



# Recirculating Aquaculture Systems as Safe Haven for Wild Fish Populations in Peril from Drought



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## CDFW has used partial recirculating aquaculture systems for several decades

- Midpond aeration towers
- Partial recirc and makeup water
- UV sterilization

## CDFW has used some circular tanks

- Holding adult anadromous fish
- Swim up and fry stages
- Production of some spp. (Lahontan cutthroat trout, Pilot Peak strain)



Years of unprecedented drought in CA = need for RAS



# 13/14 Driest Water Year in CA

Winters of 11/12, 12/13, 13/14, 14/15 all warm and dry  
15/16?

Effects on salmonid husbandry and wild fish survival

- Depopulated trout hatcheries
- MAI for anadromous egg incubation
- Self-contained RAS for drought safe haven
  - Listed fish spp. in peril from drought
  - Other populations of concern
- Major infrastructure at several hatcheries

U.S. Drought Monitor  
California





# Self-contained RAS (drought safe haven)

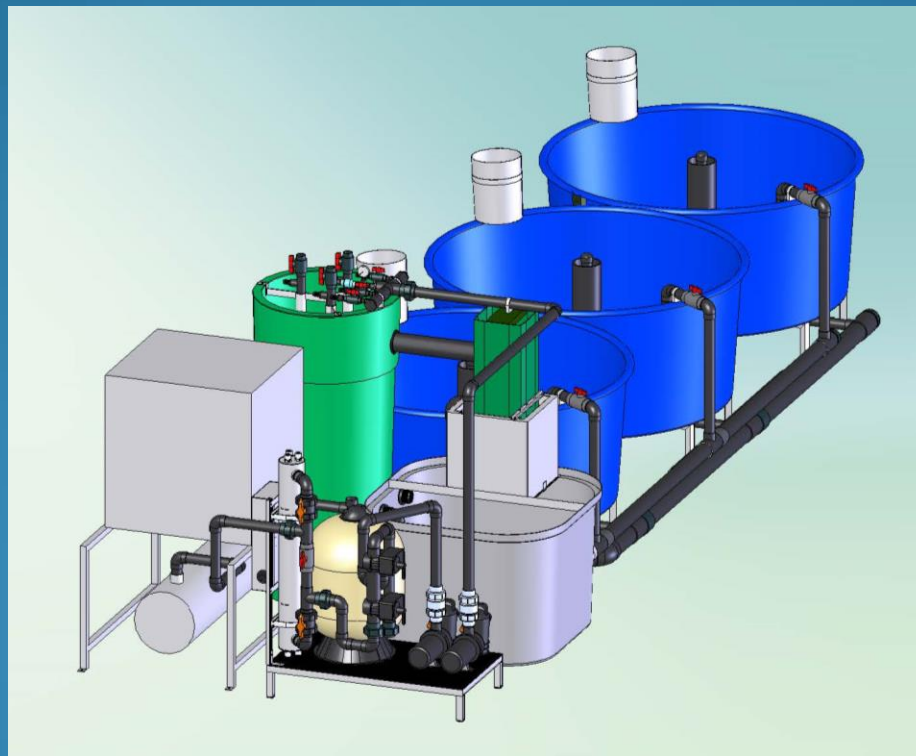
Preliminary idea from web

Modified and expanded by CDFW, put out for bid (3)

- Aquaneering (San Diego)

Designed, procured, delivered and set up in ~4 months

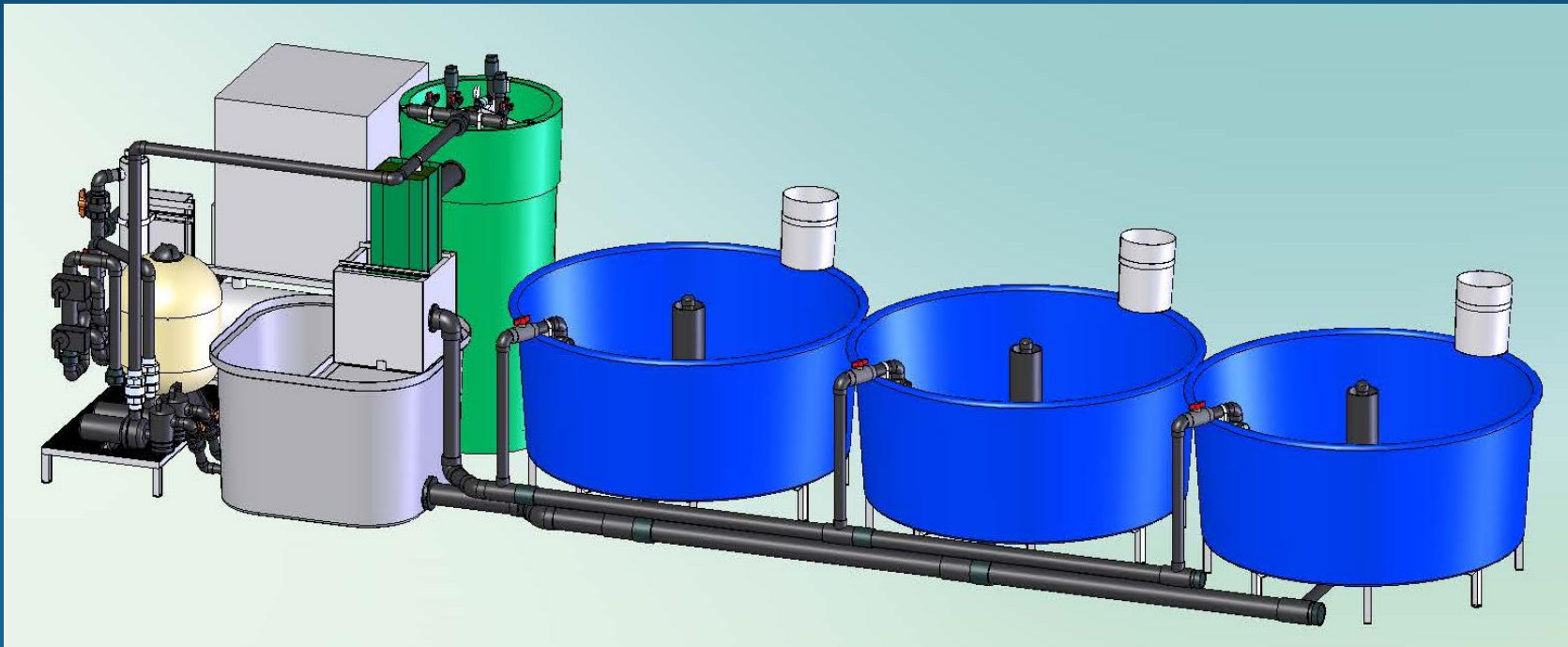
Simple, inexpensive, effective







# RAS (Drought Safe Haven)



Description of Units

Cost + Infrastructure

Wild fish: Pathology and AIS

- Secondary UV

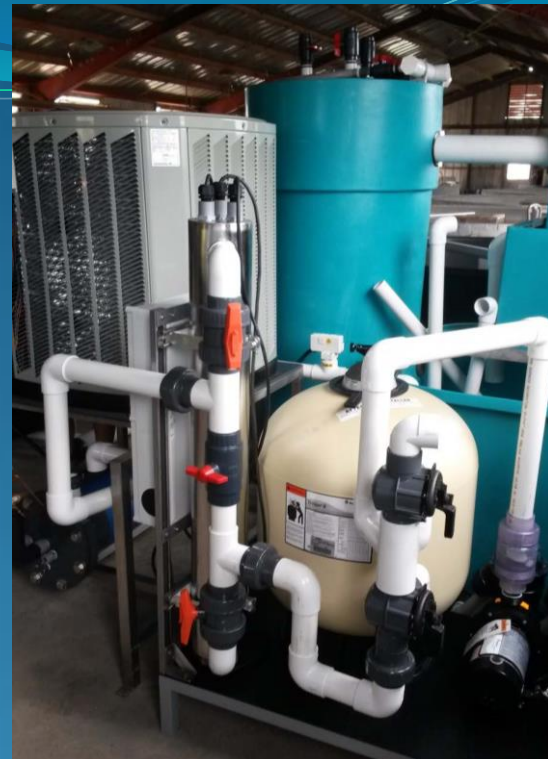
Populating Bioreactors

- Several weeks, Bactapure, feed (bad), and  $\text{NH}_4\text{Cl}$  (good), seeding (if ok)
- Water quality testing and  $\text{NH}_3$  spike, TAN



## 10 Units in 2014

4 at Fillmore (So CA SH, maybe others)  
2 at Mojave River (So CA SH, maybe others)  
2 at Merced River (CV SH)  
1 at Mt Shasta (McCloud River redband)  
1 at Iron Gate (Klamath- SONCC coho)





## Rescued fish in 2014

Permitting acquired

Backup power and pumps, flow switches, flow through (emergency)

Pathology and AIS completed

Oxytet Bath before introduction to RAS

- No rescues in So CA (!?)
- Merced River: 68 CV SH, some morts from capture, 2 in system = 56 on hand
  - Release as conditions improve
- Mt Shasta: 1,017 redband (3 drainages & life stages)
  - Sexual mature in captivity- spawned
- Iron Gate: 4,100 SONCC coho, 68 columnaris, 390 tagged, 4,032 released

Maintenance diet (~1% weight/d, more for fry)

Water quality monitoring ongoing





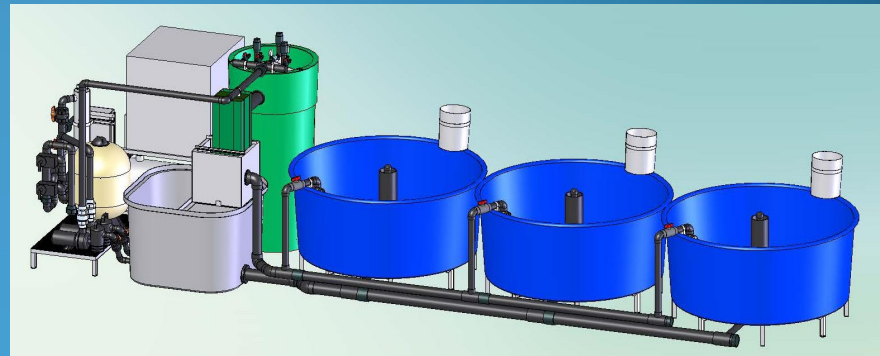


## 8 more units in 2015

- American River - 3
- Kern River- 1
- Silverado - 2
- Mt Shasta- 2

### Improved design/bells and whistles

- Isolate tanks and sump (gate and ball valves)
- Spray bars
- Belt feeders (no electrical)
- Increased gas exchange (larger and after chiller)
- External standpipes
- Leveling stands with tabs to center tanks
- Tank insulation







# American River Trout Hatchery

- Lahontan Cutthroat Trout- Independence Strain
  - Heenan Lake ~7,000 ft elev



Hatchery ~150 ft elev, water from Sierra

- Water quality (temp) affecting hatching and production
- Drought: project need and funding





# American River Trout Hatchery

## Major project:

- Supply New Hatchery Building with filtered, UV, chilled water





# American River Trout Hatchery

## Primary Project Components:

- Micro-filtration
  - 1,800 gpm
  - 43 microns







# American River Trout Hatchery

## Primary Project Components:

- UV disinfection
  - 1,800 gpm
  - 318,000  $\mu\text{Wsec}/\text{cm}^2$
  - 318  $\text{mJ}/\text{cm}^2$







# American River Trout Hatchery

## Primary Project Components:

- Chilling
  - $\Delta T = 10^{\circ} \text{ F}$  @ 900 gpm





# American River Trout Hatchery

## Primary Project Components:

- Round Fish Culture Tanks
  - 2 ea @ 15' diameter
  - Capacity ~ 6,000 gallons
  - Intended for chilled water LCT rearing

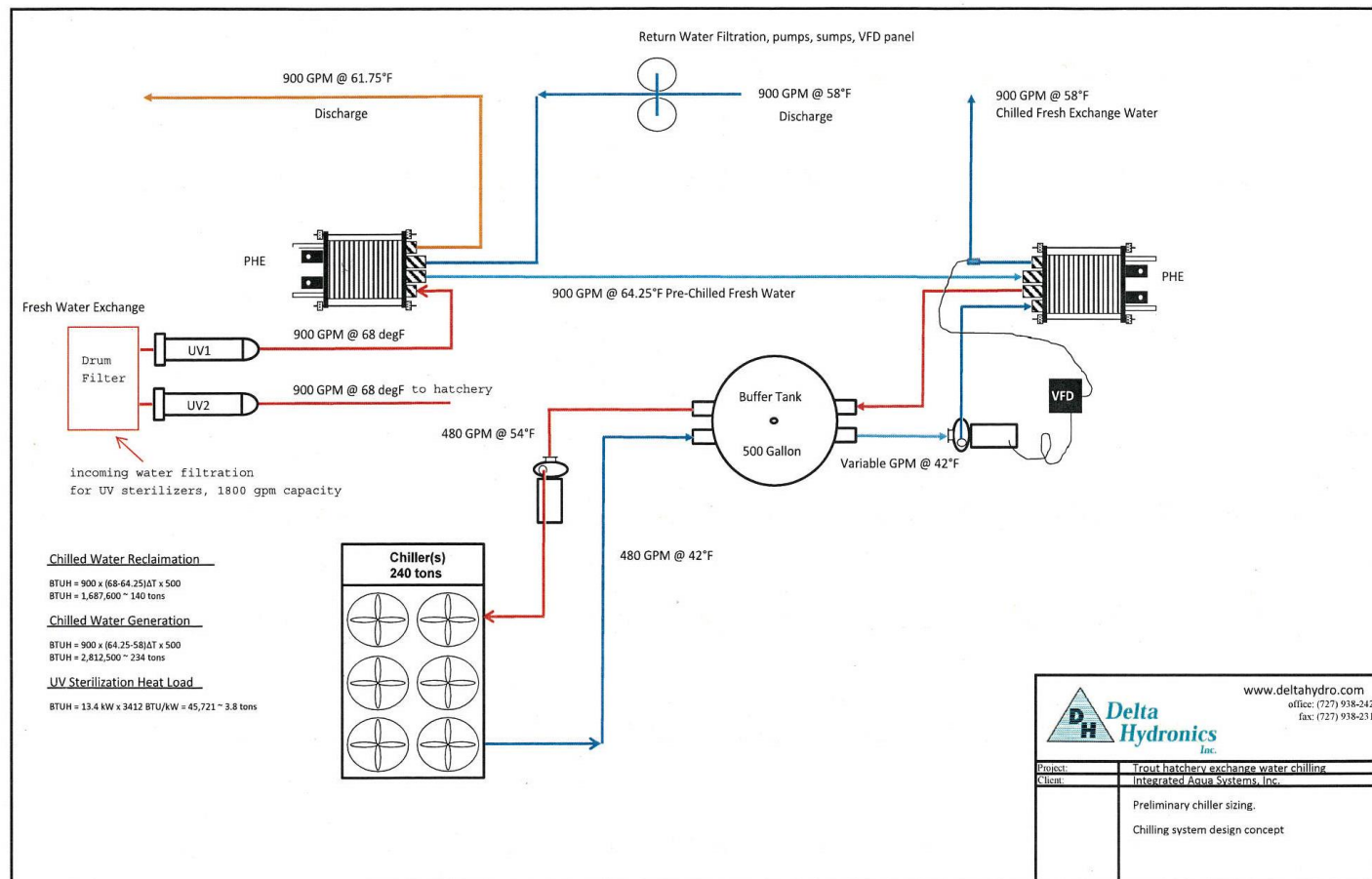




# American River Trout Hatchery

## Primary Project Components:

- Heat Exchanger







# American River Trout Hatchery

## Ancillary Components:

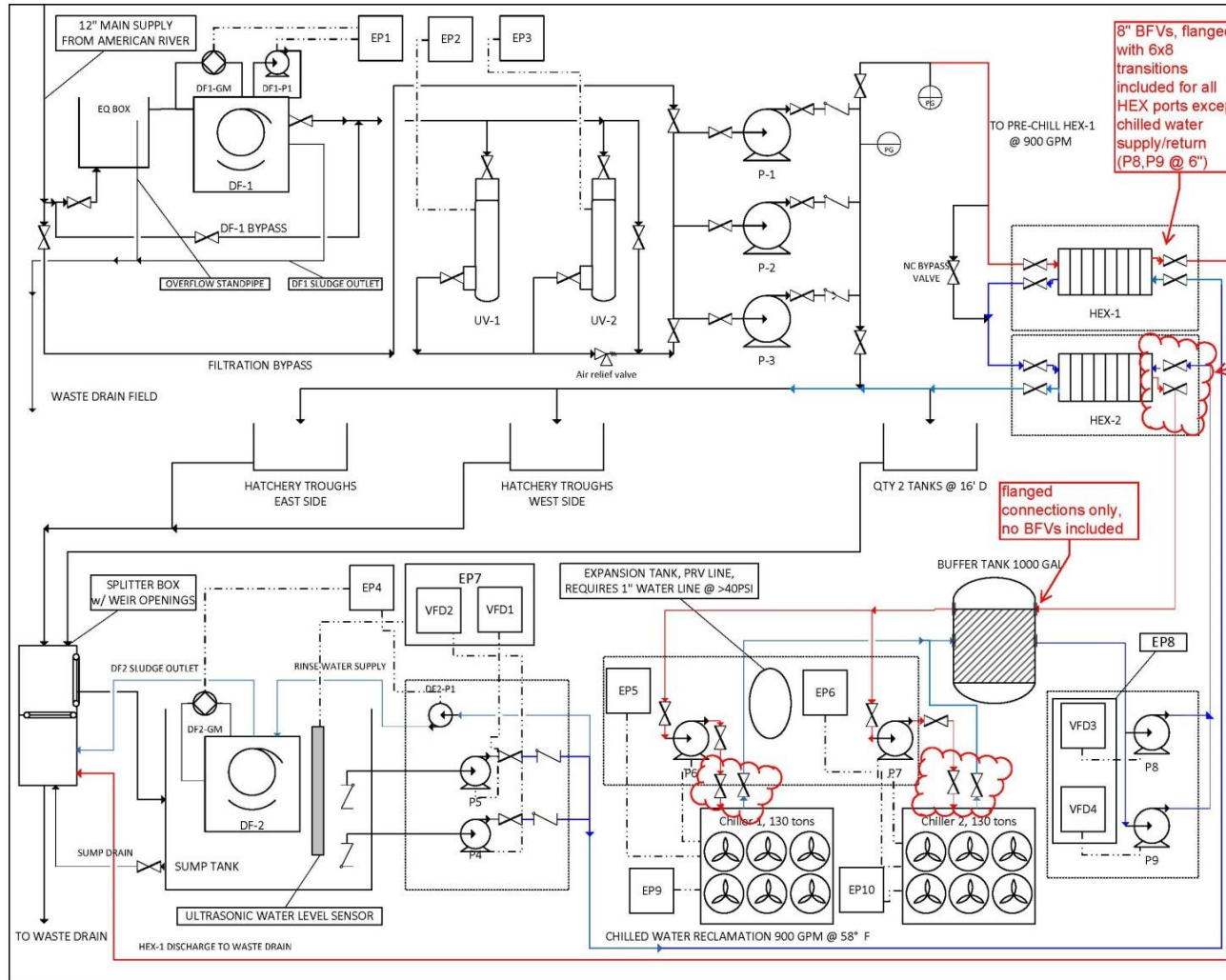
- New electrical service and transformer
- Add Back-up booster pump
- 400 gpm pump house for water supply to Regional HQ
- Overflow drain to settling pond
- Splitter box/drum screen for effluent heat recovery
- Valves and plumbing to optimize operational flexibility
- Concrete etc.







# American River Trout Hatchery



## PROJECT/MODEL

CA Department Fish & Wildlife  
American River Trout Hatchery Project

REV.	DESCRIPTION	DATE	BY
1	Split chillers	9/11/14	SC
2	level sensor	9/11/14	SC
3	EP7, AirVent	9/16/14	SC
4	Dry vault rev	9/19/14	SC
5	DF1 rev	9/22/14	SC
6	Electrical rev	10/1/14	SC
7	Valve edit	11/3/14	SC

## NOTES:

sch80 PVC pipe/fittings used on chilled water supply/return. All other connections use sch40 PVC pipe/fittings. Recommend insulating cold water piping between chillers and HEX units.

## SYMBOL LIBRARY

	Air Relief Valve
	Float Operated Valve
	Pressure Gauge
	Flanged Butterfly Valve
	Check Valve
	Flow Control Valve or Weir
	UV Sterilizer
	Pump
	Drum Filter (Open Vessel)
	Plate & Frame Type Heat Exchanger

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DWG #:		ARTH P&ID-1	
DATE:		7/16/2014	SCALE: NTS
SIZE: B	SHEET: 1 OF 1	DRAWN: SC	



# American River Trout Hatchery

## Anticipated results

- Better hatching success
- Better survival
- Less therapeutics
- Better program in general



Lahontan Cutthroat Trout



## Major Infrastructure Projects at Anadromous Hatcheries due to Drought

- Iron Gate Hatchery
  - Macrolite Filtration, UV, re-plumbed entire Hatchery Building
- Merced River Hatchery
  - Drum filters, UV, some chilling and recirculation
- Nimbus Hatchery
  - Drum filters, UV, some chilling and recirculation





# American River Trout Hatchery

## Summary:

CA getting its feet wet with RAS

Other applications:

- Kern River rainbow trout
- Manipulating husbandry environment for broodstock
  - Temp, photo period, pathogens







# Questions?

