple filter, and place the female end inside one of the bins (you will need to remove or offset the bin lids).
2. When you have finished flushing out the system and are ready to fill the bins, turn off the power supply without closing off any of the t-valves.
3. Attach the banjo adapter to the triple filter (see image below), then turn on the power supply again. This will initiate flow through the filters and into the bins. To avoid pressure build-up in the system, allow the SCMI garden hose to continuously pump water into the drain port.
4. Filling the bins
    1. If you are filling up the entire mesocosm system, you will need to fill both bins about 3/4 full twice to obtain 400 gallons, requiring two trips to SCMI.
    2. If you are only doing a partial water change or refill, fill the bins with slightly more than you need in case any water is lost en route to CSUN.

Figure 6.2: Figure 2. Hose T-valve Alignments

Figure 6.3: Figure 3. SCMI Filter System

Figure 6.4: Figure 4. Triple Filter

5. When you are finished filling, **first turn off the power supply**, then close the t-valve on the pipe between the power supply and the filter chamber, and finally close the t-valves at the base of the hoses.
    1. CLosing off any t-valves before shutting off the power could cause a pressure build-up in the PVC and may rupture the system.
6. Place the lids on the water containers and use the ratchet straps or rope to secure the bin lids down (this will help with water spillage on the drive back to CSUN).
7. Remove the banjo adapter from the pool hose and the triple filter, and replace the PVC "U" back on the pool hose.
8. Remove the garden hose from the triple filter, then tilt the triple filter upside down to allow water inside the filter chambers to flow out before loading it back in the truck.

Filling the Sump

1. Once back at CSUN, pull into the laoding bay between Citrus and Eucalyptus, and back up to the Field Room, leaving just enough space to open the door.
2. Unstrap and remove the lids. Place one end of the large pool hose in one of the containers, and use a weight to keep it from floating up.
3. Pull the free end of the hose to the sump, and start a siphon. Gently wedge the end of the hose in between the matalamesh filters in the sump for hands-free siphoning and to filter the water as it goes into the system.
    1. To start a gravity-fed siphon, fill the hose with as much water as you can, displacing the air. Keep one end of the hose weighed down in the seawater container and the other end wedged in the sump. Starting near the sump end of the hose and working toward the bin end, lift the hose section by section to redirect the bulk of the water within toward the bin end until at least 1/3 of the hose at the bin end is filled with water. Lower the hose section you are holding to return flow back toward the sump end.
4. When water volumne in the first bin is nearly at the top of the hose opening, remove the weight while holding down the hose opening toward the bottom of the bin.
    1. Keep the opening at an angle to the bottom to allow for continued suctioning of water without exposure to air.
5. When you are ready to switch bins, preserve the siphon by cupping the palm of your hand against the hose end, submerging the hose in the next bin, then removing your hand. Place the weight again to avoid the hose floating to the surface.

6. If you plan to collect water again that day, simply replace the lids once you have finished siphoning, and drive back to SCMI for another round.
7. Once you are finished filling the sump and emptying the bins, attach the garden hose to the fresh water tap on the outside of the Field Room, and turn on water by using the metal screw key hanging on a pipe just inside the Field Room door to the left.
8. Hose down the entire back, bed, and sides of the truck, everything that may have been exposed to salt water. Also unscrew the filter chambers of the triple filter and hose down the chambers, the rack, and the filters sufficiently to clean off any debris or particulates.
9. Place the large pool hose back in one of the bins, and once you turn off the hose water, replace the key and store the garden hose back in the Field Room.
10. Before parking the truck, back it up to the same location where you picked up the bins, and drop/place the bins back on the grass. If there is any water left in the bins, dump that out before leaving them stacked.

Chapter 7

Tidal Manipulation

Controling the tidal cycle of each experimental tank with the Apex. This is achieved by manipulating the incoming and outgoing flow rates of each individual tank with the needle valves described in the System Details, and setting the ON/OFF time cycle of the supply line with the solenoid. The basic procedure is outlined below.

1. Set the flow rate of the supply line N[#]FLW (without the solenoid), for example 10.5 Liters/Hr, by slowly turning the black knob counterclockwise to increase flow or clockwise to decrease flow.
    1. You can view rates on the Fusion dashboard.
    2. Note that the Apex controller has some lag time in registering the flow rate after the valve has been adjusted, and the delay can be up to 30 seconds or more, so make small adjustments and monitor the change on Fusion.
    3. Once the rate is set you should check periodically to make sure the rate has not changed both on Fusion and by using a graduated cylinder and a timer.
2. Adjust the outgoing flow rate of the drain line D[#]FLW higher than the N[#]FLW, for example 15 Liters/Hr.
    1. With the above condition, the outgoing flow rate is higher than the incoming, so this will create a low tide effect over a 5-5.25 hr period.
3. To create a high tide effect, change the setting of SOL-TNK-# (outlets 3 and 7 on each EB832) to ON on the Fusion dashboard, then manually turn on and adjust the flow rate of the supply line S[#]FLW , for example 10 Liters/Hr.

4. Once the S[#]FLW is set, change the setting of SOL-TNK-# to AUTO on the Fusion dashboard.

1. With the above condition, the total incoming flow rate (N+S) is higher thatn the outgoing (D), so this will create a high tide effect over a 5-5.25 hr period.
2. For a constant ON/OFF cycle over a 12.5 hour period, the Advanced program should look like the program below:

Fallback ON
Osc 000:00/375:00/375:00 then ON

1. In the event the EnergyBar loses connection with the Apex Base, "Fallback ON" will keep the solenoid open, allowing water to continuously flow from S[#]FLW.

2. The oscillate (Osc) command as written will open flow from S[#]FLW for 6.25 hours, initiating the High Tide scenario, then close for 6.25 hours, initiating the Low Tide scenario. This will provide the effect of two high and two low tides of a semidiurnal tidal cycle over a 25 hour period.
    1. Using the flow rates stated above, each tidal shift will last 5.25 hours and maintain the tide height for 1 hour.

For more advanced programming features, see the Comprehensive Manual. Start on Page 65 for Seasonal Features and Moon cycles.

Chapter 8

Controlling pH

The pH is controlled with the addition of CO_2 gas to the system. The gas is delivered to the tank by air stone and is controlled through the Apex Controls with a solenoid valve connected to the EB832.

1. Once the CO_2 regulator is connected to a tank, open the main tank valve.
2. Use the pressure adjusting screw (larger knob in front with Tunze label) to adjust the pressure (in bar) on the pressure gauge. Turning **clockwise to open**, thus increasing pressure, while turning **counterclockwise to close**, thus reducing pressure.
3. The pressure should be set to 0.5 up to 1 bar on the gauge (~7.5psi) - ideally 0.6 bar.
4. Open the fine adjustment valve (smaller valve next to the tubing connecting the regulator to the tanks) to allow gas to the tank solenoid. If the pressure on the gauge is too high this may prevent the CO_2 solenoid from completely closing, which will inject excess CO_2 into the system.
5. Programming the solenoid for a consistent pH: pH-TNK-#
    1. From your ApedFusion dashboard, click the icon for Outlets
    2. Find the gear icon in the upper right-hand corner of the Outlets page and select "Add a Virtual Outlet"
    3. Label the outlet to be specific for the tank and treatment for a particular time block (see example below)

Control type: pH Control
Probe name: pH
Fallback: OFF
High Value: 8.2
Low Value: 7.9
On when: High

6. Programming the solenoid for diel variance:
    - Using Advanced programming and Virtual outlets
    - Create a unique virtual outlet for every time block which requires a different pH, and for every tank/probe which requires that pH treatment.
    - Virtual Outlet Example (for the 6 hours between 6:31am and 12:30pm, the CO2 solenoid will dose CO2 into tank 1 while the probe reads 8.10 or above):

Fallback OFF
Set OFF
If Time 06:31 to 12:30 Then ON
If pH-1 < 8.10 Then OFF
* Advanced Program Example (Every 6 hours, the pH setpoint changes, and each of the four time blocks has a unique virtual outlet name, as presented below in the four programming lines. The CO2 solenoid will dose the tank when the conditions of the virtual outlet program are met):

Fallback OFF
Set OFF
If Output pH_1_630 = ON Then ON
If Output pH_1_1230 = ON Then ON
If Output pH_1_1830 = ON Then ON
If Output pH_1_0030 = ON Then ON

Refer to Comprehensive Manual for set point programming.

Chapter 9

Controlling Temperature

The temperature is controlled by a single 200-W Hydor heater programmed via Neptune Apex to raise the temperature, while incoming cooler sump water lowers temperature (more or less depending on flow rate in and sump set temperature).

- Programming the heater for a consistent temperature: HEATER-TNK#

Control type: Heater Control
Probe name: Tmp-#
Fallback: OFF
On Temperature: 24.9
Off Temperature: 25.0

- Programming the heater for diel variance:
  - Using Advanced programming and Virtual outlets
  - Create a unique virtual outlet for every time block which requires a different temperature, and for every tank/probe which requires that temperature treatment.

  1. From your Apex Fusion dashboard, click the icon for Outlets
  2. Find the gear icon in the upper right-hand corner of the Outlets page and select "Add a Virtual Outlet"
  3. Label the outlet to be specific for the tank and treatment for a particular time block (see example below)

  - Virtual Outlet Example
    * For the 4 hours between 7:01am and 11:00am, the heater will remain on in the specified tank while the temp probe reads 16.9 or below

#_morning
Control type: Advanced
Fallback OFF
Set OFF
If Time 07:01 to 11:00 Then ON
If Tmp-# > 17.0 Then OFF
#_midday
Fallback OFF
Set OFF
If Time 11:01 to 15:00 Then ON
If Tmp-# > 18.5 Then OFF
#_afternoon
Fallback OFF
Set OFF
If Time 15:01 to 18:00 Then ON
If Tmp-# > 17.0 Then OFF
#_night
Fallback OFF
Set OFF
If Time 18:01 to 07:00 Then ON
If Tmp-# > 15.5 Then OFF

- Advanced Program Example
  - For each time block specified in each unique Virtual Outlet, the temperature setpoint changes, and each of the time blocks has a unique virtual outlet name, as presented below in the four programming lines. The heater will turn on only when the conditions of the virtual outlet program are met

Fallback OFF
Set OFF
If Output 1_morning = ON Then ON
If Output 1_midday = ON Then ON
If Output 1_afternoon = ON Then ON
If Output 1_night = ON Then ON

Refer to Comprehensive Manual for set point programming.

Chapter 10

Apex Programming Guide

Recommendations for programming the Apex aquarium controllers designated for the Silbiger Lab Mesocosm, located in the loading bay between Citrus Hall and Eucalyptus Hall at California State University, Northridge. These recommendations are for maintaining tanks at ambient conditions. Changes should be made according to your study aims.

The following are using the numbered system of Apex1_39106, controlling tanks 1-4. All methods are transferrable across all 5 Apex controllers to yield the same outcome in all 20 tanks, or change programs for varied results.

Contents
- **Accessing the Programming Edit Screen in Apex**
- **Probes**
- **Modules, Outlets, and Ports**
- **Programming Outlets and Outlet Setup in ApexFusion**
- **Profiles**

For some quick tutorials on advanced programming in Fusion, check out Neptune Systems' Control Freak page.

Accessing the Programming Edit Screen

1. From the ApexFusion Dashboard, select the Expand icon (gears) from the top toolbar to provide more options.
    - Outputs: grants access to the page controlling all outlets and connected items that are programmable by the apex
    - Profiles: create a scenario that can occur if some condition is met for an Output program (see example with the Lights below)
    - Modules: to update, rename, or set units for a module connected to the Apex

- Inputs: to calibrate, rename, or set units for any probes and other inputs providing data to the Apex
- Misc Setup: to restart the apex or set the frequency of data logging
- Network Setup: to manually configure network settings or check current network settings

2. The most utilized option above is often Outputs, where you can program anything plugged into the Apex. Select this icon.
3. You can either select an output already configured to program that outlet, or create a "Virtual Outlet", which, similar to profiles, allows you to program a particular condition that if true, can trigger some other action in the program of a "real" Output.
    - When using a Virtual Outlet in programming a "real" Output, select Advanced prgoramming and use the folling line as an example: If Output your_output_name = ON Then ON
4. For all other Outputs, you can use the drop down menu to select the type of item you're programming for a fill-in style program option, or select Advanced to create your own program.
    - Examples of Advanced programming for different types of Outputs are below and in the controlling_pH guide.

Probes

- Salt-1 (Base)
- TMP-1 (Base)
- PH-1 (Base)
- TMP-2 (PM1_2)
- PH-2 (PM1_2)
- TMP-3 (PM1_3)
- PH-3 (PM1_3)
- TMP-4 (PM1_4)
- PH-4 (PM1_4)

Modules, Outlets, and Ports

- Base Unit Variables
- WHITE-TNK-1
- BLUE-TNK-1
- WHITE-TNK-2
- BLUE-TNK-2
- Base Unit Alarms

- SndAlm_I6
- SndWrn_I7

- EmailAlm_I5
- EB832_1
- HEATER-1
- PWRHD-1
- SOL-TNK-1
- LIGHT-TNK-1
- HEATER-3
- PWRHD-3
- SOL-TNK-3
- LIGHT-TNK-3
- PH-TNK-1
- PH-TNK-3
- EB832_2
- HEATER-2
- PWRHD-2
- SOL-TNK-2
- LIGHT-TNK-2
- HEATER-4
- PWRHD-4
- SOL-TNK-4
- LIGHT-TNK-4
- PH-TNK-2
- PH-TNK-4
- VDM
- WHITE-TNK-3
- BLUE-TNK-3
- WHITE-TNK-4
- BLUE-TNK-4
- BluLED_11_5
- WhtLED_11_6
- FMM_1
- S1-FLW
- N1-FLW
- D1-FLW
- FMM_2
- S2-FLW
- N2-FLW
- D2-FLW
- FMM_3
- S3-FLW
- N3-FLW
- D3-FLW
- FMM_4
- S4-FLW
- N4-FLW
- D4-FLW

Programming Outlets and Outlet Setup in ApexFusion
All configurations are for Control Type: Advanced

- HEATER-#
- Fallback OFF
  Set OFF
  If Tmp-# < 17.0 Then ON

- PWRHD-#
- Fallback ON
  Set ON

- Alternative program is to set Control Type: Always

- SOL-TNK-#
- Fallback ON
  OSC 000:00/375:00/375:00 Then ON (for tidal oscillations)

- Log Enabled

- LIGHT-TNK-#
- Fallback OFF
  Set OFF
  If Sun 0/0 Then ON
  If Moon 0/0 Then ON
  If Tmp-# > 35.0 Then OFF
  Min Time 030:00 Then OFF

- Log Enabled

- PH-TNK-#
- Fallback OFF
  Set OFF
  If pH-1 > 8.10 Then ON (for more specific examples, see controlling_pH)

- Log Enabled

- WHITE-TNK-#
- Fallback OFF
  Set OFF
  If Sun 0/0 Then RampUp

- BLUE-TNK-#
- Fallback OFF
  Set OFF
  If Moon 0/0 Then Blue

- WhtLED_#
- Fallback OFF
  Set OFF
  If Sun 0/0 Then RampUp

- BluLED_#
- Fallback OFF
  Set OFF
  If Moon 0/0 Then Blue

Profiles

- RampUp:
- Type: Ramp
- Ramp Time: 30 min
- Start Intensity: 0
- End Intensity: 100
- Blue:
- Type: Ramp
- Ramp Time: 30 min
- Start Intensity: 0
- End Intensity: 100

Chapter 11

Apex Fusion

To access the Silbiger Lab Fusion account, go to ApexFusion.com, click "Get Control" and enter the login information:
[Please request Login Information upon use of the Silbiger Lab Mesocosm System]

Contents
- **Dashboard Display**
- **Module Setup**
- **Outlet Setup**
- **Downloading Data Logs**
- **Update System**

For some quick tutorials on advanced programming in Fusion, check out Neptune Systems' Control Freak page.

Dashboard Display

- Left column displays the current system time, Reminders, and Temperature and pH trending line graphs for each tank.
- Middle and right columns display the Watt, Amp, and Volt readings for each EB832, the state of each outlet (OFF, AUTO, or ON), and the flowmeter readouts for the N-valve (continuous inflow), S-valve (controllable inflow) and D-valve (outflow) for each tank.
- You can manually control the state of the outlet by moving the slide bar to either OFF or ON. To let the program settings control the outlet state, move the slide bar to AUTO.
- Adjusting the Solenoid status bar to OFF will stop flow from the S-valve, while adjusting the status to ON will open flow from the S-valve. Adjusting the status to AUTO will allow your program to control when the Solenoid opens and closes.

- To modify the dashboard (add, remove, or reorganize items), click the padlock icon in the upper right-hand corner then click and drag a tile to move it or click the "x" to store it in the upper tile bank.

Module Setup

1. Expand the Options menu and select the Modules icon to view all modules.
2. Click any module to view a summary of its connection and software status, rename the module, or perform an action with that module (Configure, Update Software, or Delete).

Outlet Setup

1. Click the Outlets icon in the upper left-hand options bar.
2. Outlets are arranged by the name you give them, the module they're associated with, the type of output, and whether or not you have chosen to log activity.
3. Select an outlet to modify its name, display symbol, and program settings.
    1. To use a program template, use the "Control Type" dropdown menu to select which item you intend to use in this outlet location, then fill in the required information to control the outlet state.
    2. To write your own program, select Advanced from the dropdown menu, and write your progrm in the source code box that appears.
4. Once you've completed your settings and program, click the orange cloud icon in the upper right to send your new settings to the Apex.

Downloading Data Logs

When connected to the same network as the Apex units, you can download data logs for the systems following the directions below.
Note To connect to the same network, you must plug your device into one of the live ethernet cables in the Mesocosm.

General Format for your internet browser URL (see specifics below):
http://:/cgi-bin/datalog.xml?sdate=yymmddhhmm&days=n
* The datalog provides data from all logged outputs (probe readings and outlet energy consumption) for the set logging interval http://:/cgi-bin/outlog.xml?sdate=yymmddhhmm&days=n
* The outlog provides information for when logged outlets or alarms turn ON or OFF

- Accessible logs:
- Datalog – records probe value snapshots (Temp, pH, ORP, etc.) based on the logging interval you define (default = 20 minutes). You can change the interval via the Display module under Data Log – Log Interval. A new log is started daily at midnight. Log is named "yymmdd.pdat".

- Outlog – every time the Apex changes the state of an outlet a record is written to this log. If no outlet ever changed state you would have zero records in this log. A new log is started daily at midnight. Log is named "yymmdd.odat".

Examples of what to enter into your internet browser:
http://172.24.113.25/cgi-bin/datalog.xml?sdate=191005
http://172.24.113.25/cgi-bin/datalog.xml?sdate=191005&days=7

- The value after date= is the start date for when you want logged information, and days=n yields data n days after that start date.
- Hours and Minutes are optional in the date parameter.

1. Following the above format, enter the unique IP address for the Apex containing the logs you want to access.
    1. Apex_1 (SN 39106): 172.24.113.25
       Apex_2 (SN 40216): 172.24.113.22
       Apex_3 (SN 39952): 172.24.113.23
       Apex_4 (SN 37810): 172.24.113.21
       Apex_5 (SN 41239): 172.24.113.24

2. Import Log Data (Windows/PC)
    1. Open a new Excel file and go to the Data tab
    2. Select From Web in the Get External Data box
    3. A New Web Query dialog box will open. Type or copy the url from your browser into the data source Address field. Click Import.
    4. Your XML data should be imported into your empty spreadsheet and automatic filters created for each column making it easy to select and analyze data.
3. Import Log Data (Mac)
    1. Open the web browser for the apex data you want to downlaod
    2. Wait for the page to fully load (the top line of the page will read "This XML file does not appear to have any style information associated with it. The documnet tree is shown below.")
    3. Right click somewhere on the webpage and click Save As.
    4. Save your file in an accesible location or in your R workspace with a name identifying the apex unit and date.
        1. Manually type .csv to save the file as a csv instead of an xml file.
        2. Ex. datalog_apex1_200804d3.csv identifies Apex_1, the saved data starts on 08-04-2020, and the data is saved through 3 days after the start date (through 08-07-2020).
    5. Refer to Mesocosm_Environmental_Data/Datalog_Data_Tidy.R for a guide to clean up the data into a usable format.

Update System

1. From the Apex List menu
    1. If the orange icon next to the apex name shows an upward facing arrow in a circle, click that icon and select “Update Available” from the dropdown menu.
    2. The popup window will display the current AOS version and the most recent AOS version available for the system. If the popup says “it’s recommended that you update”, then make sure the Apex is connected via ethernet cable and click “Update”.
2. From the Dashboard Display
    1. Click the down arrow next to the apex name in the upper left corner and select “Network” from the dropdown menu.
    2. Under “Apex Operating System” you can view the installed AOS and Available AOS. If the installed version is out of date, there will be an orange bar next to “AOS Update” reccommending you “Update AOS”. Click the bar, then make sure your Apex is connected via ethernet cable and click “Update”.
3. Once the system has completed the update, go to your Modules page. If any modules need to be updated (under “Status” there will be an error icon rather than a check mark), click that module and change the Configuration Action to “Update Software” then click the orange cloud icon.

Chapter 12

Breaker Box Connections

Following switches from top-down, then left-right:

1,3: Main Disconnect
5,7: Air Conditioner
9,11: Condenser (Chiller, Filtration)
2: General Power (Lights and Outlet Box #1)
4: Outlet Box #2 (Tanks 17-20)
6: Outlet Box #3 (Tanks 13-16)
8: Outlet Box #4 (Tanks 9-12)
10: Outlet Box #5 (Tanks 5-8)
12: Outlet Box #6 (Tanks 1-4, outdoor sump pump)

Powering the container:

1. Turn on (flip left to right) the Main Disconnect switches. Once powered, the remaining switches will supply power to their individual breakers.
2. Turn on (flip right to left) the General Power switch. Once powered, the light switch to the right of the entrance will turn on/off the overhead light, the O2 sensor above the light switch will be activated, and all outlets in Outlet Box #1 will be active.
3. Turn on (flip left to right) the Air Conditioner switches. Once powered, the A/C unit can be controlled via remote control or the front display panel on the unit.
4. Switches 4, 6, 8, 10, and 12 all correspond to outlet boxes lining the upper perimeter of the container. Each box is used to power up to two (2) Apex units and enough modules and other devices for up to four (4) tanks. Each outlet covering has a number corresponding to the labeling for these switches. To turn any or all on, flip the switch(es) right to left.
5. Leave the Condenser switches (9 and 11) in the "off" position unless the chiller and filtration system become connected

Chapter 13

Troubleshooting Guide

Contents
- **Loss of Power to the Sump/Tripped Breaker**
- **Flowmeter Misreadings**
- **Rebooting the Apex**
- **Sump Pump Malfunction**
- **Turning off Sump flow**
- **Light not responding to program**
- **pH probe malfunction**
- **pH spikes**

Loss of Power to the Sump/Tripped Breaker

1. Breaker tripped in the field room (pump, UV filter, CO2 scrubber all off)
    1. If you just plugged in an item that correlated with the power shutting off, unplug that item. It may have tripped the breaker.
        1. Check for other items plugged into EDP C-4 outlets that shouldn't be plugged in or seem out of place. Alert PPM of anything that shouldn't be plugged into those outlets (e.g. CSUN golf carts).
    2. Make sure it's a tripped breaker and not the GFI outlet needing to be reset.
        1. On the West wall inside the Field Room, just to the right of the secondary sump, there is a quadplex (4-plug outlet) that has a Reset button. Push that button until you hear a click. If you hear the click but the power is not restored, then follow the next steps.
        2. This GFI outlet is also connected to the quadplex down by the sump on the South wall, so all 8 outlets are controlled by the GFI and could initiate the need for a Reset.

3. Call PPM (818-677- ext. 2222) and let them know a breaker tripped at Citrus Hall in outside room 3114 - the room next to the Mechanics Room on the outside and South side of Citrus Hall.
4. When PPM arrives, let them know the breaker box is on the 3rd floor of Citrus in Room 3303 and the switch is for EDP C-4

Sump Pump Malfunction and Turning off flow to the Mesocosm Tanks

1. If the sump pump (the outside underground pump between the Mesocosm container and the Field Room) stops pumping water to the sump, it will overflow out onto the concrete and into the loading bay driveway.
2. If you notice the pump has malfunctioned, do the following:
    1. Check if the GFI outlet on the outside of the Mesocosm container needs to be reset. On the 2-plut outlet, there is a Reset button. Push that button until you hear a click. If you hear the click but the pump does not respond (or you see the light at the bottom right corner of the outlet flash red), then follow the next steps.
    2. Turn off flow to the Mesocosm tanks
        1. There is a **T-valve** located along PVC which goes from the chiller to outside the Field Room. Turn this T-valve **clockwise** so it sits perpendicular to the PVC, closing off flow from the sump to the mesocosm, but retaining circulating flow within the sump.
        2. The T-valve is in line with a PVC pipe running parallel to the sump, slightly above and to the side of the blue and black biofilter mesh.

Turning off Sump Flow

1. If a situation arises where you need to shut off the recirculating flow of the entire system, unplug the UV light from the South wall quadplex, then unplug the pump from the same quadplex.
2. If you would like to also turn off the CO2 scrubber, unplug both air pump plugs from the same South wall quadplex.

Flowmeter Misreadings

1. Flowmeter on ApexFusion is reading 0 or some incorrect value
2. Sometimes the flowmeters (FM) inline with water flow will either have a bubble or some debris affecting the spin of the turbine within the FM.
    1. Make sure to check the flowmeter connections back at the FMM module for a connection issue. Unplug and plug back in the cable for the FM in question.

    2. Try clearing bubbles. If gently tapping the FM doesn't resolve the issue, you may have to remove the FM to clear it out.

3. Removing the FM for cleaning

    1. Turn off flow to the Mesocosm Tanks and wait 15-20 minutes to ensure there is no flow to the tanks.
    2. Unscrew the FM at both of its compression fittings until the fittings are loose on the tubing, then pull gently at the tubings to remove them from the FMM (if the compression fitting is all the way unscrewed, but the tube isn't coming out of the FMM, pull a little harder beacuse sometimes the tubing just gets stuck in the FM).
    3. Visually expect the inside of the FM, and if needed, use a small long object to probe and spin the internal turbine to dislodge any debris.

Rebooting the Apex

1. If the Apex needs to be restarted for any reason, there are multiple ways to reboot the system.
2. Apex Fusion

    1. Click the Expand Settings gears icon and go to the Misc page (wrench icon).
    2. Under Power, check the box for Reboot: Restart Apex, then click the orange cloud in the upper right corner to send this command to Apex. Wait a few minutes for the devices to come back online.

3. Restart Button

    1. Under the Apex Base Unit, above the pH port, there is a small hole encasing the Restart button.
    2. Insert a push pin or small object until you feel the button press down and hold about 10 seconds.
    3. If you require a full system reboot back to factory settings, hold this button for 1 minute. This will erase all modules, programming, log data, and probe calibrations, so be very sure.

Light not responding to program

1. Sometimes manually turning the light OFF on Apex, then back ON again, the light will function properly.
2. If a light doesn't turn on when the program indicates it should be ON, go into Programming settings for Light-TNK-#, adjust the advanced program slightly (e.g. change an "ON" to an "OFF") and click the orange cloud to send to the Apex. Then change the program back to what it was before you made a change, then see if the light resumes its proper program.

3. If the light still doesn't turn on, try rebooting the apex.

pH Probe Malfunction

1. If a pH probe is giving an 'off' reading, first calibrate the probe.
    1. On your Fusion dashboard, click the gear symbol to the right of the pH reading to go to its settings.
    2. Select Automatic Calibration, and follow the instructions, using new packets of 7 and 10 calibration solution.
    3. When placing the probe into the calibration solution, swirl the probe in the solution a little before starting the reading.
2. If the reading is still off, go back into the pH probe's settings on Fusion and select Advanced to do a Manual Calibration.
    1. Make sure Temp Compensate is Disabled then select Manual Calibration, and follow the instructions.
    2. When placing the probe into the calibration solution, swirl the probe in the solution a little before starting the reading. Let the probe sit in the calibration solutions for about 5 minutes (or longer as necessary) to ensure a stable reading.
3. If the reading is still off after both the Automatic and Manual Calibrations, try a Factory Reset.
    1. Go back into the pH probe's settings on Fusion and select and select Advanced.
    2. Select Manual Calibration again, but this time just click "Next" through the steps quickly. Don't let the numbers settle. Then click "Finish". If the numbers for the 7 and 10 calibrations are the same, the probe calibration will be wiped and reset, ready for a new calibration.
    3. From the Apex's "Misc" settings, check the box for Reboot: Restart, and click the orange cloud to send this command to the Apex. Wait for the Apex to fully reboot.
    4. Run through the Manual Calibration steps again.
4. If after following the above steps, the pH probe is still malfunctioning, call Neptune Systems for support.

pH Spikes

1. If you noticed the pH in your take plummetting down when the CO2 solenoid is actively dosing.
    1. It is likely that the fine tuning needle valve on the tank's CO2 solenoid needs to be closed a little more (turned slightly clockwise) to bring the flow of CO2 out of the air stone bubbler down.

2. If the flow is too high, this could cause rapid changes in pH in your tank before the probe can even detect the change.
3. By the time the probe detects the change and turns off the bubbler, plus with a slight residual time between the solenoid closing and the remaining CO2 gas being emitted from the bubbler, the pH may have dropped lower than desired.
4. Turn the CO2 flow down using the large nob on the solenoid's needle valve so that you see a gentle stream of bubbles slowly coming from the bubbler.
5. The CO2 solenoid is connected to the tank's bubbler tubing. It is a white box with the Neptune Systems logo and an arrow indicating flow direction. Connecting the tubing and the white box is a metal needle valve. The end knob of that needle valve can be turned slightly for fine tuning gas flow.