Climate Induced Hatchery Upgrades

Fish Springs Hatchery

Alternatives Analysis Submittal

Final Report
Revision No. 4

February 2025

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Revision Log

Revision No.	Date	Revision Description
0	4/26/2024	65% Draft Internal Technical Review
1	4/30/2024	65% Draft for CDFW Review
2	8/19/2024	100% Draft for CDFW and Internal Technical Review
3	10/31/2024	Final Submittal to CDFW
4	2/14/2025	Final Submittal to CDFW, ADA Accessible Document

Appendices

The appendices that accompany this document are not ADA compliant. For access to the following appendices, contact Fisheries@wildlife.ca.gov. If assistance is needed for an ADA compliant version of the appendices, please include that in the email.

- Appendix A. Site Visit Report
- Appendix B. Bioprogramming
- Appendix C. Concept Alternative Drawings
- Appendix D. Design Criteria TM
- Appendix E. Alternatives Development TM
- Appendix F. Cost Estimates
- Appendix G. Meeting Minutes
- Appendix H. LEED and ZNE Evaluations

Executive Summary

McMillen, Inc. (McMillen) was retained by the California Department of Fish and Wildlife (CDFW) to provide an assessment of 21 CDFW fish hatcheries throughout the State of California in the context of their vulnerability to the effects of climate change. Climate modeling was performed by Northwest Hydraulic Consultants (NHC).

Fish Springs Hatchery has an aging infrastructure and deficiencies that need to be addressed in the near future to meet and maintain fish production goals in the face of climate change. Los Angeles Department of Water and Power well deficiencies, the aeration tower distribution, aged plumbing, exposure to New Zealand Mud Snails (*Potamopyrgus antipodarum*) in the effluent pond, water treatment limitations, insufficient incubation and early rearing space, exposure to predation issues in the raceways, raceway deterioration, and a lack of a quarantine area for incoming eggs are all items that have been noted to hinder current production. The effects of which will magnify with climate change.

The preferred alternative for hatchery upgrades includes upgrading the existing well houses from diesel to propane generators, upgrading the alfalfa plate-style valves and piping, rebuilding the aeration tower, installing circular tanks with partial recirculating aquaculture systems (PRASs) in a fully enclosed building with solar panels, raceway upgrades, constructing a new hatchery building with solar panels for the Rainbow Trout Program, constructing a quarantine area for incoming eggs, adding a chiller to the existing hatchery building for Cutthroat Trout incubation, providing additional backup power generation, demolishing and removing the existing nursery raceways, and incorporating a bubbler system and flow measurement to the settling pond.

The Class 5 Opinion of Probable Construction Cost (OPCC) for constructing the preferred alternative upgrades can be found in the table below (Table 6-2 provides the Class 5 OPCC summary). The table also includes the estimated cost of photovoltaic systems to offset the energy consumption of the new equipment and to maintain zero net energy. These upgrades would not significantly affect fire or flood risks at the facility, and all work would occur within already-developed areas. Operationally, CDFW would need to update feeding, harvesting, and water quality monitoring protocols to accommodate the transition to partial recirculating aquaculture systems with circular tanks. The proposed upgrades would provide a solid foundation for CDFW to sustain fish production at the hatchery, even as climate change increasingly disrupts current and future operations.

Project Total (Maintain Production)	Project Total (Maximize Production - 18 cfs)	Photovoltaic – Zero Net Energy (Maintain Production)	Photovoltaic – Zero Net Energy (Maximize Production – 18 cfs)
$ 62,334,000	$ 99,207,000	$ 10,101,000	$ 16,187,000

1.0 Introduction

1.1 Project Authorization

McMillen, Inc. (McMillen) was retained by the California Department of Fish and Wildlife (CDFW) to provide a climate change evaluation for 21 hatcheries operated by CDFW throughout the State of California. The contract for this Climate Induced Hatchery Upgrade Project (Project) was executed on March 21, 2023.

1.2 Project Background

California relies on CDFW hatcheries to provide recreational fishing opportunities for the public and for the conservation of endangered or threatened species. However, climate change threatens the business-as-usual production of fish with the existing CDFW hatchery infrastructure. Climate change impacts have already affected many CDFW hatcheries, resulting in altered or inconsistent operation schedules, lowered production, and emergency fish evacuations. These climate impacts include increasing water and air temperatures, changes to groundwater availability, low flows and water shortages, increased flood and fire risks, and other second-hand impacts associated with each of these categories (i.e., emerging pathogens and non-infectious diseases, low adult salmon returns, decreased worker safety, etc.).

A total of 21 hatcheries were visited by McMillen to evaluate the existing infrastructure and fish production operations. During these visits, McMillen assessed the existing hatchery infrastructure deficiencies and replacement needs. The assessment was used to aid in determining the potential upgrades for each hatchery that would maintain the existing program production goals for the various species reared at each facility while providing conceptual alternatives for climate resilience. Climate change has had an impact worldwide and will continue to affect CDFW's statewide fish production operations. Developing technologies and methods to meet fishery conservation and sport fisheries is critical to CDFW's goal of maintaining hatchery productivity while conserving precious cold-water supplies for native species.

We have based our detailed work plan on achieving the following project objectives stated in the Request for Proposals (RFP). As presented in Sections 2 and 3 of our proposal, we have intentionally comprised our team of experts in all required disciplines with experience in fish husbandry and hatchery engineering and design to successfully meet all CDFW's project goals.

- **Objective 1:** Review the state of each facility via data collection, review of documents, site visits, and discussions with hatchery personnel. Identify climate change impacts that are likely to negatively impact operations at each hatchery over the next 40 years.
- **Objective 2:** Develop cost effective and programmatically viable alternatives that will maintain current fish propagation goals given climatic impacts in the future.
- **Objective 3:** Assess the risks of each alternative to natural biological systems, environmental conditions, husbandry techniques for fish health and fish safety, and potential impacts to water quality.
- **Objective 4:** Determine the short- and long-term economic costs for the modifications to each hatchery in current year dollars. Account for construction, permitting, design, operational, and maintenance costs within the overall economic analysis. Prioritize the list of alternatives and associated hatcheries based on limited annual hatchery budgets.
- **Objective 5, Phase 2 Work:** Provide complete designs with issued for construction drawings and specifications for projects at as many hatcheries as are feasible. The focus shall be on those hatcheries that are deemed most susceptible to negative climate change impacts identified from the evaluation above.

1.3 Project Purpose

The purpose of the Project is to determine the CDFW hatcheries and the existing infrastructure conditions that are most susceptible to reduced fish production attributable to climate change and provide a prioritization of the hatcheries for improvements. With input from CDFW, designs for climate change resiliency upgrades will be advanced for as many facilities as is feasible.

1.4 Project Location Description

The Fish Springs Hatchery is located in Big Pine, CA in the Eastern Sierra-Nevada Mountain Range approximately 21 miles south of Bishop. Figure 1-1 shows the Fish Springs Hatchery location map.

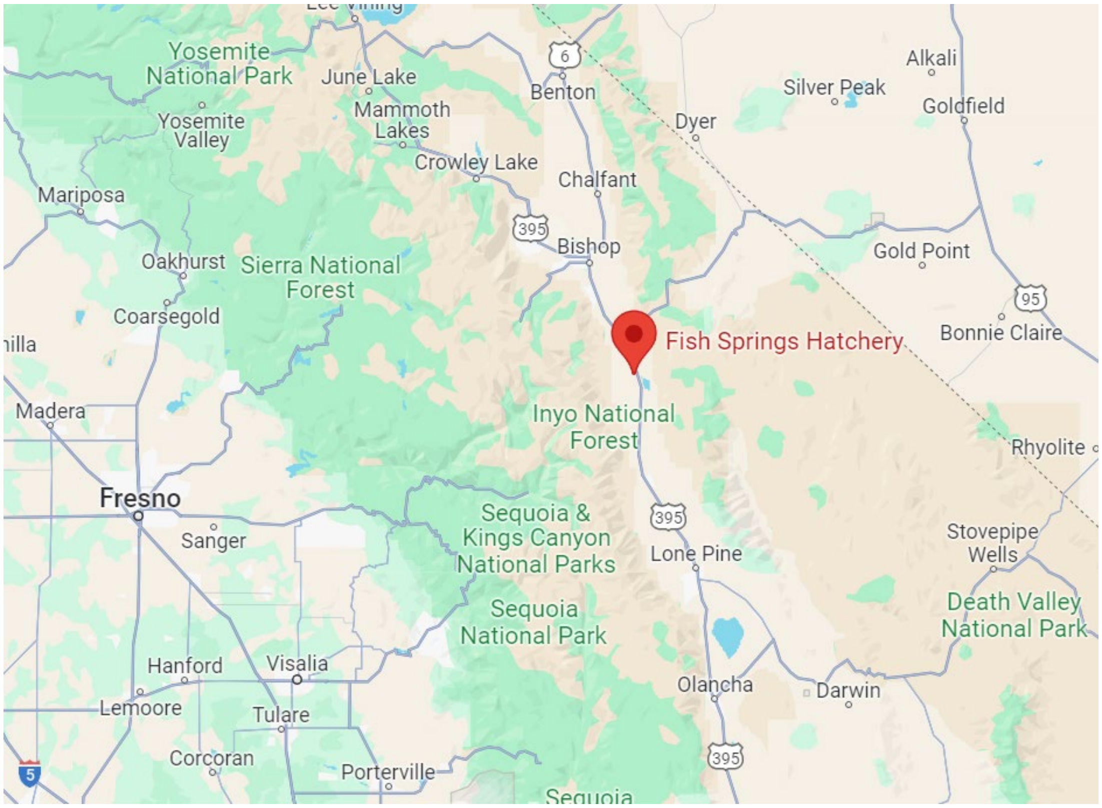

Figure 1-1. Fish Springs Hatchery Location Map.

The Fish Springs Hatchery was originally constructed in 1952 and reared fish in two earthen ponds. In 1972, the hatchery added six raceways, 1,000 feet in length to modernize the facility and to provide rearing space for the production of larger fish. In 2009, a hatchery building was constructed that included 20 deep troughs (troughs) providing egg incubation capability in upwelling jars and early rearing in the troughs. The Fish Springs Hatchery raises Rainbow Trout (*Oncorhynchus mykiss*), Brown Trout (*Salmo trutta*), and Lahontan Cutthroat Trout (*O. clarkii henshawi*) with a production goal of approximately 325,000 pounds of which 305,000 pounds comprise the Rainbow Trout Program. The hatchery utilizes pumped well water from two wells supplying water for all fish rearing activities. The wells are owned and operated by the Los Angeles Department of Water and Power (LADWP). The wells produce water with a constant temperature of 60°F year-round. The general facilities are shown in Figure 1-2. More detailed descriptions and photos of the Fish Springs Hatchery are described in the Site Visit Report (Appendix A).

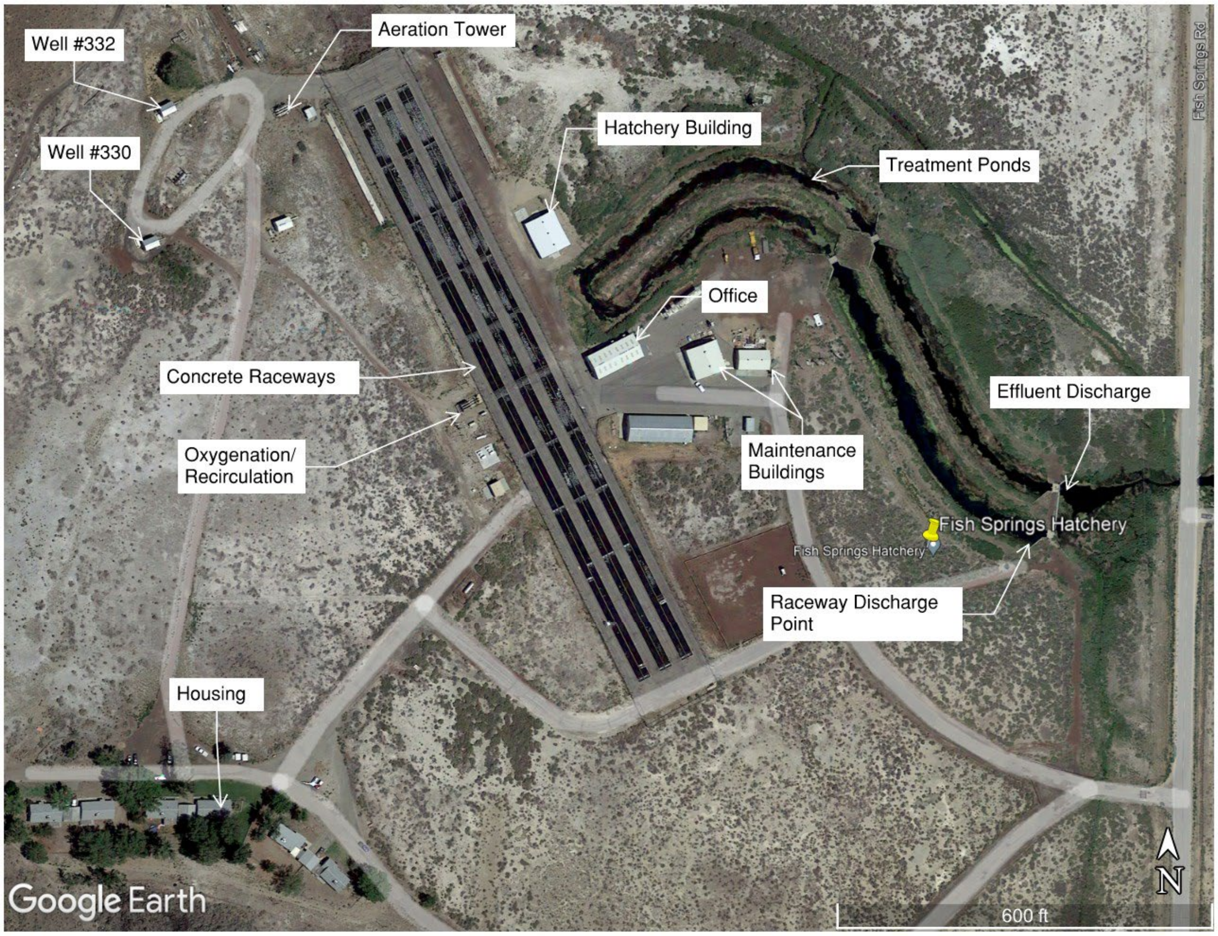

Figure 1-2. Fish Springs Hatchery Facility Layout.

2.0 Bioprogram

2.1 Production Goals and Existing Capacity

2.1.1 Inland Fisheries

California's hatchery production goal for inland trout is based on sport fishing licenses sold in the previous calendar year. This requirement sets a production goal for CDFW hatcheries to produce and release 2.75 pounds of trout per sport fishing license sold. The requirement stipulates that the majority of released fish be of a catchable size (2 fish per pound [fpp]) or larger and requires CDFW to achieve this goal in compliance with certain policies, including the Strategic Plan for Trout Management. Currently, CDFW achieves approximately 35% of the required production based on sport fishing license sales. CDFW is also required, to the extent possible, to establish and maintain native wild trout stocks and protect native aquatic and nonaquatic species. CDFW currently utilizes a trout triploid program (sterile trout) to avoid genetic impacts to native trout populations through the stocking program.

The Fish Springs Hatchery produces Rainbow Trout, Brown Trout, and Lahontan Cutthroat Trout. The Capacity Biological Program (Capacity Bioprogram) for the facility was developed for the Site Visit Report (Appendix A) and provides the total numbers of fish and biomass that can be produced for all rearing tanks based on tank volume, operational water flows, and size of the fish. The calculations utilize the density and flow indices previously identified for the preliminary bioprograms, which encompass water temperature and elevation criteria to ensure oxygen levels appropriately align with production (Piper 1982). This information is available in the Site Visit Report (Appendix A). The calculations include a 10% safety factor to provide a 90% maximum capacity based on both the density index (DI) and flow index (FI) requirements identified. The annual production goal at the Fish Springs Hatchery is approximately 325,000 pounds of fish of which 315,000 pounds are comprised of Rainbow Trout according to information provided by CDFW. The fish production rearing capacity determined by the Capacity Bioprogram is shown in Table 2-1, Table 2-2, and Table 2-3. The total goal for all species is 900,000 fish, which is 323,333 lbs. The following are the fish production goals for each species:

- Rainbow Trout: 2 fpp: 600,000 fish (300,000 lbs) 10 fpp: 140,000 fish (14,000 lbs)
- Brown Trout: 10 fpp: 80,000 fish (8,000 lbs)
- Lahontan Cutthroat Trout: 10 fpp: 80,000 fish (1,333 lbs)

Table 2-1. Production Capacity of Rainbow Trout Rearing Units at the Fish Springs Trout Hatchery per the Capacity Bioprogram (Appendix A).

Rearing Unit (max. fish size in fish per pound [fpp])	Total Capacity (Fish)[a]	Limiting Factor
Deep Tanks (500 fpp/1.7 inches)	390,456 (781 lbs)	Water Flow
Raceways (10 fpp/6.3 inches)	789,264 (78,926 lbs)	Water Flow
Raceways (2 fpp/10.8 inches)	270,604 (135,302 lbs)	Water Flow

a This is an estimate of 90% production capacity to allow for a buffer in circumstances where more flexibility is needed for hatchery operations.

Table 2-2. Production Capacity of Brown Trout Rearing Units at the Fish Springs Trout Hatchery per the Capacity Bioprogram (Appendix A).

Rearing Unit (max. fish size in fish per pound [fpp])	Total Capacity (Fish)[a]	Limiting Factor
Deep Tanks (200 fpp/2.3 inches)	202,197 (1,011 lbs)	Water Flow
Raceways (10 fpp/6.3 inches)	125,874 (12,587 lbs)	Water Flow

a This is an estimate of 90% production capacity to allow for a buffer in circumstances where more flexibility is needed for hatchery operations.

Table 2-3. Production Capacity of Lahontan Cutthroat Trout Rearing Units at the Fish Springs Trout Hatchery per the Capacity Bioprogram (Appendix A).

Rearing Unit (max. fish size in fish per pound [fpp])	Total Capacity (Fish)[a]	Limiting Factor
Deep Tanks (60 fpp/3.6 inches)	89,691 (1,495 lbs)	Rearing Volume

[a] This is an estimate of 90% production capacity to allow for a buffer in circumstances where more flexibility is needed for hatchery operations.

2.2 Bioprogram Summary

The Capacity Bioprogram in the Site Visit Report (Appendix A) demonstrates the total capacity of each rearing area at the Fish Springs Hatchery for several stages of fish production. The capacity of each rearing area (-10% to provide an additional safety factor), limited by water flow or available rearing volume, is shown in Table 2-1, Table 2-2, and Table 2-3. At a high level, the total capacity for the Fish Springs Hatchery falls short of the production goal (see Section 2.1.1); though, nuances of the timing of egg arrivals and fish stocking allows for annual production to exceed this total capacity. Details about the various rearing areas and infrastructure are discussed in the Site Visit Report, found in Appendix A.

In this current report, we developed an initial Production Bioprogram (Appendix B) to illustrate the potential maximum production that the facility is capable of while remaining within the limits set by the Capacity Bioprogram.

2.2.1 Criteria

The methods and reasoning used to determine the criteria associated with biological programming for the Fish Springs Hatchery can be found in Appendix A. For reference, the established criteria are shown in Table 2-4. To model the production cycle schedule for the Production Bioprogram, several assumptions are made and included in Table 2-5. Additional assumptions include the following:

- The ability of CDFW to have Rainbow Trout eggs available throughout the year by either purchasing eggs from private vendors or through CDFW’s own photoperiod programs.
- There will be optimal conditions for egg development and fish growth given the existing water temperatures at the facility.
- The mid-raceway aeration functions and restores oxygen to saturation for the fish being reared in the lower 500 feet of the raceways.

Klontz (1991) provides optimal growth rates (0.8 inches per month [Klontz] and from hatchery records) for Rainbow and Brown Trout at designated water temperatures, while growth rates for Lahontan Cutthroat Trout were provided by CDFW. Survival rates were provided in the questionnaire completed by Fish Springs Hatchery staff.

Table 2-4. Criteria Used for the Production Bioprogram. Criteria are Discussed in Detail in Appendix A.

Criteria	Value
Density Index (DI)	Rainbow and Brown Trout: 0.3[a] Cutthroat Trout: 0.3
Flow Index (FI)	Rainbow Trout: 1.16 Brown and Cutthroat Trout: 1.11
Water Temperature	Consistent 60°F

[a] Information from the questionnaire stated a DI of 0.5 for Rainbow and Brown Trout and a DI of 0.32 for Cutthroat Trout; McMillen has decreased this to 0.3 based on further discussions with CDFW.

Table 2-5. Assumptions Used for the Production Bioprogram.

Species	Survival
Rainbow Trout	Egg-to-fry: 70% Fry-to-juvenile (200 fpp): 75% Juvenile-to-outplant (2 fpp): 75%
Brown Trout	Egg-to-fry: 60% Fry-to-juvenile (60 fpp): 80% Juvenile-to-outplant (10 fpp): 85%
Lahontan Cutthroat Trout	Egg-to-fry: 50% Fry-to-juvenile (100 fpp): 72%

2.2.2 Production Bioprogram

This bioprogram (Appendix B) is meant to view hatchery operations at a high level and does not capture the nuances of the specific timing of fish transfers, grading, sorting, or stocking. The model is meant to show an example of how production may occur given the criteria and assumptions outlined in the previous section. This program includes Brown Trout, Lahontan Cutthroat Trout (Cutthroat) and the Production Rainbow Trout which for this exercise will include three groups (pulses) of Rainbow Trout. Rainbow Trout eggs are typically received from the Mount Shasta Hatchery as eyed eggs. The Rainbow Trout eggs are received at different times throughout the year for each pulse to maximize annual production at the Fish Springs Hatchery.

Brown Trout

The Brown Trout eggs arrive in early December. It takes approximately 20 days from receipt of eggs (i.e., eyed eggs) to first feeding using the hatchery's water temperature of 60°F. The fry are approximately 4,218 fpp (0.84 inches) at first feeding and are initially reared in the stainless-steel troughs (troughs). The Brown Trout can be reared in 10 troughs through February when they reach a size of 300-400 fpp (Table 2-6). The Brown Trout will be transferred into a 100-foot section of a single raceway and as they grow, they will occupy half of a 1,000-foot raceway. In this exercise, it is assumed that approximately 235,000 eggs are incubated, 196,000 fry are hatched from those eggs, and 117,647 juvenile fish are transferred to the troughs based on survival rates provided by Fish Springs Hatchery staff. The Brown Trout will remain in half of a raceway (one 500-foot section) until October when they reach their target sub-catchable size (10 fpp) yielding approximately 80,000 fish weighing 8,000 pounds.

Table 2-6. End of Month Production Information for the Brown Trout Bioprogram Including Realized DI and FI Values.

Production Stage/Month	Tank Type	Tanks Occupied	fpp	Length (in)	Total Fish (#)	Biomass (lbs)	Max. Flow (cfs)	DI	FI
Early Rearing Dec/Jan	SS Trough	10	930.0	1.40	117,647	126.5	0.5	0.13	0.41
Early Rearing Feb	SS Trough	10	340.0	1.90	111,986	329.4	0.5	0.24	0.79
Mar	Raceway	0.5	164.0	2.50	106,325	648.3	4.5	0.03	0.13
Apr	Raceway	0.5	90.0	3.00	100,664	1,118.5	4.5	0.04	0.19
May	Raceway	0.5	55.0	3.60	95,000	1,727.3	4.5	0.05	0.24
Jun	Raceway	0.5	36.0	4.10	92,000	2,555.6	4.5	0.07	0.31
Jul	Raceway	0.5	24.5	4.70	89,000	3,632.7	4.5	0.08	0.39
Aug	Raceway	0.5	17.7	5.20	86,000	4,858.8	4.5	0.10	0.47
Sep	Raceway	0.5	13.1	5.80	83,000	6,335.9	4.5	0.12	0.55
Oct	Raceway	0.5	10.0	6.30	80,000	8,000.0	4.5	0.14	0.63

Lahontan Cutthroat Trout

The Cutthroat eggs originate from lakeside spawning efforts at Heenan Lake, typically in April; however, there is variability in the timing depending on weather conditions. It takes approximately 40 days from fertilization (i.e., green eggs) to first feeding using the hatchery's water temperature of 60°F. The fry are approximately 4,218 fpp (0.84 inches) at first feeding and are initially reared in 10 troughs. The other 10 troughs are reserved for Pulse 2 Rainbow Trout group. Cutthroat are held in 10 tanks through the end of June, at this point the Rainbow Trout have been transferred to the raceways and the Cutthroat Trout are split into all 20 available troughs. The next groups of fish requiring the early rearing tanks are the Brown Trout and Pulse 3 Rainbow Trout in October. The Cutthroat are reared to 60 fpp (3.6 inches) which they achieve at the end of September (Table 2-7). In this exercise, approximately 225,000 eggs are received producing approximately 112,000 fry and eventually yielding approximately 80,000 Cutthroat weighing 1,333 pounds (60 fpp, 3.6 inches) available for stocking.

Table 2-7. End of Month Production Information for the Lahontan Cutthroat Trout Bioprogram Including Realized DI and FI Values.

Production Stage/Month	Tank Type	Tanks Occupied	fpp	Length (in)	Total Fish (#)	Biomass (lbs)	Max. Flow (cfs)	DI	FI
Apr	SS Trough	10	1,300.0	1.3	112,000	86.2	0.5	0.09	0.30
May	SS Trough	10	524.0	1.8	105,600	201.5	0.5	0.16	0.52
Jun	SS Trough	10	261.0	2.2	99,200	380.1	0.5	0.24	0.78
Jul	SS Trough	20	148.0	2.7	92,800	627.0	1.0	0.16	0.53
Aug	SS Trough	20	92.0	3.1	86,400	939.1	1.0	0.21	0.68
Sep	SS Trough	20	60.0	3.6	80,000	1,333.3	1.0	0.26	0.84

Production Rainbow Trout

The Rainbow Trout includes three separate groups (pulses) of eggs which are received at different times throughout the year. Since the water temperatures are constant throughout the year at 60°F, growth projections for these three pulses are the same. Pulses 1 and 3 have identical production numbers, survival and resulting biomass. Pulse 2 differs from Pulses 1 and 3 in timing and production numbers as this pulse must share early rearing space with Cutthroat during the same time period. Table 2-8 is representative of Pulses 1 and 3 and Table 2-9 is representative of Pulse 2. The specific timing and rearing areas used for Pulses 1, 2 and 3 is presented in Figure 2-1.

Eyed eggs are received in January for Pulse 1, in April for Pulse 2 and in September for Pulse 3. It takes approximately 20 days from receipt of eggs to first feeding using the hatchery's water temperature of 60°F. The fry are approximately 4,218 fpp (0.84 inches) at first feeding and are initially reared in the troughs. Initially, fish in Pulse 1 will share early rearing space with Brown Trout through the end of February. Once Brown Trout are transferred to raceways in February, Pulse 1 Rainbow Trout will occupy all early rearing tanks in the building.

Available early rearing space limits the number of Rainbow Trout transferred to raceways and the Rainbow Trout make up the largest numbers and biomass produced at the facility. Therefore, the young juveniles are typically transferred into the raceways at a size around 500 fpp (1.7 inches) to maximize the number of fish in production. Transfer to the raceways occurs around the end of March for Pulse 1, the end of June for Pulse 2 and the end of November for Pulse 3 (Table 2-8, Table 2-9). Initially, each pulse of fish will inhabit half of a raceway (one 500-foot section) and as the fish grow, they will require additional flow which will require the use of additional raceways. Pulses 1 and 3 will require three full 1,000-foot raceways as the fish approach the catchable size while Pulse 2 will require half of this space (i.e., 1.5 raceways) since less fish will be produced for this pulse of Rainbow Trout.

In this exercise for Pulses 1 and 3, it is assumed approximately 300,000 eyed eggs are incubated and 205,000 fry are reared to approximately 500 fpp in 20 troughs before being transferred into the raceways based on survival rates provided by the Fish Springs Hatchery staff. These fish will be reared in the raceways until they achieve their target size of 2 fpp in February (Pulse 1) and October (Pulse 3) yielding approximately 140,000 catchable Rainbow Trout per pulse. For Pulse 2, it is assumed approximately 150,000 eyed eggs are incubated and 110,000 fry are reared to approximately 500 fpp in 10 troughs before being transferred to the raceways at survival rates provided by the Fish Springs Hatchery staff. The Pulse 2 fish will also be reared until they achieve their target size of 2 fpp in May yielding approximately 75,000 catchable Rainbow Trout.

The three pulses collectively produce approximately 355,000 catchable Rainbow Trout weighing approximately 177,500 pounds. The strategy of staggering the production of multiple groups of Rainbow Trout throughout the year allows the hatchery to maximize production. Each pulse of Rainbow Trout requires approximately 14 months of care from receipt as eyed eggs to reach the final stocking size at 2 fpp. There are opportunities to increase the number of fish entering the raceways and then stock out a portion of fish when they reach the sub-catchable size to increase production. However, flexibility in the timing of when fish groups arrive at the facility is limited, and additional sub-catchable production may have cascading effects for other production programs at the facility.

Table 2-8. End of Month Production Information for the Production Rainbow Trout Pulses 1 and 3 Bioprogram Including Realized DI and FI Values.

Prod. Stage/ Month	Prod. Stage/ Month	Tank Type	Tanks Occupied	fpp	Length (in)	Total Fish (#)	Biomass (lbs)	Max. Flow (cfs)	DI	FI
Pulse 1 Feb/ Mar	Pulse 3 Oct/ Nov	Early Rearing SS Troughs	20	500.0	1.7	205,000	410.0	1.0	0.17	0.55
Apr	Dec	Raceway	0.5	156.0	2.5	190,000	1,217.9	2.2	0.05	0.48
May	Jan	Raceway	0.5	62.5	3.4	185,000	2,960.0	2.2	0.10	0.88
Jun	Feb	Raceway	1.0	34.0	4.2	180,000	5,294.1	4.5	0.07	0.63
Jul	Mar	Raceway	1.0	20.0	5.0	175,000	8,750.0	4.5	0.10	0.87
Aug	Apr	Raceway	1.5	12.1	5.9	170,000	14,049.6	6.7	0.09	0.80
Sep	May	Raceway	1.5	8.1	6.7	165,000	20,370.4	6.7	0.11	1.02
Oct	Jun	Raceway	2.0	5.9	7.5	160,000	27,118.6	8.9	0.10	0.90
Nov	Jul	Raceway	2.0	4.3	8.3	155,000	36,046.5	8.9	0.12	1.08
Dec	Aug	Raceway	3.0	3.2	9.2	150,000	46,875.0	13.4	0.09	0.85
Jan	Sep	Raceway	3.0	2.5	10.0	145,000	58,000.0	13.4	0.11	0.97
Feb	Oct	Raceway	3.0	2.0	10.8	140,000	70,000.0	13.4	0.12	1.08

Table 2-9. End of Month Production Information for the Production Rainbow Trout Pulse 2 Bioprogram Including Realized DI and FI Values.

Production Stage/Month	Tank Type	Tanks Occupied	fpp	Length (in)	Total Fish (#)	Biomass (lbs)	Max. Flow (cfs)	DI	FI
Early Rearing May/Jun	SS Troughs	10.0	500.0	1.7	110,000	220.0	0.5	0.18	0.59
Jul	Raceway	0.5	156.0	2.5	100,000	641.0	2.2	0.03	0.25
Aug	Raceway	0.5	62.5	3.4	97,500	1,560.0	2.2	0.05	0.46
Sep	Raceway	0.5	34.0	4.2	95,000	2,794.1	2.2	0.07	0.67
Oct	Raceway	0.5	20.0	5.0	92,500	4,625.0	2.2	0.10	0.92
Nov	Raceway	1.0	12.1	5.9	90,000	7,438.0	4.5	0.07	0.64
Dec	Raceway	1.0	8.1	6.7	87,500	10,802.5	4.5	0.09	0.81
Jan	Raceway	1.0	5.9	7.5	85,000	14,406.8	4.5	0.10	0.96
Feb	Raceway	1.5	4.3	8.3	82,500	19,186.0	6.7	0.08	0.77
Mar	Raceway	1.5	3.2	9.2	80,000	25,000.0	6.7	0.10	0.91
Apr	Raceway	1.5	2.5	10.0	77,500	31,000.0	6.7	0.11	1.03
May	Raceway	1.5	2.0	10.8	75,000	37,500.0	6.7	0.13	1.15

2.2.3 Summary

It should be noted that the FIs and DIs at the end of each month fish are in the raceways are within the criteria specified in Table 2-4; this provides some flexibility in rearing and provides limited work windows for maintenance, cleaning, and disinfection of the troughs and raceways. Pulse 2 Rainbow Trout could be reared in two raceways rather than 1.5 raceways in this exercise since the FI approaches the maximum for the facility, and the space should be available provided there is no variability in the timing of production at the hatchery. Ultimately, production is limited by flow in both the troughs and raceways.

This production schedule allows for some opportunities to depopulate, clean, and maintain early rearing areas, with the capability of producing a combined total for all species of approximately 515,000 fish weighing 186,833 pounds per year. This falls short of the annual production goal of the facility but maintains production within recommended DI and FI criteria for the facility. Individual production goals for the Brown Trout and the Cutthroat are achieved. Water flows limit the facility's existing rearing capability in both the troughs and in the raceways for the Brown Trout and the Rainbow Trout; rearing volume limits the Cutthroat reared in the troughs because of the differences in FI criteria (Table 2-1 through Table 2-4). For this bioprogram, there is limited flexibility to rear fish in the hatchery building for an extended period except for the Cutthroat. To produce large numbers of fish, the hatchery transfers the Brown Trout and Rainbow Trout from the troughs into the raceways at smaller sizes than desired. Potential bottlenecks could occur as the previous year's cohorts overlap with the next year's production in the raceways if egg receipt timing varies outside of the modeled production rearing schedule (Figure 2-1). This practice does not allow the hatchery staff to administer bath vaccinations to fish indoors for *Lactococcus* spp. as desired. This requires more labor-intensive work and increased fish handling to bath vaccinate fish while they are held in raceways. Once fish reach the target stocking size, they should be stocked out relatively soon to perform any maintenance, cleaning and avoid production bottlenecks in the rearing units with the next cohort of fish. Water demand will be the highest in February and in August, September, and October (Figure 2-1). The water flow specified in Figure 2-1 is meant to show the flow requirement assuming all rearing areas are supplied with the maximum water flow. In practice, once fish have been transferred from the hatchery building to the raceways, they will likely not require the maximum water flow. This provides additional flexibility for water use in other rearing areas, as necessary. Note that the different colored blocks in the following figure correspond to the months for when each species is in either the deep tanks or in the raceways, along with noting when eggs are received and incubated.

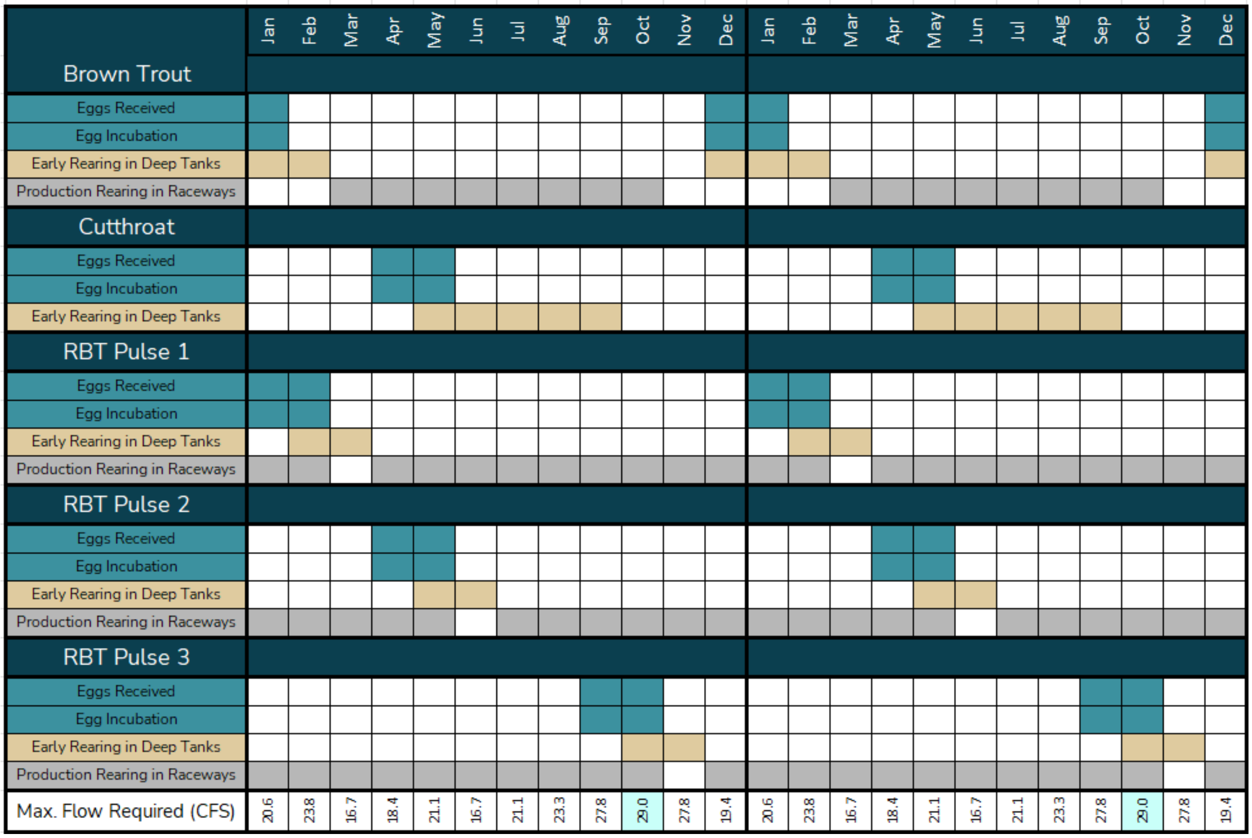

Figure 2-1. Production Rearing Schedule Over 2 Years with peak Water Demand in February and August, September, and October each Year (as highlighted in the Max Flow Required row).

3.0 Climate Evaluation

3.1 Introduction

In this section, climatic and hydrologic projections of conditions at the hatchery are presented for the next 20 years (2024-2043) and the following 20 years (2044-2063). These time horizons are referred to as the near-future period and the mid-century period, respectively. These projections inform the project team of potential needs for adaptive changes. Air temperature projections inform of potentially hazardous working conditions, and water temperature projections inform of risks to fish rearing.

3.2 Water Sources and Water Temperature

The hatchery's primary water source are two wells: well 330 (4,500 gpm maximum flow) and well 332 (8,000 gpm maximum flow). Depth to groundwater table varies in time between 30 and 90 feet, with an average of 62 feet in the period of record, 2002-2022.

The hatchery staff reports that well water entering the hatchery has remained at a constant 60°F throughout the year, and before leaving the hatchery may reach 65-67°F during the hottest days. The hatchery raises Rainbow Trout, Brown Trout, and Cutthroat Trout, which generally have an optimal temperature range between 50°F and 60°F. Current temperatures are at the upper end of this optimal range, producing strong fish growth rates. If extreme air temperatures become higher, or just more common and more prolonged in the future, the increase in water temperature through the facility may become more pronounced, resulting in a more stressful environment for fish rearing.

3.3 Methodology for Climate Change Evaluation

This study uses future climatic and hydrologic projections based on global climate model (GCM) simulations associated with the data set known as CMIP5, which was part of the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC 2014). The projections in this report are based on results from 10 different global climate models under the Representative Concentration Pathway (RCP) RCP4.5 scenario of future greenhouse gas emissions, which represents a future with modest reductions in global emissions compared to current levels.

An ensemble of 10 global climate models (GCMs), listed in Table 3-1, is used for capturing a wide range of plausible climate projections. Since this project's future time horizon is limited to 40 years, the dominant source of uncertainty in climate projections is expected to be the natural variability of the earth's climate (and the variability present in every GCM model run), with the second major source of uncertainty being differences between GCMs. Using this ensemble will simultaneously address both uncertainty sources. The selection of 10 GCMs was based on tests of their ability to accurately simulate California climate, following the study of 35 CMIP5 models by (Krantz et al., 2021).

Table 3-1. List of Global Climate Models Used in This Study.

No.	GCM	Research Institution
1	ACCESS-1.0	CSIRO, Australia
2	CanESM2	Canadian Centre for Climate Modelling and Analysis, Canada
3	CCSM4	National Center for Atmospheric Research, United States
4	CESM1-BGC	National Science Foundation, Department of Energy, and National Center for Atmospheric Research, United States
5	CMCC-CMS	Centro Euro Mediterraneo per Cambiamenti Climatici, Italy
6	CNRM-CM5	Centre National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancées en Calcul Scientifique, France/European Union
7	GFDL-CM3	NOAA Geophysical Fluid Dynamics Laboratory, United States
8	HadGEM2-CC	Met Office Hadley Centre, United Kingdom
9	HadGEM2-ES	Met Office Hadley Centre, United Kingdom
10	MIROC5	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies, Japan

Hydrologic projections utilize daily timestep results from the Variable Infiltration Capacity (VIC) hydrologic model (Figure 3-1) that was driven by the projected daily climate time series. VIC divides the watershed into grid cells (about 5x7 km in this study) where properties of the soil column and land cover and all major fluxes of water and energy are represented. Soil infiltration capacity is spatially variable within each grid cell, and baseflow is represented as a non-linear function of soil water storage.

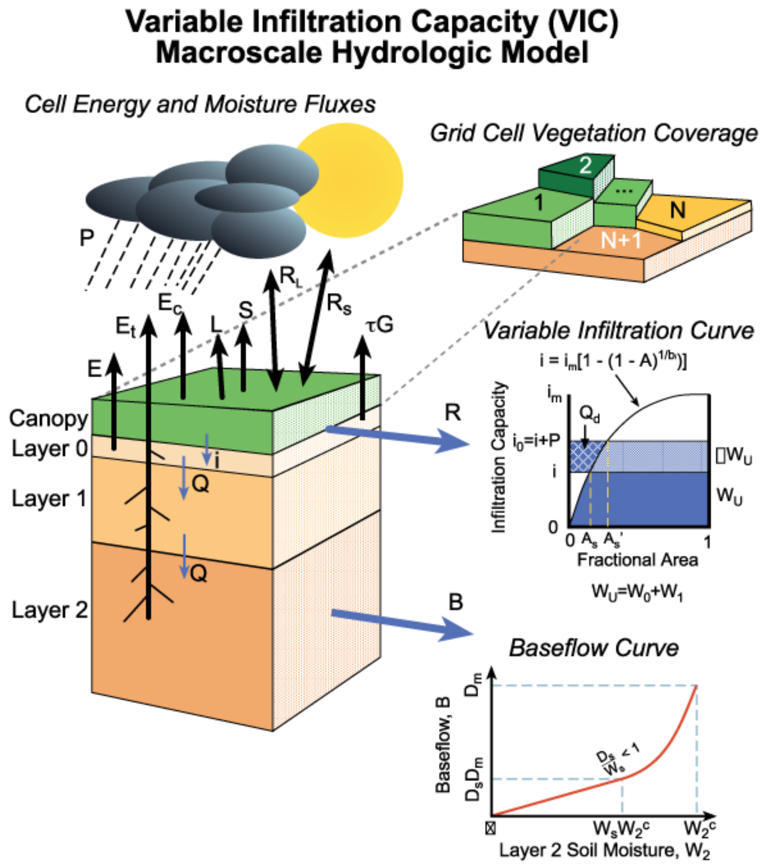

Figure 3-1. The VIC Hydrologic Model (University of Washington Computational Hydrology Group, 2021)

The methodology used for obtaining projections of climate, water temperature, hydrology and flood risk is summarized in Figure 3-2. The sections below provide additional detail, as well as discussion of fire risk:

1. **Projections of climatic variables** (air temperature, precipitation, and evapotranspiration) were based on simulations by the 10 selected CMIP5 global climate models (GCMs). The GCM projections were statistically downscaled (using different methodologies) by a consortium of research institutions and made publicly available for all of California at a grid cell spatial resolution of 1/16° x 1/16° (about 5 km x 7 km) (Vano et al., 2020). In this report, the downscaling methodology named “Localized Constructed Analogs” (LOCA) is used. The choice of the LOCA data set was guided by its proven ability to represent extreme values of the downscaled climatic variables (important to this study) and because the hydrologic projections made available by the same research consortium (item 2. below) used the LOCA-downscaled climate projections. The difference between greenhouse gas emissions scenarios is

small for a time horizon of 20 years; therefore, it is sufficient to use one greenhouse gas emissions scenario in this study, and the moderate scenario RCP4.5 is used.

2. **Projections of wildfire risk** at each hatchery site were evaluated at a high level based on the projections by Westerling (2018), which are available through the California government Cal-Adapt.org website (Cal-Adapt, 2023). In addition to the risk that fire poses to the facility, it has the effect of reducing soil permeability, increasing peaks of runoff and stream flows that impact flooding and water quality, and potentially affecting groundwater recharge.

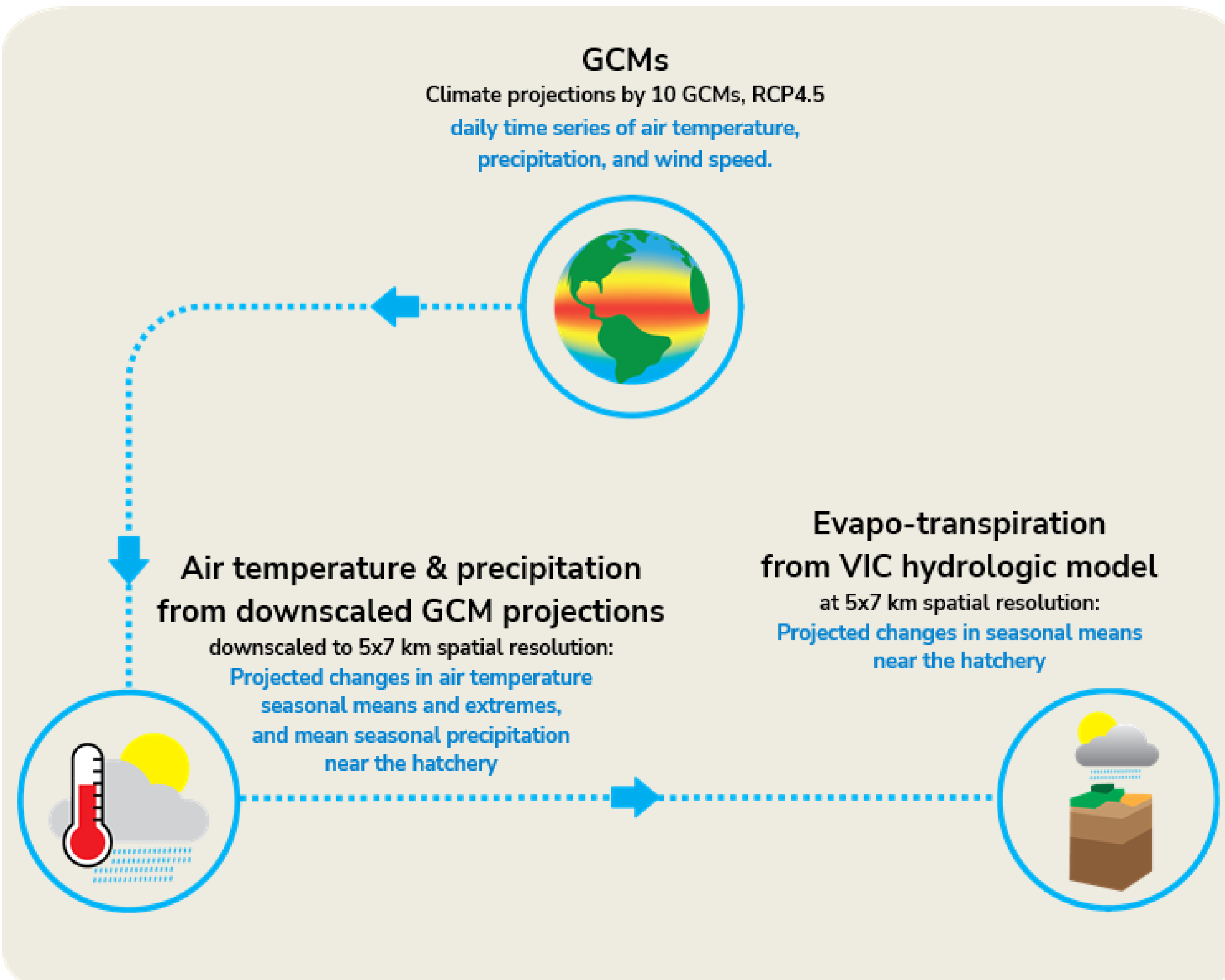

Figure 3-2. Methodology for Obtaining Projections.

3.4 Uncertainty and Limitations

It is important to acknowledge the uncertainty associated with these and any projections of climate and hydrology. While there is a need to provide climate projections for a variety of planning purposes, the underlying projections of climate change are subject to large and unquantifiable uncertainty. There is also uncertainty associated with the VIC hydrologic model simulations, and evaluating how well the model had been calibrated to the watershed was beyond the scope of this project. The changes in seasonal precipitation minus the evapotranspiration projected by VIC (i.e., the difference between a future period and the reference period) will be reported below, but the absolute values of these variables and their difference are omitted because model calibration over the historical period was not verified.

The projections of air temperature, water temperature, precipitation, evapotranspiration, and wildfire risk developed in this work should therefore be considered as plausible representations of the future, given the best current scientific information, and do not represent specific predictions. The actual future realizations of these variables over the areas studied will differ from any of the projections considered here, and their differences compared to historical climate may be greater or smaller than the differences in the projections considered.

3.5 Projected Changes in Climate at the Hatchery Site

3.5.1 Air Temperature

Figure 3-3 displays the simulated mean daily air temperature (solid lines) and its range from minimum to maximum (shaded areas) for each day of the year, at the hatchery site. The near-future time period and the reference period are represented in red and blue, respectively. All data are simulated by the ensemble of 10 GCMs for each time period. Higher peaks of daily temperature are seen for the near future compared to the reference period, while the historical period has lower minima.

Table 3-2 and Table 3-3 list the projected mean seasonal air temperature for two future time periods, and the temperature change relative to the reference period (1984-2003). All time horizons, including the reference period, are simulated by the ensemble of 10 GCMs. The lowest and highest of the 10 GCM daily projections define the lower and upper limits of the shaded areas in Figure 3-3, and are given in Table 3-2 and Table 3-3.Table 3-4 and Table 3-5 list the projected percentiles of highest air temperature in each day (T_{max}) for two future time periods, relative to the reference period. All time horizons, including the reference period, are simulated by the ensemble of 10 GCMs.

At the hatchery site, mean annual air temperature is projected to rise by 2.7°F in the near future period compared to the reference period (1984-2003), and by an additional 1.1°F in the mid-century period. The season with the most warming is the summer (Figure 3-3, Table 3-2, and Table 3-3) and the highest temperature rises are projected to occur in the hottest days (Table 3-4 and Table 3-5). Days with maximum daytime temperatures representing the 75th percentile (i.e., the upper quartile of temperatures) are projected to warm by 3.1°F in the next 20 years, relative to the reference period. The 97th percentile of the daytime maximum temperature is projected to rise by even more, 3.5°F, reaching 104°F. These projected temperatures represent potentially hazardous outdoor working conditions at the hatchery.

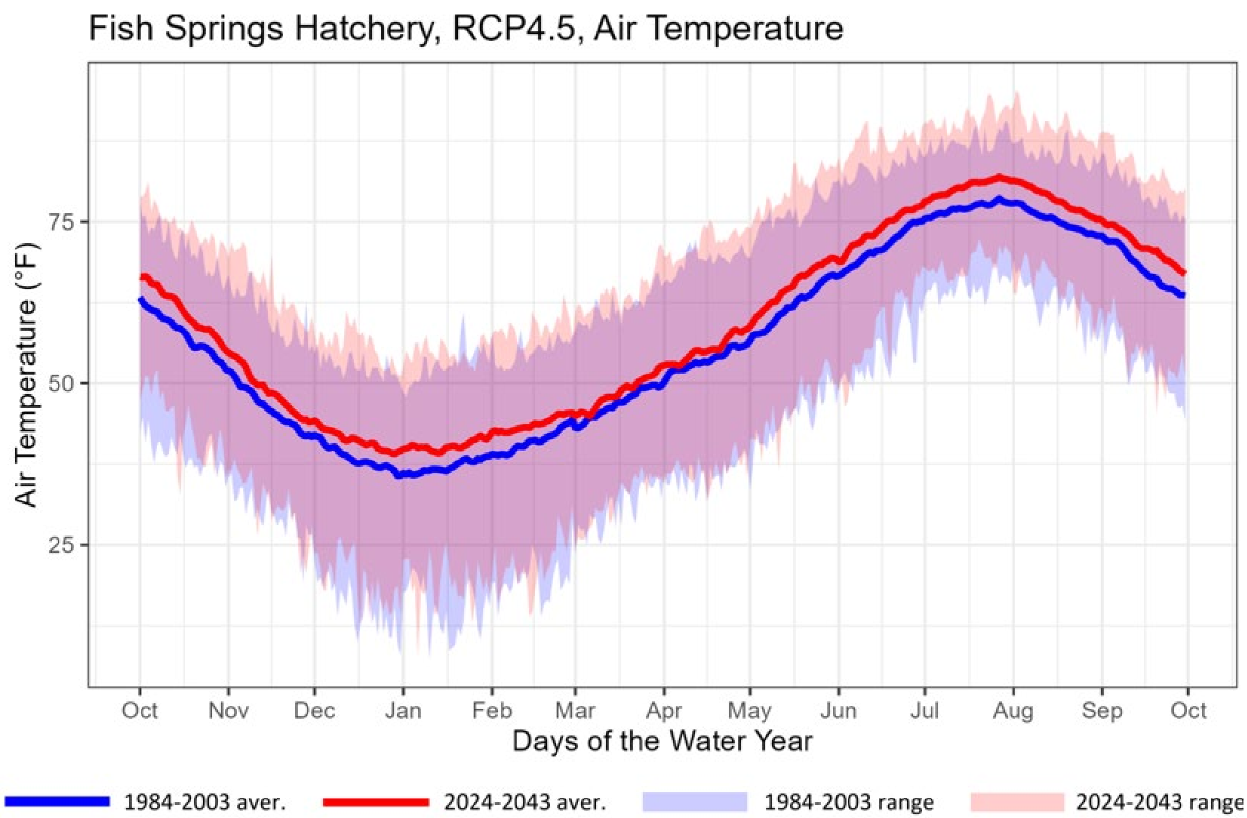

Figure 3-3. Mean Daily Air Temperature and Range for Each Day of the Year at the Hatchery Site.

Table 3-2. Projected GCM 2024-2043 Mean Seasonal Air Temperature at the Hatchery Site (change relative to 1984-2003).

GCM	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Ensemble mean	59.9°F (+2.7°F)	42.0°F (+2.7°F)	58.1°F (+1.8°F)	78.8°F (+3.3°F)	60.6°F (+3.0°F)
Lowest	59.4°F (+1.9°F)	40.7°F (+1.1°F)	57.4°F (+0.8°F)	77.7°F (+2.1°F)	59.2°F (+1.5°F)
Highest	60.5°F (+4.0°F)	42.9°F (+3.8°F)	59.2°F (+2.9°F)	80.3°F (+5.4°F)	61.4°F (+3.8°F)

Table 3-3. Projected GCM 2044-2063 Mean Seasonal Air Temperature at the Hatchery Site (change relative to 1984-2003).

GCM	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Ensemble mean	61.1°F (+3.8°F)	43.3°F (+4.2°F)	59.4°F (+2.9°F)	79.9°F (+4.4°F)	61.8°F (+3.9°F)
Lowest	60.5°F (+2.9°F)	42.6°F (+3.0°F)	58.6°F (+1.7°F)	79.0°F (+3.3°F)	60.2°F (+2.2°F)
Highest	62.0°F (+4.9°F)	44.0°F (+4.7°F)	60.0°F (+3.7°F)	81.6°F (+6.6°F)	63.1°F (+5.6°F)

Table 3-4. Projected GCM 2024-2043 Percentiles of Highest Air Temperature in Each Day (T_{max}) at the Hatchery Site (change relative to 1984-2003).

GCM	3rd perc.	25th perc.	50th perc.	75th perc.	97th perc.
Ensemble mean	46.1°F (+2.6°F)	61.4°F (+2.2°F)	76.5°F (+2.3°F)	92.6°F (+3.1°F)	104.0°F (+3.5°F)
Lowest	44.8°F (+1.3°F)	60.5°F (+1.1°F)	75.6°F (+1.8°F)	92.1°F (+2.1°F)	102.4°F (+2.1°F)
Highest	47.9°F (+4.5°F)	62.2°F (+3.4°F)	77.1°F (+3.3°F)	93.4°F (+4.3°F)	105.5°F (+5.5°F)

Table 3-5. Projected GCM 2044-2063 Percentiles of Highest Air Temperature in Each Day (Tmax) at the Hatchery Site (change relative to 1984-2003).

GCM	3rd perc.	25th perc.	50th perc.	75th perc.	97th perc.
Ensemble mean	47.7°F (+4.0°F)	62.6°F (+3.5°F)	77.9°F (+3.5°F)	93.9°F (+4.2°F)	104.7°F (+4.4°F)
Lowest	46.3°F (+2.6°F)	61.8°F (+2.2°F)	77.2°F (+2.2°F)	93.1°F (+2.9°F)	103.5°F (+3.0°F)
Highest	48.9°F (+5.8°F)	63.5°F (+4.5°F)	78.6°F (+4.6°F)	95.3°F (+5.7°F)	106.4°F (+6.5°F)

3.5.2 Precipitation Minus Evapotranspiration

Projected annual precipitation minus evapotranspiration (P-ET) in the vicinity of the hatchery is projected to change little in either the near-future or mid-century period relative to the reference period, per the ensemble of 10 GCM projections (Table 3-6 and Table 3-7). These very small changes projected by the ensemble are in the order of magnitude of 1 mm per season. Individual GCM projections cover a wider range, also given in Table 3-6 and Table 3-7, but remain relatively small. This range reflects natural variations as simulated by the models, as well as differences between models. As an ensemble, there is no indication of an anthropogenic climate change signal significantly influencing the P-ET balance.

This variable P-ET is an indicator of future direction of change in groundwater recharge rates but has large associated uncertainty given that precipitation in California is subject to great natural variability, experiencing large departures from the mean in any given year or multi-year period. Mimicking this natural variability, precipitation projections for the next 20 years vary widely between different GCM runs and are subject to great uncertainty.

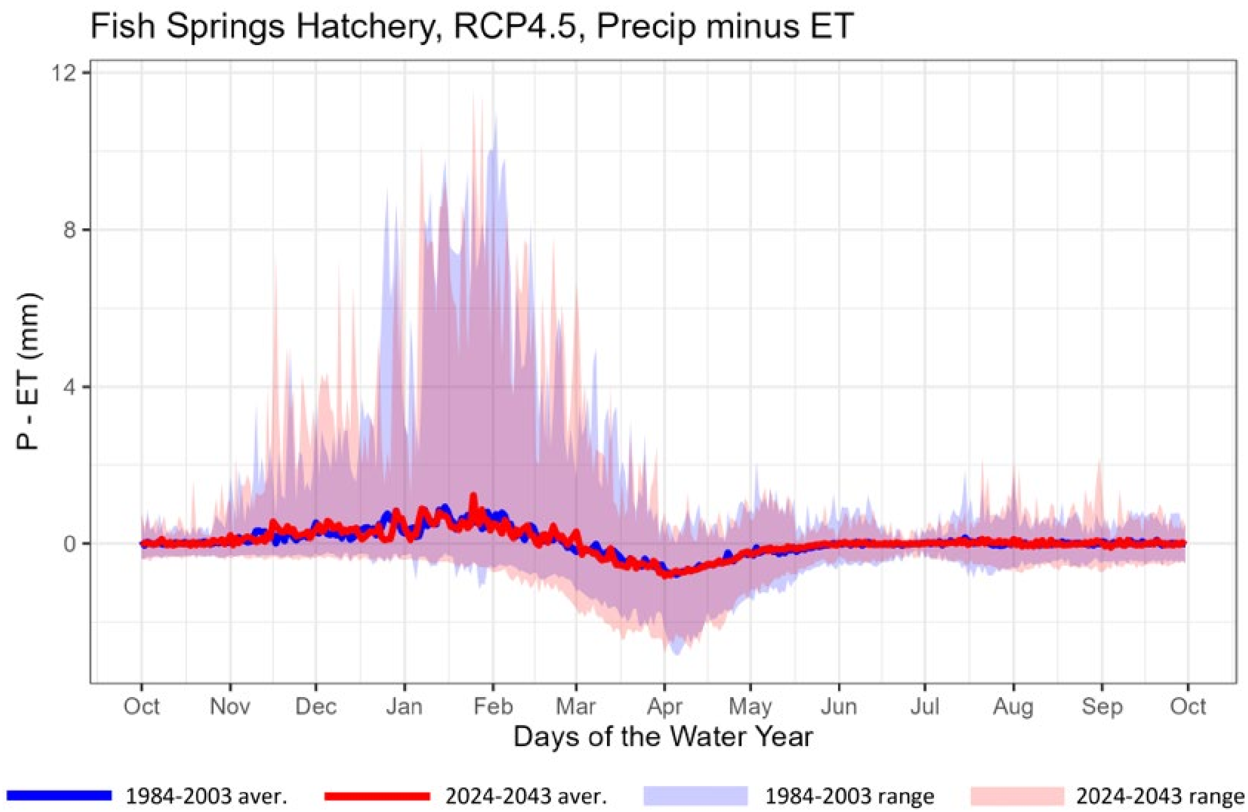

Figure 3-4. Mean Daily Precipitation Minus Evapotranspiration and Range for Each Day of the Year in the Vicinity of the Hatchery.

Table 3-6. Projected GCM 2024-2043 Percentage Change in the Seasonal Total Precipitation Minus Evapotranspiration (Relative to 1984-2003).

GCM	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Precip-ET mean	-1%	-1%	-2%	+1%	+1%
Lowest	-10%	-18%	-25%	0%	-4%
Highest	+4%	+26%	+9%	+1%	+9%

Table 3-7. Projected GCM 2044-2063 Percentage Change in the Seasonal Total Precipitation Minus Evapotranspiration (Relative to 1984-2003).

GCM	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Precip-ET mean	0%	+1%	-1%	+1%	-1%
Lowest	-7%	-18%	-33%	0%	-4%
Highest	+7%	+33%	+14%	+2%	+6%

3.5.3 Fire Risk

Historical wildfires have been documented in the surrounding uplands of the Fish Springs Hatchery but have not occurred within the past twenty years (Figure 3-5). In 2011, the John Fire came within less than a mile of the hatchery and covered 5,800 acres. The surrounding landcover consists of sparse wildfire fuels including a mix of herbaceous and desert shrubland.

Expressing wildfire risk as a percent chance of occurring at least once in a decade, the projected wildfire risk at the hatchery site is less than 5% through mid-century (Figure 3-5). The risk increases to more than 10% in the hills above the valley floor.

Fire-related risks to the hatchery are more limited to infrastructure risk than water supply risk, as compared to hatcheries that rely on surface water. Wildfires are expected to have a smaller impact on groundwater supply, which appears to be constant in supply and temperature over time. Fires are rarer in desert shrubland systems, but past fires at Fish Springs Hatchery indicate that close range fires are possible in this area.

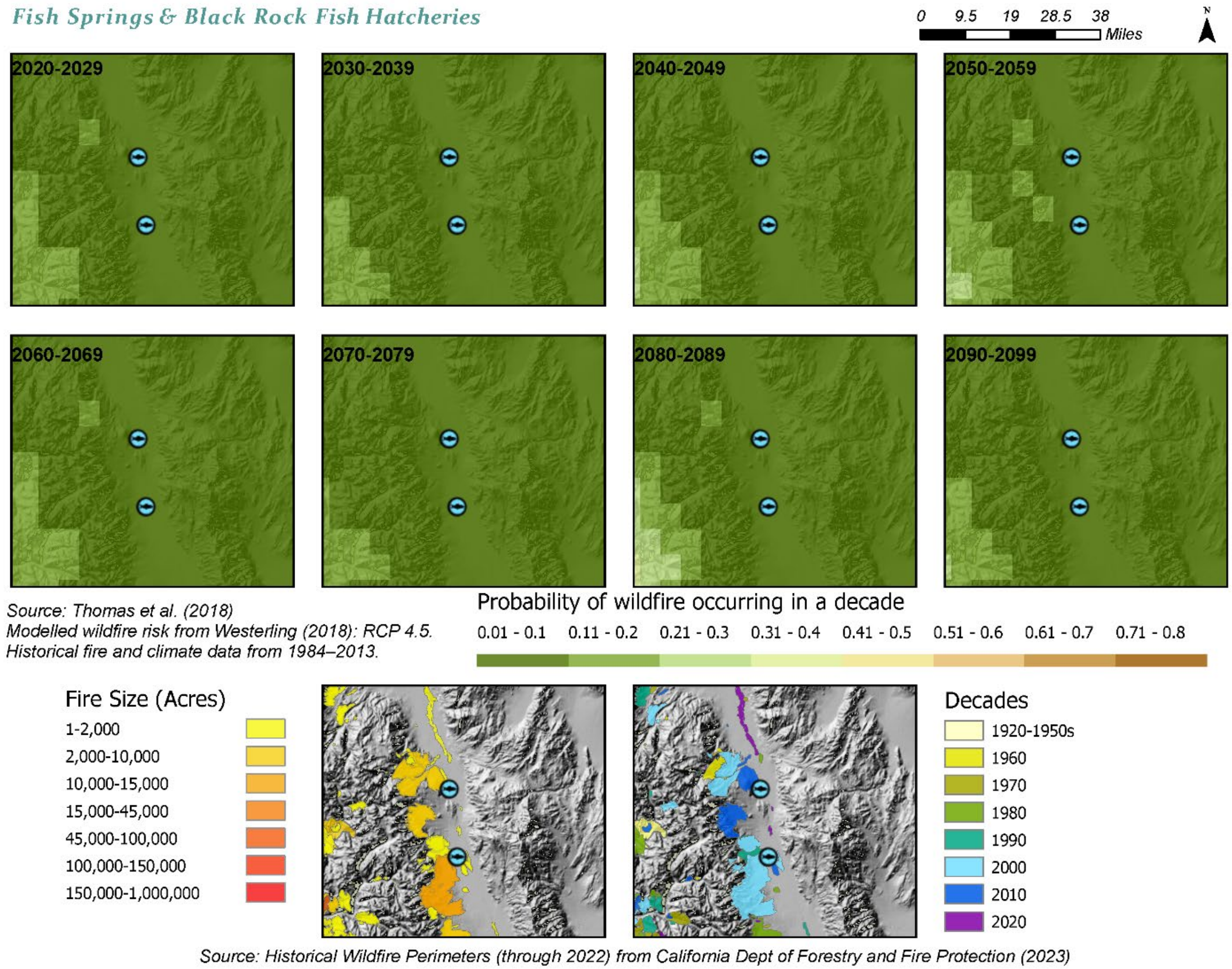

Figure 3-5. Wildfire Risk as Probability of Future Occurrence and Known Historical Fires.

3.6 Conclusions

Significant increases in air temperature are expected for the hatchery location. Mean annual air temperature is projected to rise by 2.7°F in the next 20 years (2024-2043) and by an additional 1.1°F in the mid-century period (2044-2063), compared to the reference period (1984-2003). The summer will experience the most warming, and the largest temperature increases are projected to occur on the hottest days. Days with temperatures representing the 75th percentile and 97th percentile of daily temperatures are projected to warm by 3.1°F and 3.5°F, respectively, in the next 20 years, relative to the reference period, reaching 104°F and representing potentially hazardous outdoor working conditions at the hatchery. Such an increase in the peak air daytime temperature requires adaptation measures for protection of hatchery workers against heat stroke and other health effects of heat exposure. Roads and roofs may also need to be replaced using more heat-resistant and reflective materials.

The hatchery staff reports that its source well water has remained at a constant 60°F throughout the year, and before leaving the hatchery may reach 65-67°F during the hottest days. Given that water temperature has not in the past responded to rising air temperatures, it appears likely that it will not warm appreciably in the near future. But given that its current temperature is already at the upper range for fish rearing, any additional warming, even if small, may require adaptation through cooling.

Projections for the difference between precipitation and evapotranspiration are for no significant change attributable to anthropogenic climate change. Natural variability, however, will continue to lead to multi-year periods of above-average and below-average values, resulting in increased or decreased groundwater recharge.

The hatchery is at moderate risk of wildfires. There is a history of small fires in the uplands above the valley bottom, but proximal fires have not occurred within the past two decades, which increased the fire risk in the near future. The projected chance of at least one wildfire occurring in a 10-year period at the hatchery site is estimated as less than 5% through mid-century. Local wildfires have come within one mile of the Fish Springs Hatchery, indicating that fires are possible even in this desert shrubland.

4.0 Existing Infrastructure Deficiencies

While the Fish Springs Hatchery is an operational facility, multiple deficiencies were identified during the site visit and described in Section 4 of the Site Visit Report (Appendix A). Section 5.4 of the Site Visit Report identified potential technologies and solutions available to address specific deficiencies that would allow the hatchery to meet production goals and provide protection against climate change. The main areas of concern for the hatchery included the LADWP wells' backup power generators, insufficient early rearing space, inadequate water treatment for reuse alternatives, raceway deterioration, and old plumbing throughout the hatchery. Biosecurity deficiencies and potential solutions for addressing these concerns were identified in Sections 3.0 and 3.2 of the Site Visit Report, respectively. These measures include constructing a quarantine area to temporarily hold recently received eggs, placing footbaths at the entrance of each hatchery building with a Virkon™ Aquatic (Lanxess) alternative, and covering the outdoor rearing vessels with a solid roof structure and enclosing the sides. Additional considerations include upgrading backup power generation, construction of an additional building for Rainbow Trout rearing and egg development, replacing the nursery raceways with circular tanks, and incorporating a 'drop' between effluent discharge and the settling pond with NZMS. The details of these deficiencies are further expanded upon in Sections 4.1 and 4.2.

4.1 Water Process Infrastructure

4.1.1 LADWP Well Deficiencies

Currently, there are two wells, Well #330 and Well #332, at Fish Springs Hatchery that supply water at a consistent temperature between 58-60°F. Both wells are provided by LADWP and have diesel backup power generators. Power outages are frequent in this area. Hatchery staff noted four power outages in July 2023 alone. Therefore, the existing backup power generators for the wells are heavily relied upon. Diesel backup power generators create exhaust emissions concerns and obtaining large quantities of diesel to the site can be difficult. Due to the reliance on backup power generators, it is important that they are upgraded to ensure effective production for the next 40+ years. According to CDFW, attempts have been made to drill additional backup wells previously but have been unsuccessful due to high concentrations of hydrogen sulfides.

4.1.2 Aeration Tower

Currently, incoming production water only flows through two of the three existing packed columns in the aeration tower. Distributing water through all three of the available packed columns is expected to increase the efficiency of the hatchery's aeration system.

4.1.3 Aged Plumbing

The water conveyance piping and valves throughout the hatchery are functioning but should be replaced due to aging and insufficient water control valves. With the existing plumbing and valving setup, the hatchery is unable to throttle/control flows from the wells to the hatchery, and alfalfa plate-style valves are used for the raceways which can be difficult to operate. There have not been catastrophic failures of the systems, but there is a need for preventative maintenance to avoid issues in the future.

4.1.4 Exposure to NZMS in Effluent Pond

New Zealand Mud Snails ([NZMS]; *Potamopyrgus antipodarum*) are present in the Fish Springs Hatchery Effluent Pond. This provides the potential to expose the hatchery to NZMS through the effluent discharge pipe.

4.1.5 Water Treatment Limitations

The hatchery staff have reported several fish health concerns within the hatchery. This has included *Lactococcus garvieae*, bacterial coldwater disease (causative agent *Flavobacterium psychrophilum*), bacterial gill disease (generally associated with causative agent *F. branchiophila*), and *Gyrodactylus* spp. There are no water treatment systems to treat incoming water to Fish Springs Hatchery except for an aeration tower that provides small increases in dissolved oxygen concentrations. This leaves the facility susceptible to pathogen exposure, increased turbidity, and dissolved oxygen levels below saturation. Without additional water treatment capabilities, the hatchery is also limited as a flow-through facility with no biosecure way to recirculate production water. This is especially restrictive due to rearing capabilities in the hatchery building and raceways being flow-limited to meet production goals (see Section 2.0).

4.2 Rearing Infrastructure

4.2.1 Insufficient Incubation and Early Rearing Space

The existing hatchery building is space-limited to reach production goals at Fish Springs Hatchery. Rainbow Trout and Brown Trout often require being transferred into the outdoor raceways at smaller sizes than the target size of 200 fpp due to early rearing space in the hatchery building deep tanks being limited. Additionally, CDFW has implemented new fish vaccination programs due to emergent pathogen concerns. The vaccination programs require fish to be held indoors until they can be vaccinated (approximately 170 fpp or 2.5 inches). The hatchery building was not designed to consistently rear fish to this size indoors and reach the annual production goals for the facility. The limited early rearing space poses a bottleneck in production and CDFW must constantly balance maintaining fish welfare at the expense of reduced production levels.

4.2.2 Exposure and Predation Issues in Raceways

The raceways are enclosed in chain-link fencing with bird wire strung across the top. However, fish in the raceways still experience predation (generally assumed to be avian and small mammals). In addition to losses associated with predation, predators also increase the risk of spreading pathogens to the fish and NZMS to hatchery infrastructure. Birds and other animals can carry diseases and cause stress in the fish which can result in fish loss. With only bird wire above, the raceways experience direct sunlight during increased temperature periods in the summers. Prolonged exposure to sunlight and UV rays warms the water, can cause sunburn on the fish, and damages the infrastructure. As noted in Section 3.0 , air temperatures at Fish Springs Hatchery are projected to increase in the future which will only exacerbate these concerns. This is especially important given the current water temperatures at the hatchery are already in the upper range for salmonids.

4.2.3 Raceway Deterioration

The existing concrete raceways are showing signs of deterioration due to age. There are also two concrete nursery raceways that are no longer used due to construction issues. The slope of the existing nursery raceways carried water away from the drains when in use.

Additionally, the avian predation exclusion wire above the raceways experiences tangling and gaps. According to CDFW staff, the bird exclusion wires provide effective protection against seagulls (*Larus* spp.) and blue herons (*Ardea* spp.) but are largely ineffective at keeping the ravens (*Corvus* spp.) and night herons (*Nycticorax* spp.) out of the raceways.

4.2.4 Lack of Quarantine Area

Fish Springs Hatchery has eggs brought on site from Mt. Shasta Hatchery, Crystal Lake Hatchery, and the Heenan Lake egg collection station. These fish eggs are a potential pathway for pathogens to enter the facility. There is currently no quarantine area to temporarily hold eggs received from other sources until they are disinfected and determined to be a low risk for transmitting pathogens to the general hatchery population.

5.0 Alternative Selected

5.1 Alternative Description

During the site visit, several deficiencies were identified that currently limit the hatchery's ability to meet fish production goals. These deficiencies have been summarized in Section 4.0 of this report. Appendix E – Alternatives Development Technical Memorandum (TM) provides a discussion of alternative technologies that may be used to address the existing deficiencies and potentially expand production, improve biosecurity, and increase operational efficiencies. The following section presents a summary of the preferred alternative that would best utilize the alternative technologies to respond to the existing deficiencies, maximize fish production, and respond to the climate change projections described in Section 3.0 . The conceptual layout of the alternative described below is shown in Appendix C.

5.1.1 Upgrade Well Houses from Diesel to Propane Backup Generators

LADWP wells at Fish Springs Hatchery recently had diesel backup power generator replacements. Due to exhaust emissions concerns related to diesel power generators and difficulties obtaining large quantities of diesel to the site, it is recommended that both wells' backup power generators be upgraded. Propane-powered backup generator replacements have the potential to improve exhaust emissions and potentially lower operational costs.

5.1.2 Upgrade the Alfalfa Plate-Style Valves and Piping

Various valves and pipes across the hatchery are more than 50 years old. Additionally, at the time of the site visit, Fish Springs Hatchery was unable to throttle flows from the wells to the hatchery, and alfalfa plate-style valves are used for the raceways which limits overall control of hatchery flows. According to CDFW, there is a contract underway to add restrictor valves to the existing wells to be completed by November 2024. The preferred alternative is to inspect valves and pipes throughout the hatchery and replace infrastructure that is leaking, not operable, heavily aged/worn, or likely to fail in the near future. The hatchery plumbing and valving should be upgraded to include water control valves for all production areas. Additional control valves will greatly improve operational challenges. Replacing the valves and pipes would allow for better flow control and would allow for the hatchery to continue operating into the future.

5.1.3 Rebuild Aeration Tower

The existing aeration tower distribution only utilizes two of the three available packed columns for degassing supply water. Replacing the existing aeration tower with a new tower will help the hatchery overall by providing better quality production water for fish rearing. The new aeration tower would include counter-current packed columns for removing nitrogen and carbon dioxide and Low Head Oxygenators (LHOs) to provide oxygen to the water flow.

It is assumed that there would be multiple packed columns and that the water would discharge into the LHOs below. Based on standard packed column design, an average of 100 gpm flow needs 1 square foot of packed column area for proper aeration/stripping. Outdoor-rated exhaust-type blowers would be mounted to the packed columns to pull air up through the packed column media, improving the gas exchange rate from air to water. The exhaust would be vented outside to prevent potential carbon dioxide and other undesirable gases from accumulating within the building.

After flowing down the packed columns, water would fall into LHOs and be injected with oxygen. Once water is degassed and oxygenated, it would discharge into the head tank below where it would then be split and conveyed to specific rearing areas throughout the facility.

5.1.4 Demolish Unused Well

An additional well was drilled at Fish Springs Hatchery, but due to hydrogen sulfide concerns is not utilized. The unused well is recommended to be decommissioned, demolished, and removed to make room for the proposed covered production PRAS modules (see Section 5.1.5). All appurtenant structures and equipment including supply pipes, valves, pumps, etc. are to be removed as well.

5.1.5 New Production Building with Solar Panels

Shifting Rainbow Trout and Brown Trout production away from outdoor raceways to covered production areas will significantly reduce the loss of fish associated with predation, in turn reducing the total number of eggs required to maintain production goals, alleviating densities during early rearing, and reducing demand on CDFW’s egg-producing facilities. Operating new production systems as PRASs will reduce the freshwater demand per pound of fish produced, creating a more resilient production strategy for the future in the context of climate change impacts.

New production buildings would be pre-engineered metal buildings (PEMBs) with standard, easy to clean finishes. Each production room would have a dedicated HVAC system to maintain temperature and humidity, as well as lighting controls to aid production as needed.

The proposed production spaces were assessed under three different conditions:

- Maintaining production within new PRASs, under the assumption that Rainbow Trout eggs are available throughout the year.
- Maximize production with 18 cfs of fresh make-up water supply used for PRAS operations. This water supply is based on the hatchery water consumption reduction sought by the Big Pine Paiute Tribe and Inyo County to conserve groundwater in the Owens Valley.
- Maximize production with 24 cfs of fresh make-up water supply (additional raceway capacity); 18 cfs would be used for new PRASs and 6 cfs would remain for fish rearing in existing raceways. This reflects the current water consumption of the facility.

It is important to note that the proposed upgrades include PRASs for production. PRASs require specific processes to maintain optimal rearing conditions for the fish including solids removal, gas stripping, oxygenation, and disinfection. For this report, oxygen is assumed to be sourced from on-site oxygen generation as opposed to bulk liquid oxygen (LOX) deliveries. During advanced design phases, LOX availability will be evaluated and compared to oxygen generation in a cost-benefit analysis.

There are a range of operational techniques for PRASs based on the flow rates used. The recirculation rate and hydraulic residence time (HRT) of each tank affects the water consumption. Heavy densities and feed rates may require lower recirculation rates and HRTs to maintain optimal rearing conditions within the tanks, ultimately increasing water consumption. Without a biofilter, the maximum recommended recirculation rate is 75%. The maximum recommended HRT is 45 minutes, or 1.5 water exchanges per hour in each tank for 20-foot-diameter tanks; the maximum recommended HRT for smaller tanks is 30 minutes (2 complete water exchanges per hour). The circular tanks for all PRAS alternatives in these scenarios are identical, tanks are 20-foot in diameter with 6-feet of water depth and a 1-foot freeboard (1,885 ft^3). To estimate maximum production based on the potential water availability, it is assumed that all tanks are in operation simultaneously and that any PRAS uses a 75% recirculation rate. In practice, it will likely take several years for staff to gain the operational knowledge and skills required to consistently run the PRASs at these levels. More detailed modeling of exact timing of egg arrivals, growth rates, stocking efforts, and overall production cycles would occur at advanced design stages to determine a more accurate production plan and water budget. To provide a factor of safety, all fish capacity calculations assumed a 10% reduction for flexibility and avoid overcrowding systems.

A PRAS can reduce the overall water usage and improve water quality within the rearing environment. Dual-drain circular tanks provide a completely mixed environment as opposed to a raceway that has a gradient of high to low dissolved oxygen (DO) along its length. This characteristic of circular tanks makes the entire volume available to the fish, as opposed to fish crowding at a raceway's head end, and thereby not using the entire raceway volume. Other benefits include self-cleaning of fish waste, concentration of fish waste in a small center drain flow that can be treated continuously, and capacity for providing exercise velocities. Covering the tanks with a rigid roof structure will also reduce heat gain and improve biosecurity. All new PRAS production structures would include photovoltaic systems on the roof to help offset the power requirements of the new hatchery infrastructure while lowering operation costs.

Maintain Production with PRASs

This alternative assumes all raceway production would shift to PRASs. Assuming that Rainbow Trout eggs would be readily available throughout the year and the production cycle is 12 months from hatch to a catchable fish, 44 circular tanks are proposed for a total rearing volume of approximately 82,940 ft^3.

All Brown Trout production could be held in four tanks which could be organized as an independent module because the production cycle for Brown Trout is less than one year. The four-tank module would have capacity to hold approximately 128,252 fish at 10 fpp (6.3 inches), or 12,825 pounds of sub-catchable fish at a DI below 0.3.

Space for Rainbow Trout would be reserved in the remaining 40 tanks. The maximum capacity for catchable fish would be approximately 439,722 fish (219,861 pounds). Assuming that egg availability is consistent throughout the year, CDFW could produce multiple cohorts of fish throughout the year to maximize production and exceed the instantaneous capacity. Potential operations would be modeled with more detail during advanced designs and would include exact timing of egg arrivals, growth and development rates, timing of fish stocking throughout the year, and other variables.

Each 20-foot tank would require approximately 80 gpm of fresh make-up water, assuming a maximum HRT of 45 minutes and a recirculation rate of 75%. The fresh make-up water demand for the Brown Trout module would be approximately 320 gpm, and approximately 3,200 gpm (7.1 cfs) for the remaining 40 tanks.

Tanks would be organized into modules, each with eight tanks. Each module will include the necessary equipment to treat and recondition water before it is reused for production. PRAS treatment will include filtration, UV disinfection, degassing, and oxygenation; more information about the technologies evaluated is included in Appendix F. Based on the size of each module, equipment would be sized to treat up to 640 gpm of reused water to accommodate a 50% recirculation rate for additional flexibility during operation. It is recommended that CDFW staff begin with low fish densities and recirculation rates before increasing variable as they become more familiar with the PRAS. Table 5-1 shows tank characteristics, fish capacity, and water demand for the proposed PRASs. The following are other characteristics that apply to both species:

- PRASs Water Demand Combined: 3,520 gpm (7.84 cfs)
- Existing Hatchery Building Water Demand: 440 gpm (0.98 cfs)
- Proposed Hatchery Building Water Demand (Section 5.1.7): 750 gpm (1.67 cfs)
- Entire Facility Minimum Water Demand: 4,710 gpm (10.49 cfs)

Table 5-1. Maintained Production Scenario – Water Demand and Capacity Information

Characteristics	Brown Trout	Rainbow Trout
Tank Type/Dimensions	Circular (20' diameter, 6' depth)	Circular (20' diameter, 6' depth)
Volume Per Rearing Vessel (ft^3)	1,885 ft^3	1,885 ft^3
Fish Size at Outplant	10 fpp at 6.3 inches	2 fpp at 10.8 inches
Max Number of Fish in System (DI < 0.3)	128,252 (12,825 lbs)	439,722 (219,861 lbs)
Number of Rearing Vessels	4	40
Total Volume (ft^3)	7,540 ft^3	75,400 ft^3
Total Water Demand (gpm)	320 (HRT = 45 minutes, 75% Reuse Rate)	3,200 (HRT = 45 minutes, 75% Reuse Rate)

Maximize Production with Water Usage Reduction (18 cfs)

This scenario assumes all Rainbow and Brown Trout production would shift to PRAS, and that the instantaneous water demand of all systems, including the existing and proposed (Section 5.1.7) hatchery buildings, would be no greater than 18 cfs at 75% recirculation rates. For this scenario, increased production is only anticipated for catchable Rainbow Trout; it is assumed that Brown Trout production would remain near 80,000 sub-catchable fish. Advanced design phases would explore expanding production for other species based on goals identified by CDFW. The proposed upgrades for this scenario include 76 circular tanks (20-foot-diameter), providing a total rearing volume of approximately 143,260 ft^3. Operating at an HRT of 45 minutes with a 75% recirculation rate would require approximately 6,080 gpm (13.55 cfs). The maximum capacity of these tanks would be approximately 835,472 catchable Rainbow Trout (417,736 pounds) while maintaining a DI below 0.3. The minimum water demand of the facility, assuming all systems are operating simultaneously and PRASs are operating with a 75% recirculation rate, is approximately 17.75 cfs. This provides approximately 110 gpm (0.25 cfs) of additional water flow for operational flexibility and a factor of safety.

Tanks would be organized into modules, each with eight tanks. Each module will include the necessary equipment to treat and recondition water before it is reused for production. PRAS treatment will include filtration, UV disinfection, degassing, and oxygenation; more information about the technologies evaluated is included in Appendix F. Based on the size of each module, equipment would be sized to treat up to 640 gpm of reused water to accommodate a 50% recirculation rate for additional flexibility during operation. It is recommended that CDFW staff begin with low fish densities and recirculation rates before increasing variable as they become more familiar with the PRAS. Table 5-2 shows tank characteristics, fish capacity, and water demand for the proposed PRASs. The following are other characteristics that apply to both species:

- PRASs Water Demand Combined: 6,400 gpm (14.26 cfs)
- Existing Hatchery Building Water Demand: 440 gpm (0.98 cfs)
- Proposed Hatchery Building Water Demand (Section 5.1.7): 1,125 gpm (2.51 cfs)
- Entire Facility Minimum Water Demand: 7,965 gpm (17.75 cfs)

Table 5-2. Maximize Production with 18 cfs Scenario – Water Demand and Capacity Information

Characteristics	Brown Trout	Rainbow Trout
Tank Type/Dimensions	Circular (20’ diameter, 6’ depth)	Circular (20’ diameter, 6’ depth)
Volume Per Rearing Vessel (ft^3)	1,885 ft^3	1,885 ft^3
Fish Size at Outplant	10 fpp at 6.3 inches	2 fpp at 10.8 inches
Max Number of Fish in System (DI < 0.3)	128,252 (12,825 lbs)	835,472 (417,736 lbs)

Characteristics	Brown Trout	Rainbow Trout
Number of Rearing Vessels	4	76
Total Volume (ft^3)	7,540 ft^3	143,260 ft^3
Total Water Demand (gpm)	320 (HRT = 45 minutes, 75% Reuse Rate)	6,080 (HRT = 45 minutes, 75% Reuse Rate)

Additional Raceway Production Capacity

CDFW requested additional information concerning a scenario where new PRASs and hatchery buildings would operate at reduced water usage (18 cfs), but with additional production occurring in the existing raceways. The raceway production would use the remaining 6 cfs of available water supply, demonstrating potential production of the hatchery assuming they can utilize all 24 cfs of available water.

Raceway production assumes that 6 cfs would be split evenly into two full-length raceways, each with 3 cfs of flow. To maximize production, the mid-pond aeration system would operate to allow CDFW to use the entire 1,000 feet of raceway length. It is assumed that the mid-pond aeration system reconditions the process water enough to avoid any rearing limitations in the lower 500-foot sections of the raceways. Therefore, calculations assumed four raceways, each 500 feet long and each with 3 cfs of water flow.

The total rearing volume of the four raceways is approximately 36,600 ft^3. However, production is primarily limited by maintaining a flow index below 1.32, and not the available rearing space. The following presents the potential capacity of the proposed additional raceway production (assuming 6 cfs of freshwater demand) for catchable Rainbow Trout. CDFW may opt to use the raceways for other programs; more detailed bioprogramming would occur during advanced design phases to ensure production strategies maximize CDFW's return on investment during operations.

- **Tank Description**. Four 500-foot raceway sections. Organized as two upper sections and two lower sections separated by a mid-pond aeration system.
- **Raceway Dimensions.** Each raceway (4 total): 500 ft x 10 ft x 1.83 ft
- **Raceway Volume**. Each raceway: 9,150 ft^3 Total available: 36,600 ft^3
- **Flow Description**. There are 6 cfs of available fresh water, 100% is reused once in the lower 500-foot raceways. Therefore, 12 cfs of process flow is included in capacity calculations.

- **Flow Rates.** Each raceway: 1,346.5 gpm (3 cfs) Total: 5,386 gpm (12 cfs); 6 cfs is reused in lower sections
- **Max Capacity of Catchable Rainbow Trout (FI<1.32**. Each raceway: 34,552 fish (17,276 lbs) Total: 138,208 fish (69,104 lbs)

5.1.6 Raceway Upgrades

Skim Coating and Epoxy Coating

The concrete raceways have aged and deteriorated over time resulting in pitting, roughness, and cracking. The rough and cracked concrete surfaces are not ideal for fish rearing as the surfaces can irritate fish when they contact the walls, and cracks and spalling are difficult to keep clean and disinfect. Adding a coating to the concrete can help alleviate the present issues and reduce the rate at which the concrete surface deteriorates. Raceway coatings are typically epoxy, polyurethane, or mortar based, but they all serve the same general purpose. Prior to coating the raceways, they must be emptied, cleaned, and completely dried. Additionally, any large cracks in the existing concrete will need to be fixed prior to coating. After applying, the coating will need to cure which can take anywhere from 1 to 14 days depending on the manufacturer's instructions and base component of the coat. Depending on factors such as weather and sun exposure, raceway coatings can last anywhere from 5 to 15 years. Applying a coat to the concrete creates a surface which is easier to clean, does not promote algae growth, and reduces sun and water exposure to the aging concrete underneath.

Repair Existing Predation Exclusion

The existing avian predation exclusion wire above the raceways can become tangled, creating gaps for night herons and ravens to enter the raceways. The preferred alternative is to untangle and repair existing deficiencies with the bird wire system. Special consideration will be required during design given potential snow load at Fish Springs Hatchery.

5.1.7 New Rainbow Trout Hatchery Building

The existing hatchery building has been utilized for early rearing for the Rainbow Trout, Brown Trout, and the Cutthroat Trout. The hatchery building only contains 20 deep tanks which limits the hatchery's ability to reach its production potential. Based on rearing volume, the deep tanks can produce 298,452 Rainbow Trout at 200 fpp (2.3 inches) and based on water flow, the deep tanks can produce 211,305 Rainbow Trout at 200 fpp per the Capacity Bioprogram in the Site Visit Report. More importantly, the production of Rainbow Trout in the existing hatchery building conflicts with the production of Brown Trout and Cutthroat Trout in nine of the twelve months of the year.

The preferred alternative is to construct a new hatchery building for the Rainbow Trout Program which includes the production of four strains of Rainbow Trout (i.e., Hofer, Shasta, Eagle Lake, and West Virginia; received as eyed eggs from the Mount Shasta Hatchery). The proposed tank configuration is based on the production of four groups of Rainbow Trout received at staggered intervals throughout the year. This building would be a pre-engineered metal building (PEMB) with standard, easy to clean finishes. A dedicated HVAC system would be included to maintain temperature and humidity, as well as lighting controls to aid production as needed. Additionally, a new photovoltaic system would be included atop the proposed Rainbow Trout hatchery building to help offset the power requirements of the new hatchery infrastructure while also lowering operating costs.

Maintain Production

The preferred alternative to maintain production is to construct a 5,600 SF building. Utilizing the same dimensions as the deep tanks in the existing hatchery building (i.e., 18-feet long, 2.67-feet wide with an operating depth of 1.5-feet), a total of 30 deep tanks operating with a flow rate of 25 gpm will allow the hatchery to produce approximately 205,000 juvenile Rainbow Trout to a size of 150 fpp (2.6 inches) for each group of Rainbow Trout resulting in a DI of 0.24 and a FI of 0.70. Raising the fish to the 150 fpp size allows hatchery staff to administer a bath vaccination treatment for *Lactococcus* spp. prior to the fish being transferred into the PRAS circular tanks. This is also the size when hatchery staff will be transitioning the fish from the crumble style feeds to the pelleted style feeds reducing the potential of tank fouling in the PRAS systems.

The volume of each deep tank is 72 ft^3, and the total rearing volume for the proposed building is 2,162 ft^3. Each deep tank is provided with a flow rate of 25 gpm for a total maximum flow rate of 750 gpm (1.67 cfs) if all tanks are in use at the same time. It is assumed that the existing hatchery building would continue to be used for Brown Trout and Cutthroat Trout production, requiring 440 gpm (0.98 cfs) of water flow. Combined, the hatchery buildings would require approximately 1,190 gpm (2.65 cfs) to operate all tanks simultaneously.

Maximize Production with Water Usage Reduction (18 cfs)

To support full use of the available water supply of 18 cfs, the new 7,600 SF Rainbow Trout hatchery building would include 45 deep tanks total. Tank dimensions and flow rates would remain the same as the previous scenario to maintain production. This would allow the building to grow approximately 350,000 Rainbow Trout at once to a size of 150 fpp, providing an adequate group of fish to maximize production in the PRASs for this scenario. The water consumption of the building would increase to 1,125 gpm (2.51 cfs) to operate all tanks simultaneously. Combined with the existing hatchery building, egg incubation and early rearing at the facility would demand approximately 1,565 gpm (3.49 cfs) to operate all tanks at once.

Incoming Egg Disinfection and Quarantine Area

For both scenarios, the construction of a dedicated quarantine area adjacent to the hatchery building is suggested. The quarantine area would limit the biosecurity risk of hatchery eggs brought on site being a potential pathway for pathogens to enter the facility. The area would be used to temporarily hold eggs received from Mt. Shasta Hatchery, Crystal Lake Hatchery, and the Heenan Lake egg collection station until they are disinfected and determined to be a low risk for transmitting pathogens to the general hatchery population. The quarantine area would consist of a separate covered area adjacent to the Rainbow Trout hatchery building. A pass-through window would ensure that only disinfected eggs could enter the hatchery building, increasing biosecurity by preventing staff working with unclean eggs from entering the building. The quarantine area would have hoses, worktables, and drainage separate from hatchery building. Eggs would be disinfected and enumerated in the quarantine area upon arrival before being placed into incubation units inside the hatchery building.

5.1.8 Add a Chiller to the Existing Hatchery Building for the Cutthroat Trout

The Cutthroat Trout eggs are collected from Heenan Lake and transferred directly to the Fish Springs Hatchery as newly fertilized green eggs. The hatchery experiences higher losses and desires the ability to incubate the eggs and rear the fish on cooler water temperatures. The incoming well water temperatures are a constant 60°F which is at the upper end of the desired range for salmonids. The combined water usage in the existing 20 deep tanks in the hatchery building at a flow rate of 22 gpm each is 440 gpm. The preferred alternative is to add a chiller system capable of providing an inflow water temperature of 52-55°F for the Cutthroat Trout in the troughs (and upwelling jars during incubation). The chiller system can either chill a portion of this water to a lower temperature and inject it back into the delivery system allowing it to mix before it reaches the tanks or chill all of this water to yield the desired water temperature.

5.1.9 Backup Power Generation

It is important to ensure that backup power generators are appropriately sized to accommodate the permanent reuse equipment, and any other additional technology proposed. New propane-fed backup power generators would be installed to maintain production operations during periods of power outages. The generators will be chosen to meet current air quality standards required for this area and sized to meet the power needs of the hatchery during temporary outages.

5.1.10 Demolish and Remove Nursery Raceways

As identified in the Site Visit Report, the nursery raceways are no longer used due to construction issues. The slope of the existing nursery carried water away from the drains. The new hatchery building would provide adequate early rearing space to maintain production under the current vaccination requirements. The preferred alternative is to demolish and remove these nursery raceways. The space could then be used to facilitate the construction of other components of proposed alternatives.

5.1.11 Incorporate Bubbler System and Flow Measurement to Settling Ponds

New Zealand Mud Snails have been found in the settling ponds and receiving waters at Fish Springs Hatchery in the past but have not been found in any of the rearing vessels. In an effort to reduce the risk of mud snails entering the facility directly from the setting pond and impacting production, the incorporation of a bubbler system is recommended between the effluent discharge pipe and the settling pond. A bubbler system would reduce the risk of NZMS attaching to the effluent discharge pipe and climbing into the facility.

According to hatchery staff and site visit observations, there are currently no means to measure the flow entering or exiting the settling ponds. Adding a flow meter to the effluent discharge pipe or a flow measurement weir and staff gauge at the exit of the settling pond would be beneficial for maintaining future compliance.

5.2 Pros/Cons of Selected Alternative

Table 5-3 provides a high-level summary of the pros and cons for Fish Springs Hatchery's selected alternative.

Table 5-3. Pros/Cons of Selected Alternative – Fish Springs Hatchery.

Description	Pros	Cons
Upgrade well houses from diesel to propane for backup generators.	• Improves exhaust emissions. • Potentially lowers operational costs. • Provides easier sourcing as more than 1 days' worth of propane can be available.	• Increases cost due to generators. • Loss of value as CDFW recently replaced with new diesel-powered generators. • Has long distribution lead time on large generators.

Description	Pros	Cons
Upgrade the alfalfa style plate valves and piping.	• Improves operability and control of flow. • Increases in hatchery infrastructure lifespan.	• Increases cost due to installation. • Disrupts hatchery operations during construction. • Should not be done until throttle valves are added to the well supply pipes.
Rebuild aeration tower.	• Improves aeration efficiency. • Increases in DO saturation in production water.	• Disrupts hatchery operations during construction.
Construct a new production building with solar panels.	• Protects against heat gain. • Protects fish against sunburn. • Improves biosecurity and lowers predation losses. • Offsets energy requirements.	• Increases cost due to installation and operation.
Add PRAS circular tanks to the new production building.	• Improves water quality within rearing vessels. • Improves flow control. • Provides a healthier rearing environment for fish. • Provides self-cleaning. • Reduces total water required and provides flexibility. • Concentrates waste for effluent treatment for NPDES permit.	• Increases cost due to system installation. • Requires additional training for staff. • Increases pumping on site. • Requires additional components (e.g., drum screen, UV, LHO, CO_2 removal). • Increases complexity.
Upgrade raceways.	• Provides a smoother rearing environment, reduces algae growth, and protects concrete from further deterioration by resurfacing raceways. • Adds avian predation exclusion and has the potential to decrease fish loss and increase biosecurity.	• Disrupts hatchery operations during raceway resurfacing.

Description	Pros	Cons
Construct a new hatchery building with solar panels for the Rainbow Trout Program.	• Addresses early rearing volume limitations. • Eliminates rearing conflicts with Brown Trout and Cutthroat Trout. • Allows Rainbow Trout to be reared following healthy DI and FI criteria. • Allows fish to be vaccinated prior to transfer to larger rearing vessels. • Requires no additional training as early rearing in linear tanks is consistent with the hatchery's current rearing techniques and strategy. • Offsets energy requirements. • Improves biosecurity as there will be a quarantine area for incoming eggs.	• Increases new water demand at the facility. • Increases cost. • Disrupts hatchery operations during construction (this is new, so production should be minimally impacted if at all).
Add chiller to the existing hatchery building for Cutthroat Trout.	• Improves egg and rearing survival. • Reduces disease risk.	• Increases cost. • Increase maintenance for chiller. • Increases complexity.
Provide backup power generation.	• Provides power redundancy in case of potential climate change effects on power supply.	• Increases cost system installation. • Has a long distribution lead time on large generators.
Demolish and remove nursery raceways.	• Removes aging and unused infrastructure. • Provides available space for future expansion of hatchery.	• Increases cost.
Incorporate bubbler system and water flow measurement to settling ponds.	• Increases biosecurity. • Reduces the risk of NZMS entering the facility from the settling pond. • Provides flow measurement that would be beneficial for future compliance.	• Increases cost.

5.3 Alternatives for Short-Term Improvements

In the event that funding is not available to construct the preferred alternative, the following short-term improvements are recommended for continued hatchery operation.

5.3.1 Aeration Tower Upgrade

The existing aeration tower distribution only utilizes two of the three available packed columns for degassing supply water. The preferred alternative is to redistribute incoming hatchery water through all three packed columns to improve the gas exchange rate from air to water.

5.3.2 Raceway Upgrades

Skim Coating and Epoxy Coating

The concrete in the raceways is showing signs of aging. The abrasive surface caused by aging can be harmful to fish as well as a surface that promotes algae growth. Adding a coating to the concrete can help alleviate the present issues and reduce the rate at which the concrete surface deteriorates. Raceway coatings are typically epoxy, polyurethane, or mortar based, but they all serve the same general purpose. Prior to coating the raceways, they must be emptied, cleaned, and completely dried. Additionally, any large cracks in the existing concrete will need to be fixed prior to coating. After applying, the coating will need to cure which can take anywhere from 1-14 days depending on the manufacturer’s instructions and base component of the coat. Depending on factors such as weather and sun exposure, raceway coatings can last anywhere from 5-15 years. Applying a coat to the concrete creates a surface which is easier to clean, does not promote algae growth, and reduces sun and water exposure to the aging concrete underneath.

Roof Structure with Side Enclosures

Covering the raceways with a solid roof structure and enclosing the sides (e.g., fine mesh chicken wire) to eliminate access to predators, ducks, etc. would improve biosecurity. Additionally, with the presence of New Zealand Mud Snails in the surrounding waters of Fish Springs Hatchery, covering the raceways reduces the risk of birds bringing mud snails into the facility. The solid roof structure would also reduce the warming effects of the hot summer sun as the water passes through the 1,000-foot-long raceways. As mean and maximum ambient air temperatures continue to rise in the future, reducing the solar effects on water temperature in the hatchery will be critical to maintaining temperatures within the range for salmonids. This is especially important given that when air temperatures peak in the summer months, raceway water can already reach the upper range for salmonids which is when Lactococcosis symptoms and mortalities have occurred historically.

Additionally, a new photovoltaic system would be included atop the raceway roof structure to help offset the power requirements of the new hatchery infrastructure while also lowering the overall cost of operating the hatchery.

Replacement of Raceway Head Valves

Fish Springs Hatchery's existing infrastructure utilizes alfalfa plate-style valves for the raceways which limits overall control of hatchery flows. The raceway head valves should be upgraded to include water control valves. Control valves will greatly improve operational challenges, allow for better flow control, and allow for the raceways to continue operating into the future.

5.3.3 Incorporate Bubbler System and Flow Measurement to Settling Ponds

New Zealand Mud Snails have been found in the settling ponds and receiving waters at Fish Springs Hatchery in the past but have not been found in any of the rearing vessels. The incorporation of a bubbler system is recommended between the effluent discharge pipe and the settling pond to reduce the risk of NZMS attaching to the effluent discharge pipe and climbing into the facility.

According to hatchery staff and site visit observations, there are currently no means to measure the flow entering or exiting the settling ponds. Adding a flow meter to the effluent discharge pipe or a flow measurement weir and staff gauge at the exit of the settling pond would be beneficial for maintaining future compliance.

5.4 Natural Environment Impacts

The proposed upgrades to the Fish Springs Hatchery should have negligible impacts on the natural resources in the surrounding area. All improvements would occur within currently developed areas, avoiding requirements for additional environmental or cultural permits not identified in Section 7.0 . An exception may occur if any existing structures fall under the jurisdiction of California's Office of Historic Preservation (OHP).

5.4.1 Fire and Flood Risk

The recommended changes to Fish Springs Hatchery will change the existing infrastructure and the number of rigid structures on site. However, they will not increase or decrease the fire risk. Based on the climate change evaluation, the projected fire risk is moderate through mid-century. Historic wildfires nearby indicate that fires are possible even in the desert shrubland.

The recommended changes will increase the total impervious surface on the site but decrease the impact of flooding on the facility. This is primarily done by changing the type of rearing vessel from concrete raceways to fiberglass circular tanks. Installing circular tanks for intermediate and final rearing will provide some additional flood protection. The tanks will be placed with the tank tops located 30 to 36 inches above ground. The tank height will provide protection from overland flow entering fish rearing vessels, and the ground will be graded to carry water away from the tanks to the extent feasible.

Additionally, replacing the valves and piping will provide the hatchery with better flow control of the facility. The hatchery staff will be able to manage surges in flow and prevent flooding of the rearing vessels.

5.4.2 Effluent Discharge

The recommended changes to maintain production at the hatchery do not include an overall increase in production goals at Fish Springs Hatchery. This will ensure there will be no change to NPDES permit requirements. If improvements to increase and maximize production are implemented, the NPDES permit may need to be reevaluated to maintain compliance. The recommended alternatives may lead to a slight increase of the waste production concentration of the effluent if fish production is maintained but water use is reduced. However, the existing settling ponds are assumed to have sufficient retention time to maintain water quality required by the NPDES permit.

It is important to note that changes to existing aquaculture programs (renovations, new construction) may trigger (administratively) the requirement for new and/or updated NPDES permits. Acknowledging that waste load (fish biomass) is not anticipated to change with the proposed alternatives, we assume that the increase in effluent removal efficiencies provided by the PRAS systems will result in net effluent “gains” to the overall aquaculture program.

5.5 Hatchery Operational Impacts/Husbandry

Multiple groups (pulses) of trout will be produced starting at different times throughout the year to maximize production capability at the hatchery. Early rearing fish culture practices will continue as the hatchery has operated previously with single pass flow-through in the deep tanks. As the fish outgrow the deep tanks, they will be transferred into PRAS circular tanks. A small fish pump (e.g., 2.5-inch hose diameter) would minimize handling and stress on the fish as they are transferred. If enumeration of the fish is desired, a fish counter may be utilized in conjunction with the fish pump. Linear distances from origin to destination rearing tanks may limit how fish can be transferred throughout the hatchery. Once the fish are in the grow-out PRAS circular tanks, the fish will be grown to their target release size at which time they will maximize the biomass and DI capacity of the system. Truck loading for fish release will basically continue as the hatchery has operated in the past utilizing fish pumps and dewatering towers with a few minor adjustments unique to circular tanks relative to traditional raceways.

One of the benefits of this proposed design is to provide means for staff to maintain fish health and welfare. The construction of a new hatchery building dedicated to Rainbow Trout will provide more culture volume, enabling the hatchery to raise young fish to a larger size to allow for vaccinations (i.e., Lactococcosis) or administer chemical treatments as needed. This also isolates production among the different species raised at the Fish Springs Hatchery, providing a more secure production environment for its more sensitive species such as Cutthroat Trout.

5.5.1 PRAS Circular Tank Operations

The grow-out circular tanks will operate as PRASs, reusing up to 75% of their water flow. The hydraulic self-cleaning characteristics of the circular tanks will reduce labor associated with tank cleaning. Additional tank sweeper systems are also available and can further reduce staff labor associated with maintaining tank hygiene. Staff time will be required for monitoring PRAS components including routine water quality checks, flow adjustments, and monitoring LHO and CO_2 systems to ensure a high-quality rearing environment. Staff will make routine flow adjustments as fish grow to maintain a maximum velocity of approximately two body lengths/second (or as required for fisheries management objectives). Seine nets, clamshell crowders, or other crowder types can be used to concentrate fish for collection and handling.

Transfer of fish between tanks and for truck loading will utilize fish pumps and hosing to minimize handling and stress on the fish and decrease physical labor for staff transferring fish between tanks or loading trucks. For transferring fish into other rearing tanks requiring enumeration, a fish counter can be included at the receiving tank to obtain an accurate inventory of the fish. For fish being loaded onto a transport tanker for stocking, a dewatering tower will allow for the removal of the water through a screen prior to the fish entering the fish transport tanker. This is consistent with current hatchery practices as well as industry standards and practices and allows the hatchery to quantify fish biomass based on water displacement in the fish transport tanker. The return of the water from the dewatering tower to the PRAS module sump will be necessary to maintain the water balance within the PRAS module. Another option is to increase the fresh make-up water flow to compensate for this water loss in the module during the fish pumping process.

5.5.2 PRAS Equipment

The PRAS provides tremendous benefits in reducing the water flow requirements to produce large numbers/biomass of fish while maximizing water quality. However, these systems are more complex and require additional skillsets to monitor and maintain the equipment to ensure reliable system operations for successful fish production. Given the staggered production cycle using multiple groups of trout, the PRAS modules will not all be occupied at the same time, providing maintenance windows and opportunities for cleaning and disinfection. All PRASs should be programmed into the facility's maintenance and management system to schedule, perform, and document preventative and corrective maintenance.

5.5.3 Feeding

Early rearing feeding techniques in the deep tanks can continue using the hatchery's standard feeding practices. Hatchery staff will need to transition away from the blower-style feeding systems typically used for linear raceways to a feeding system designed for circular tanks. Fish can be fed in circular tanks utilizing the simplest of methods ranging from hand-feeding to automated systems and the techniques may vary depending on the size of the circular tanks and staff preferences. In addition to staff preferences, there are pros and cons associated with the various feeding options. Hand-feeding requires more staff time compared to automated feeding systems as it is labor intensive but allows staff to observe fish feeding and overall behavior and health. Hand-feeding allows the staff to feed the fish to satiation and minimizes overfeeding reducing wasted feed and maximizing water quality. Automated systems require an initial cost for the purchase and installation of the system. The automated feeding systems provide feed intermittently throughout the day including staff non-duty times to maximize growth and reduce staff labor. However, automatic feeding systems reduce the staff's observations during feeding, require adjustments to deliver the correct amount of feed, require preventative and corrective maintenance, and continued costs associated with these maintenance requirements. It should be noted that hand and automatic feeding systems are not mutually exclusive. Even with automatic feeding systems, culture operations should still involve regular monitoring of fish and their feeding response throughout the day.

5.6 Biosecurity

The goal of biosecurity measures is to minimize the risk of pathogens entering the facility and spreading between rearing areas at the facility. Fish Springs Hatchery reported several pathogens of concern at the facility. This included *Lactococcus* spp., bacterial coldwater disease (causative agent *Flavobacterium psychrophilum*), bacterial gill disease (causative agent *F. branchiophilum*), and *Icthyobodo multifilis* (ich). The most likely pathway for pathogens to enter Fish Springs Hatchery and spread through the facility is through environmental exposure within the hatchery.

5.6.1 Incoming Water Supply

Fish Springs Hatchery relies exclusively on groundwater sources for its water supply. Groundwater is typically the preferred source because of the low risk of pathogens and stable temperatures. However, groundwater must be managed for dissolved gases, which can be elevated and cause environmental stress such as gas bubble disease. The recommended alternatives include rebuilding the aeration tower which will allow for more efficient gas stripping and aeration. Replacing outdated valves and piping will also improve the hatchery's ability to control the flow and reduce potential debris loads entering the rearing vessels.

5.6.2 Environmental Exposure/Bio Vectors

The existing facility has a few areas that are potential pathways for pathogens due to environmental exposure. The existing concrete raceways are enclosed by perimeter fencing with bird wires overtop, but these structures have been minimally effective in excluding mammal and avian predators from accessing the raceways. The recommended alternatives reduce the risk of pathogens entering the rearing areas by reducing environmental exposure. Implementing PRAS in a covered structure will limit potential pathogen vectors, such as birds, otters, etc., from entering the rearing vessels. Additionally, installing PRAS will ensure high-quality, treated water for all rearing vessels.

5.7 Water Quality Impacts

The recommended alternatives will improve the water quality within the existing rearing vessels as well as the effluent leaving the facility. Replacing the existing concrete raceways with dual-drain circular tanks can improve the water quality of the rearing environment. Dual-drain circular tanks provide a completely mixed environment as opposed to a raceway that has a gradient of high to low dissolved oxygen (DO) along its length. This characteristic of circular tanks makes the entire tank volume available to the fish, instead of fish crowding at a raceway's head end, thereby not using the entire raceway volume. The dual-drain system in circular tanks aids in waste removal, allowing for more effective removal of solid waste and uneaten feed. This can contribute to better overall water quality.

The other PRAS equipment will also improve the water quality within the system. The microscreen drum filters will remove the solids in the water. The LHOs will ensure the dissolved oxygen levels enter the tanks at saturation or higher. The carbon dioxide strippers will remove dissolved carbon dioxide as well as other undesirable gases. The UV unit will reduce the pathogen load of the water that returns to the tanks. Additionally, installing a rigid roof structure with bird netting will reduce heat gain during the summer months and algae growth in the rearing tanks.

Each PRAS module will concentrate the fish waste into smaller flows from the center drain and drum filter backwash. The effluent waste would still be sent to the existing settling ponds for treatment prior to discharge.

The recommended alternatives also include improving the incoming water quality. The rebuilt aeration tower will increase dissolved oxygen saturation entering the facility and more efficiently strip any other undesired dissolved gases. This will improve the water quality in the proposed hatchery building, PRAS circular tank modules, and existing concrete raceways.

6.0 Alternative Cost Evaluation

6.1 Introduction

McMillen has utilized historical costs as a self-performing general contractor in the performance of similarly-technical projects, as the basis of the Preliminary Concept Planning – Opinion of Probable Construction Cost (OPCC) estimate for this Project. Additionally, McMillen has solicited pricing or utilized recently received material quotes for similar materials and equipment or components. The appropriate overhead and profit markups have been included in the project pricing. The detailed cost estimates, including assumptions and inflation information are presented in Appendix F.

6.2 Estimate Classification

This OPCC estimate is consistent with a Class 5 estimate as defined by the Association for Advancement of Cost Engineering (AACE) classification system, as shown in Table 6-1 below. For purposes of this project, McMillen has utilized an accuracy range of -30% to +50% in the estimates presented in Table 6-2.

Table 6-1. AACE Class 5 Estimate Description (Source: Association for Advancement of Cost Engineering).

Criteria	Details
Description	Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systemic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with little effort expended—sometimes requiring less than an hour to prepare. Often, little more than proposed plant type, location, and capacity are known at the time of estimate preparation.
Level of Project Definition Required	0% to 2% of full project definition.
End Usage	Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.

Criteria	Details
Estimating Methods Used	Class 5 estimates virtually always use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, and other parametric and modeling techniques.
Expected Accuracy Range	Typical accuracy ranges for Class 5 estimates are -20% to -50% on the low side, and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.
Effort to Prepare (for US$20MM project)	As little as 1 hour or less to perhaps more than 200 hours, depending on the project and the estimating methodology used.
ANSI Standard Reference Z94.2-1989 Name	Order of magnitude estimate (typically -30% to +50%).
Alternate Estimate Names, Expressions, Synonyms:	Ratio, ballpark, blue sky, seat-of-pants, ROM, idea study, prospect estimate, concession license estimate, guesstimate, rule-of-thumb.

6.3 Cost Evaluation Assumptions

The following assumptions were made while developing the Class 5 cost estimates for this alternatives analysis:

- All unit costs assume the total cost for installation including any applicable taxes.
- The cost estimate is at a Class 5 level with an accuracy range of -30% to +50% and includes a 25% contingency. This range accounts for current inflation variability within aquaculture projects, unforeseen conditions, and anticipated cost escalation leading up to the projected construction year.
- Prevailing wages are provided as a general increase based on past construction pricing.
- All Division costs are rounded up to the nearest $1,000.
- Length and area dimensions for the estimate were derived from scaled AutoCAD drawings of the facility and the property. Survey was not utilized for this initial estimate.
- Geotech investigation cost assumes seven bore holes (20 feet deep), material testing, piezometer installation, and a written report.
- Topographic survey cost assumed is based on $1,000/acre.

- Building joist/eve height will be 18 feet.
- Site geotechnical properties have not been evaluated but are assumed to be good for construction of the hatchery.
- Topographic survey has not been completed. Site survey will be required to establish elevations of all systems to ensure proper hydraulics can be achieved.
- A facility condition assessment was performed for the Fish Springs Fish Hatchery in 2022 by Terracon (Terracon Consultants, Inc., 2022). The assessment included an inventory of all facilities and equipment, code evaluations, and upgrades required to meet the assessment including the detailed replacement value. The cost of all work items generated was $1,990,682 in 2022 dollars. The work items in the Terracon facility condition assessment are not included within this report, costs, or evaluation of facilities. Some work items from the Terracon facility condition assessment may be resolved as part of the proposed upgrades at the Fish Springs Fish Hatchery, while others may still need to be addressed. The upgrades in the Terracon reports may be included in future design efforts for each facility at CDFW direction.
- Additional division specific cost evaluation assumptions may be found in Appendix F.

6.4 LEED Assessment

RIM Architects (RIM) and STŌK have reviewed and assessed this facility’s location along with reviewing the combination of state law and Leadership in Energy and Environmental Building (LEED) eligibility requirements. From this review, it is determined that this location is not eligible or required under state law to pursue LEED due to the lack of human occupancy in the proposed structures and/or square footage requirements. There is insufficient scope to pursue LEED certification. Refer to Appendix H for more information.

6.5 Net Zero Energy Evaluation

The site can nearly achieve net zero energy by converting the existing predatory netting over the raceways into a shading structure with integrated photovoltaic (PV) panels. This innovative approach minimizes the need for additional PV space, effectively leveraging existing infrastructure to meet energy demands. Only an additional 150 square feet of area for PV installation would be required to achieve full net zero operation. However, the alternatives proposed in Section 5.0 do not include a shade structure with available space for PV installation over the raceways.

6.6 Alternative Cost Estimate

The following tables illustrate the estimated costs for each of the alternatives evaluated and depicted within the figures in Appendix C.

Table 6-2. Alternative Cost Estimate – Maintain Production.

Item	Estimate
Division 01 – General Requirements	$ 6,448,000
Division 02 – Existing Conditions	$ 236,000
Division 03 – Concrete	$ 3,725,000
Division 05 – Metals	$ 320,000
Division 08 – Openings	$ 60,000
Division 13 – Special Construction	$ 18,575,000
Division 23 – Mechanical & HVAC	$ 920,000
Division 26 – Electrical	$ 5,440,000
Division 31 – Earthwork	$ 657,000
Division 32 – Exterior Improvements	$ 50,000
Division 40 – Process Water Systems	$ 2,258,000
2024 CONSTRUCTION COST	**$ 38,689,000**
Construction Contingency	$ 9,672,000
Overhead	$ 2,321,000
Profit	$ 3,095,000
Bond Rate	$ 387,000
2024 CONSTRUCTION PRICE	**$ 4,164,000**
Design, Permitting, and Construction Support	$ 8,125,000
Geotechnical	$ 5,000
Topographic survey ($1000/acre)	$ 20,000
PROJECT TOTAL	**$ 62,334,000**
Accuracy Range +50%	$ 93,501,000
Accuracy Range -30%	$ 43,634,000
Photovoltaic (Full kW Required)	$ 10,101,000
Photovoltaic (Roof kW Available)	$ 2,976,000

Table 6-3. Alternative Cost Estimate – Maximize Production (18 cfs).

Item	Estimate
Division 01 – General Requirements	$ 10,265,000
Division 02 – Existing Conditions	$ 243,000
Division 03 – Concrete	$ 4,957,000
Division 05 – Metals	$ 320,000
Division 08 – Openings	$ 80,000
Division 13 – Special Construction	$ 31,318,000
Division 23 – Mechanical & HVAC	$ 1,563,000
Division 26 – Electrical	$ 8,090,000
Division 31 – Earthwork	$ 1,033,000
Division 32 – Exterior Improvements	$ 50,000
Division 40 – Process Water Systems	$ 3,669,000
2024 CONSTRUCTION COST	**$ 61,588,000**
Construction Contingency	$ 15,397,000
Overhead	$ 3,695,000
Profit	$ 4,927,000
Bond Rate	$ 616,000
2024 CONSTRUCTION PRICE	**$ 86,223,000**
Design, Permitting, and Construction Support	$ 12,934,000
Geotechnical	$ 25,000
Topographic survey ($1000/acre)	$ 25,000
PROJECT TOTAL	**$ 99,207,000**
Accuracy Range +50%	$ 148,811,000
Accuracy Range -30%	$ 69,445,000
Photovoltaic (Full kW Required)	$ 16,187,000
Photovoltaic (Roof kW Available)	$ 5,114,100

7.0 Fish Springs Trout Hatchery Environmental Permitting

The proposed Project would involve the modification to the existing hatchery or construction of a new hatchery facility and associated infrastructure. A list of anticipated permits, agency review time, submittal requirements, and supporting documentation for the proposed project regardless of which alternative is selected are summarized in Table 7-1, Table 7-2, and Table 7-3. The review timeframes are estimated and are based on the recommendations presented in permit guidance documentation and experience with other permitting projects in California.

We reviewed the location through online mapping tools (USFWS IPAC and California BIOS) to determine if species listed under the Endangered Species Act (ESA) and the California Endangered Species Act (CESA) potentially occur at the site. The results indicated that the site has the potential for species to be present identified as endangered or threatened. The site does not contain critical habitat. The results of these mapping tools indicate that a Biological Assessment of the area would need to be prepared prior to consultation with the USFWS, NOAA, and other state agencies.

The list is developed at a high level and additional permits may need to be assessed as the project is advanced.

Table 7-1. Anticipated Federal Permits and Approvals for Selected Location

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
USFWS National Environmental Policy Act (NEPA) Compliance	Environmental Assessment	Analysis of potential impacts on various natural resources, Design Package	12 – 18 months	Evaluation of the selected alternative to identify if there would be a significant impact
U.S. Army Corps of Engineers (USACE) Clean Water Act (CWA) Section 404 - Nationwide Permit Authorization	Pre-Construction Notification Application	Wetland and Stream Delineation, Design Package	3 months	Required if jurisdictional waters of the US or wetlands are affected by the project area

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
USFWS ESA Section 7 Consultation	Biological Assessment	Field surveys of affected area, Design Package	4 months	The site has potential for species listed under the ESA to occur
National Oceanic and Atmospheric Administration (NOAA) Section 10(a)(1)(A) of the ESA	Application	Supplemental information to include description of proposed project, analysis of potential take and potential impact to species, proposed minimization and mitigation measures, and funding source	4 months	Authorization for scientific purposes or to enhance the propagation or survival of an endangered or threatened species

Table 7-2. Anticipated State Permits and Approvals for Selected Location

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
Lead Agency TBD California Environmental Quality Act (CEQA)	Environmental Impact Report	Analysis of potential impacts on various natural resources, Design Package	12 – 18 months	Required for issuing State permits. Potential to be coordinated with the NEPA compliance for efficiency

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
California Department of Fish and Wildlife (CDFW) California Fish and Wildlife Code Section 2081 Incidental Take	Application	Supplemental information to include description of proposed project, analysis of potential take and potential impact to species, proposed minimization and mitigation measures, and funding source	4 months	Required for the authorization to take any species listed under the California Endangered Species Act
California Department of Fish and Wildlife (CDFW) California Fish and Wildlife Code Section 1600 Lake and Streambed Permits	Application/ Notification	NA	1-3 months	Required for hatchery intake diversions
Lahontan Regional Water Quality Control Board (RWQCB) 401 Water Quality Certification	Application	Wetland and Stream Delineation USACE Review NEPA/CEQA Compliance	3 months	Required if jurisdictional waters of the US or wetlands are affected by the project area
California Office of Historic Preservation Section 106 Review	Concurrence Request Letter	Cultural Resources Survey, Design Package	3 months	Required as part of the NEPA/CEQA process
California Division of Water Rights Water Rights	Application or Transfer	NA	4 months	NA

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
California State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES)	Application	NA	1 month	Required if hatchery effluent is discharged to a jurisdictional waterway
SWRCB Construction General Permit	Application	Stormwater Pollution Prevention Plan (SWPPP)	2 months	Required if construction activities disturb greater than one acre

Table 7-3. Anticipated Inyo County Permits and Approvals for Selected Location

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
Inyo County Building and Safety Construction Permits	Grading, Building, Electrical, Mechanical, Pumping Applications	Project Summary and Design Package	2 months	NA

7.1 National Pollutant Discharge Elimination System (NPDES) Permitting

The Fish Springs Trout Hatchery is classified as a cold water Concentrated Aquatic Animal Production (CAAP) facility and is eligible to operate under General Order R6V-2015-0034 issued by the Regional Water Quality Control Board, Lahontan (Region 6) and NPDES Permit No. CA102806.

The hatchery discharges through Outfall 001:

Latitude 37°, 05’, 42” N, Longitude 118°, 15’, 17” W

The following limitations for effluent are specified:

- pH: 6.5 (instantaneous minimum), 8.5 (instantaneous maximum)
- Total suspended solids: 6.0 mg/L (average monthly net over influent concentration), 15.0 mg/L (instantaneous maximum)
- Flow: 26 mgd (average monthly)
- Formaldehyde: 0.65 mg/L (average monthly), 1.3 mg/L (daily maximum)
- Hydrogen peroxide: 1.3 mg/L (daily maximum)
- Nitrate: 1.0 mg/L (instantaneous maximum)
- Nitrogen: 1.8 mg/L (instantaneous maximum)
- Potassium permanganate: 0.12 mg/L (average monthly), 0.25 mg/L (daily maximum)
- Settleable solids: 0.1 mg/L (average monthly)
- Total dissolved solids: 265 mg/L (instantaneous maximum)

7.2 Water Rights

Water rights documentation can be obtained from the client if requested by an agency.

8.0 Conclusions and Recommendations

The report provides a summary of the state of the Fish Springs Trout Hatchery, identifies and quantifies the impacts the hatchery could experience as a result of climate change, and provides proposed facility design modifications to increase the resiliency of the hatchery in conjunction with the associated costs and the potential impacts of the proposed modifications.

The in-depth analysis of the available hydrologic and climatologic data performed by NHC provides projections to forecast changes that may be experienced at the hatchery. In general, significant increases in air temperature are expected at Fish Springs Hatchery. Groundwater supply is not expected to warm appreciably, but given current temperatures in the upper range for fish rearing, additional warming may require adaptation. Additionally, the risk of wildfire is moderate.

To meet CDFW's goal of continuing to provide recreational fishing opportunities for the public and for the conservation of endangered or threatened species as the climate changes, the resiliency of existing hatcheries will need to be increased. Increasing resiliency will also require updating existing infrastructure that is nearing the end of its effective lifespan.

Some recommendations that would help to achieve this goal include the following:

- Replacing each well's backup generator with a propane-powered generator has the potential to improve exhaust emissions and potentially lower operational costs.
- Replacing pipes and valves that are near the end of their effective lifespan or are currently inoperable due to age will provide improved flow control.
- Replacing an aeration tower with oxygenation will improve production water quality.
- Demolishing the unused well on site will provide space for additional rearing infrastructure.
- Replacing flow-through style raceway production with circular dual-drain tanks utilizing PRAS will reduce the amount of water that is required to raise fish.
- Covering all rearing vessels with solid roofs will reduce the impacts of increased air temperatures for both the fish and the employees.
- Refinishing the concrete raceways with a skim and epoxy coating will extend the usable life of existing rearing infrastructure.
- Constructing a hatchery building for the Rainbow Trout Program will eliminate early rearing conflicts with Brown Trout and Cutthroat Trout and allow for indoor vaccinations. Providing a quarantine area for incoming eggs will improve biosecurity.

- Providing a chiller to the existing hatchery building will provide Fish Springs Hatchery with the ability to incubate eggs and rear fish in cooler water temperatures.
- Providing additional backup power generators will ensure that hatchery staff can maintain production operations during periods of power outages.
- Demolishing the nursery raceways will remove unused infrastructure, freeing up space for other components of the proposed alternatives.
- Incorporating a bubbler system to the settling pond would reduce the risk of NZMS attaching to the effluent discharge pipe and climbing into the facility.
- Installing a flow meter to the effluent discharge pipe or a flow measurement weir and staff gauge at the exit of the settling pond would be beneficial for maintaining future compliance.
- Installing solar panels atop new structures will offset some of the power demands associated with new hatchery equipment.

Per CDFW's request, alternatives were also provided to maximize production at Fish Springs Hatchery utilizing 18 cfs and 24 cfs of water supplied to the hatchery. The 18 cfs scenario is based on the hatchery water consumption reduction sought by the Big Pine Paiute Tribe and Inyo County to conserve groundwater in the Owens Valley. This scenario consists of the same recommendations listed above, but the quantities of incubation jars, early/intermediate rearing deep tanks, and final rearing circular tank PRAS modules were increased. The number of tanks was determined by the fresh make-up demand of all tanks and the total water supply of 18 cfs while providing a ~0.25 cfs buffer. The 24 cfs scenario reflects the current water consumption of the facility. This scenario consists of the same recommendations and quantities of tanks as the 18 cfs scenario, with the additional 6 cfs available for fish rearing in the existing raceways.

The proposed upgrades to the Fish Springs Hatchery would have negligible impacts on the natural resources in the surrounding area. All improvements would occur within currently developed areas, which lessen the permit requirements. The total cost estimate of the proposed design modifications to maintain production is $62,334,000 and to maximize production utilizing the available water supply (18 cfs) is $99,207,000.

9.0 References

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