Climate Induced Hatchery Upgrades

Hot Creek Hatchery

Alternatives Analysis Submittal

Final Report
Revision No. 4

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Revision Log

Revision No.	Date	Revision Description
0	5/03/2024	65% Draft Internal Technical Review
1	5/10/2024	65% Draft for CDFW Review
2	9/4/2024	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).

Hot Creek Hatchery has an aging infrastructure and deficiencies that need to be addressed to meet and maintain fish production goals. The spring water source for the facility is unreliable; flow rates from some spring flows can decrease to 12 cubic feet per second during certain months. Spring water capture and screening infrastructure is also aging and in need of replacement. Additionally, the water source is infested with the aquatic invasive species New Zealand Mud Snails (*Potamopyrgus antipodarum*, NZMS), which significantly limits where hatchery fish can be released. The paved asphalt throughout the facility is cracking and destroyed in many areas and is a liability for CDFW. Concrete surfaces of the raceways are cracking and spalling, and predator exclusion infrastructure is inadequate which causes low survival rates for fish. The backup power generators are undersized and incapable of powering all water treatment systems simultaneously. Because fish must be raised indoors for longer to reach proper vaccination sizes, there is not enough available rearing space for early life stages to execute ideal vaccination procedures. Lastly, the current effluent system does not effectively condition water before discharge, and the facility has had several compliance issues with its National Pollutant Discharge Elimination System (NPDES) permit. These issues have all been noted during site visits and discussions with hatchery staff. The negative impacts associated with the hatchery's deficiencies are expected to magnify as climate change impacts become more severe. The infrastructure issues must be addressed to maintain fish production in the present and future.

The preferred alternative for hatchery upgrades includes adding a groundwater well as a supplemental water source, adding a water treatment facility for early rearing production water, replacing the concrete supply pond for Hatchery Building 2, replacing and upgrading site valves and piping, replacing the production raceways with circular tank PRAS, replacing the Rainbow Trout broodstock raceway and adding a roof structure and predator controls, repairing and resurfacing the Brown Trout broodstock raceway and adding a roof structure and predator controls, replacing Hatchery Building 1 to help meet production goals, and removing and replacing asphalt paving throughout the hatchery.

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 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	Photovoltaic – Zero Net Energy
$65,426,000	$9,434,000

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 existing hatchery infrastructure deficiencies and replacement needs. The assessment was used to aid in determining the potential upgrades for each hatchery that would maintain 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 in the four previous objectives.

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 Hot Creek Hatchery is located in Mammoth Lakes, CA in the Eastern Sierra-Nevada Mountain Range approximately 37 miles from Bishop, CA (Figure 1-1).

Figure 1-1. Hot Creek Hatchery Location Map.

Fish production at the Hot Creek Hatchery dates to 1928 with trout reared in earthen ponds. The ponds were replaced with concrete raceways in the 1980s. In the 1990s, the hatchery buildings were replaced with a larger, more modern hatchery building. In 2006, New Zealand Mud Snail (*Potamopyrgus antipodarum*, NZMS) were detected at the hatchery; therefore, the hatchery is limited to stocking waters that are also NZMS positive.

The Hot Creek Hatchery raises Rainbow Trout (*Oncorhynchus mykiss*), Brown Trout (*Salmo trutta*), and Lahontan Cutthroat Trout (*O. clarkii henshawi*) with a combined production goal of approximately 152,000 pounds. The hatchery uses spring water originating from four springs for all fish production throughout all life stages (i.e., incubation, early rearing, and final rearing). The maximum water supply is 36 cubic feet per second (cfs), but flow is highly variable. Seasonally, low flows of 8 to 12 cfs are observed from December through April; this can worsen during drought cycles and have been as low as 1 cfs from the AB Spring Supply. The general facilities are shown in Figure 1-2. More detailed descriptions and photos of the Hot Creek Hatchery are described in the Site Visit Report (Appendix A).

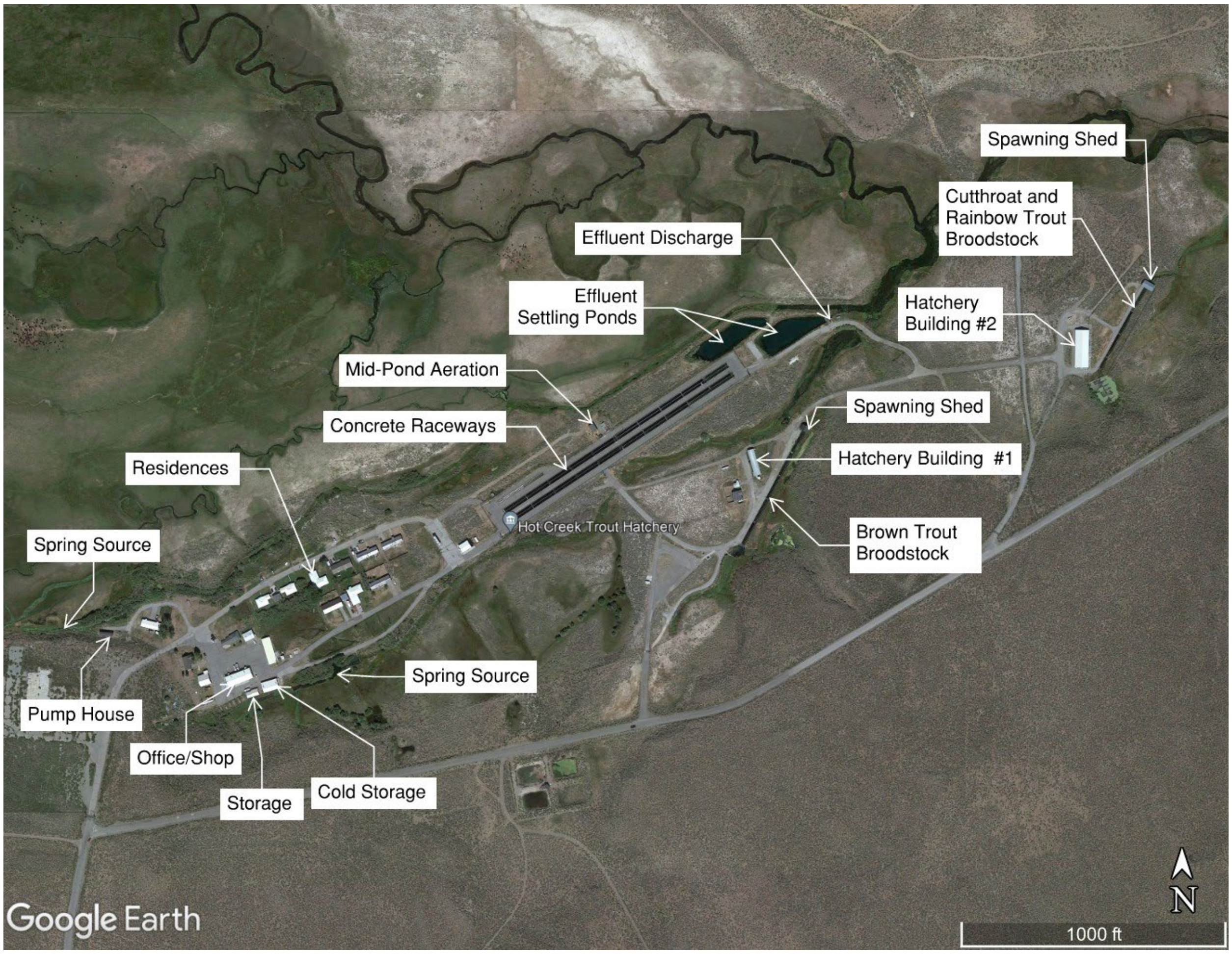

Figure 1-2. Hot Creek Hatchery Layout, Google Earth Image Date: September 2019.

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 Hot Creek 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 for all species combined at the Hot Creek Hatchery is approximately 152,000 pounds of fish, as provided by CDFW in the initial questionnaire. The rearing capacity determined by the Capacity Bioprogram is shown in Table 2-1, Table 2-2, and Table 2-3. The following are fish production goals for each species.

- **Rainbow Trout.** 10 fpp: 150,000 fish (15,000 lbs) / 2 fpp: 250,000 fish (125,000 lbs)
- **Brown Trout.** 10 fpp: 60,000 fish (6,000 lbs) / 2 fpp: 150,000 fish (75,000 lbs)
- **Lahontan Cutthroat Trout.** 10 fpp: 150,000 fish (15,000 lbs)

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

Rearing Unit (max. fish size in fish per pound [fpp])	Total Capacity (Fish)[a]	Limiting Factor
California Troughs Hatchery Building 2 (250 fpp/2.2 inches)	14,747 (59 lbs)	Rearing Volume
Deep Tanks Hatchery Building 2 (140 fpp/2.6 inches)	150,368 (1,074 lbs)	Water Flow
Silver Tanks Hatchery Building 2 (140 fpp/2.6 inches)	133,660 (955 lbs)	Water Flow
Round Tanks Hatchery Building 2 (140 fpp/2.6 inches)	106,928 (764 lbs)	Water Flow
Raceways (10 fpp/6.3 inches)	225,552 (22,555 lbs)	Water Flow[b]
Raceways (2 fpp/10.8 inches)	77,332 (38,666 lbs)	Water Flow[b]

[a] This is an estimate of 90% production capacity to allow for a buffer in circumstances where more flexibility is needed for hatchery operations.
[b] Although flow is identified as the limiting factor for production in the raceways, production numbers for this report were calculated based on limits of either rearing volume or water flow during early rearing since LHOs are utilized at the head and mid-point of the raceways, thus allowing for increased production in the raceways.

Table 2-2. Production Capacity of Brown Trout Rearing Units at the Hot Creek 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 Hatchery Building 1 (250 fpp/2.2 inches)	95,752 (383 lbs)	Rearing Volume
Raceways (10 fpp/6.3 inches)	75,184 (7,518 lbs)	Water Flow[b]
Raceways (2 fpp/10.8 inches)	25,777 (12,889 lbs)	Water Flow[b]

[a] This is an estimate of 90% production capacity to allow for a buffer in circumstances where more flexibility is needed for hatchery operations.
[b] Although flow is identified as the limiting factor for production in the raceways, production numbers for this report were calculated based on limits of either rearing volume or water flow during early rearing since LHOs are utilized at the head and mid-point of the raceways, thus allowing for increased production in the raceways.

Table 2-3. Production Capacity of Lahontan Cutthroat Trout Rearing Units at the Hot Creek 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 Hatchery Building 2 (160 fpp/2.6 inches)	112,140 (701 lbs)	Rearing Volume
Silver Tanks Hatchery Building 2 (160 fpp/2.6 inches)	139,552 (872 lbs)	Rearing Volume
Round Tanks Hatchery Building 2 (160 fpp/2.6 inches)	121,949 (762 lbs)	Rearing Volume
Raceways (10 fpp/6.6 inches)	78,764 (7,876 lbs)	Water Flow[b]

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

[b] Although flow is identified as the limiting factor for production in the raceways, production numbers for this report were calculated based on limits of either rearing volume or water flow during early rearing since LHOs are utilized at the head and mid-point of the raceways, thus allowing for increased production in the raceways.

2.2 Bioprogram Summary

The Capacity Bioprogram in the Site Visit Report demonstrates the total capacity of each rearing area at the Hot Creek 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 Hot Creek Hatchery falls short of the production goal discussed in Section 2.1.1; though, nuances of the timing of egg arrivals, fish stocking, and varied release sizes allows for annual production to exceed this total capacity. Details about the various rearing areas and infrastructure are discussed in the Site Visit Report.

In this 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 Hot Creek 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:

- There will be optimal conditions for egg development and fish growth given the existing water temperatures at the facility.
- Flow is highly variable at the facility from the spring water sources. It is assumed water flows meet the flow rates provided by CDFW for the various rearing vessels.
- The rearing volume for tanks utilized for early rearing in Hatchery 1 were combined, and tank dimensions were adjusted as well as the water flow rate per tank to represent the cumulative early rearing capacity. The total volume and flow rate were used for the Production Bioprogram calculations.
- The rearing volume for tanks utilized for early rearing in Hatchery 2 were combined, and tank dimensions were adjusted as well as the water flow rate per tank to represent the cumulative early rearing capacity. The total volume and flow rate were used for the Production Bioprogram calculations.
- The low head oxygenators (LHOs) located in the head box and at the mid-point of each raceway provide saturated oxygen levels for the lower 500 feet of the raceways; therefore, flow is not limiting as identified in the Capacity Bioprogram in the Site Visit Report (Appendix A).

Klontz (1991) provided optimal growth rates (variable based on water temperature) for Rainbow and Brown Trout at designated water temperatures, and survival rates were provided in the questionnaire completed by Hot Creek 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 Trout: 0.7 Brown Trout: 0.31 Cutthroat Trout: 0.32
Flow Index (FI)	1.02
Water Temperature	Variable 52-63°F

Table 2-5. Assumptions Used for the Production Bioprogram. Criteria are Discussed in Detail in Appendix A.

Species	Survival
Rainbow Trout	Egg-to-fry: 50% Fry-to-juvenile (140 fpp): 80% Juvenile-to-outplant (2 fpp): 50%
Brown Trout	Egg-to-fry: 28% Fry-to-juvenile (250 fpp): 70% Juvenile-to-outplant (2 fpp): 60%
Cutthroat Trout	Egg-to-fry: 60% Fry-to-juvenile (160 fpp): 80% Juvenile-to-outplant (10 fpp): 80%

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 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 incorporates the Rainbow Trout (Hofer), Brown Trout, and Lahontan Cutthroat egg receivals, growth and stocking schedules for the hatchery to maximize annual production.

2.2.2.1 Rainbow Trout (Hofer Strain)

The Rainbow Trout are typically spawned in November. It takes approximately 45 days from fertilization (i.e., green eggs) to first feeding using the hatchery's water temperature of approximately 56°F. The Rainbow Trout are initially reared in the early rearing tanks located in Hatchery 2. The first feeding would be initiated in mid-December when fish are approximately 4,218 fpp (0.84 inches). These fish should reach approximately 140 fpp (2.6 inches) by the end of February (Table 2-6). In this exercise, it is assumed that approximately 1,000,000 eggs are incubated, 500,000 fry are hatched from those eggs, and 390,000 juvenile fish are transferred to the raceways based on survival rates provided by the Hot Creek Hatchery staff. Available water flows in the early rearing systems limit the total number of fish that can be reared to the 140 fpp size. The established criteria in this scenario does not allow the hatchery to meet the production goal of 150,000 sub-catchable and 250,000 catchable Rainbow Trout. As the juvenile fish are transferred into the raceways from the early rearing tanks in Hatchery Building 2, they initially reside in five 100-foot sections of the raceways. As fish grow and biomass increases, they occupy 2.5 raceways (2,500 linear feet of raceways) of the four available raceways on site. The half-raceway used by the Rainbow Trout consists of the lower half (500 feet) of a raceway, downstream from the Lahontan Cutthroat production which occupies the upper half (500 feet) of the raceway. These fish remain in the raceways until they have reached their target size of 2 fpp in March yielding a total of approximately 224,640 catchable Rainbow Trout weighing 112,320 pounds. In the Capacity Bioprogram in the Site Visit Report (Appendix A), the FI was calculated based on water flow for the raceways without including the benefit of the LHOs relative to oxygen levels. The calculations for the Production Bioprogram below utilized the FI limitations (Table 2-4) for early rearing which in turn limits the number of juvenile fish transferred into the raceways to be produced as catchable Rainbow Trout.

Table 2-6. End of Month Production Information for the Rainbow Trout (Hofer) 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
Dec	Hat 2 Early Rearing Tanks	All Tanks	1,140	1.30	500,000	438.6	2.6	0.11	0.29
Jan	Hat 2 Early Rearing Tanks	All Tanks	312.5	2.00	445,000	1,424.0	2.6	0.23	0.61
Feb	Hat 2 Early Rearing Tanks	All Tanks	140.0	2.60	390,000[a]	2,785.7	2.6	0.34	0.92
Mar	Raceways	2.5	69.0	3.30	351,000	5,087.0	14.5	0.03	0.24
Apr	Raceways	2.5	42.0	3.90	312,000	7,428.6	14.5	0.04	0.29
May	Raceways	2.5	25.7	4.60	296,400	11,533.1	14.5	0.05	0.39
Jun	Raceways	2.5	16.7	5.30	280,800	16,814.4	14.5	0.06	0.49
Jul	Raceways	2.5	11.6	6.00	275,184	23,722.8	14.5	0.08	0.61
Aug	Raceways	2.5	8.2	6.70	269,568	32,874.1	14.5	0.10	0.75
Sep	Raceways	2.5	6.4	7.30	263,952	41,242.5	14.5	0.11	0.87
Oct	Raceways	2.5	5.0	8.00	258,336	51,667.2	14.5	0.13	0.99
Nov	Raceways	2.5	3.9	8.60	252,720	64,800.0	14.5	0.15	1.16[b]
Dec	Raceways	2.5	3.1	9.30	247,104	79,711.0	14.5	0.17	1.32[b]
Jan	Raceways	2.5	2.5	10.00	241,488	96,595.2	14.5	0.19	1.49[b]
Feb	Raceways	2.5	2.1	10.60	235,872	112,320.0	14.5	0.21	1.63[b]

Production Stage/Month	Tank Type	Tanks Occupied	fpp	Length (in)	Total Fish (#)	Biomass (lbs)	Max. Flow (cfs)	DI	FI
Mar	Raceways	2.5	1.7	11.30	224,640	132,141.2	14.5	0.23	1.80[b]

[a] This is approaching the maximum fish capacity of Hatchery Building 2 early rearing tanks for fish at this size based on available water flow.

[b] Although flow is identified as the limiting factor for production in the raceways, production numbers for the Rainbow Trout were calculated based on limits of water flow during early rearing which determines the number of fish transferred into the raceways. LHOs are utilized at the head and mid-point of the raceways thus allowing for increased production of Rainbow Trout in the raceways.

2.2.2.2 Brown Trout

Brown Trout eggs are collected in November. It takes approximately 60 days from fertilization (i.e., green eggs) to first feeding using the hatchery's water temperature of approximately 56°F. The Brown Trout are initially reared in the early rearing tanks located in Hatchery 1. The first feeding would be initiated in late-January when fish are approximately 4,218 fpp (0.84 inches). These fish should reach approximately 250 fpp (2.2 inches) by the end of March (Table 2-7). In this exercise, it is assumed that approximately 490,000 eggs are incubated, 136,000 fry are hatched from those eggs, and 95,750 juvenile fish are transferred to a raceway based on survival rates provided by the Hot Creek Hatchery staff. Early rearing space limits the total number of juvenile fish that can be reared to the 140 fpp size. Adhering to established criteria in this scenario does not allow the hatchery to meet the production goal of 60,000 sub-catchable and 150,000 catchable Brown Trout. As the juvenile fish are transferred into the raceways from the early rearing tanks in Hatchery Building 1, they initially reside in a single 100-foot section of a raceway. As these fish grow and biomass increases, they will occupy half of a full raceway length (500 feet). These fish will remain in the raceway until they have reached their target size of 2 fpp in June yielding a total of approximately 40,215 catchable Brown Trout weighing 20,108 pounds. In the Capacity Bioprogram in the Site Visit Report (Appendix A), the FI was calculated based on water flow for the raceways without including the benefit of the LHOs relative to oxygen levels. The calculation for the Production Bioprogram below utilized the DI criteria (Table 2-4) for early rearing which in turn limits the number of juvenile fish transferred into the raceways to be produced as catchable Brown Trout.

Table 2-7. 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 Jan/Feb	Hat 1 Early Rearing Tanks	All Tanks	740.0	1.50	110,112	148.8	0.7	0.13	0.30
Mar	Hat 1 Early Rearing Tanks	All Tanks	270.0	2.10	95,750[a]	354.6	0.7	0.22	0.51
Apr	Raceways	0.1	127.0	2.70	88,569	697.4	2.9	0.13	0.20
May	Raceways	0.1	69.4	3.30	81,388	1,172.7	2.9	0.18	0.27
Jun	Raceways	0.1	42.1	3.90	74,207	1,762.6	2.9	0.23	0.35
Jul	Raceways	0.1	27.3	4.50	67,025	2,455.1	2.9	0.27	0.42
Aug	Raceways	0.5	18.8	5.10	64,344	3,422.6	2.9	0.07	0.52
Sep	Raceways	0.5	13.5	5.70	61,663	4,567.6	2.9	0.08	0.62
Oct	Raceways	0.5	10.0	6.30	58,982	5,898.2	2.9	0.09	0.72
Nov	Raceways	0.5	7.7	6.90	56,301	7,311.8	2.9	0.11	0.82
Dec	Raceways	0.5	5.9	7.50	53,620	9,088.1	2.9	0.12	0.93
Jan	Raceways	0.5	4.7	8.10	52,280	11,123.3	2.9	0.14	1.06[b]
Feb	Raceways	0.5	3.8	8.70	50,939	13,405.0	2.9	0.15	1.19[b]
Mar	Raceways	0.5	3.1	9.30	48,258	15,567.1	2.9	0.17	1.29[b]
Apr	Raceways	0.5	2.6	9.90	45,577	17,529.6	2.9	0.18	1.36[b]
May	Raceways	0.5	2.1	10.80	42,896	20,426.7	2.9	0.19	1.45[b]
Jun	Raceways	0.5	1.8	11.10	40,215	22,341.7	2.9	0.20	1.55[b]

[a] Approaching the maximum capacity of Hatchery Building 1 early rearing tanks for fish at this size based on available rearing volume.

[b] Although flow is identified as the limiting factor for production in the raceways, production numbers for the Brown Trout were calculated based on limits of rearing volume during early rearing which determines the number of fish transferred into the raceways. LHOs are utilized at the head and mid-point of the raceways thus allowing for increased production of Rainbow Trout in the raceways.

2.2.2.3 Lahontan Cutthroat

The Lahontan Cutthroat Trout (Cutthroat) are spawned in May at Lake Heenan. It takes approximately 45 days from fertilization (i.e., green eggs) to first feeding using the hatchery's water temperature of approximately 56°F. The first feeding would be initiated in June when fish are approximately 4,218 fpp (0.84 inches). The Cutthroat are reared for an extended period of time in the Hatchery Building 2 early rearing tanks. The target size for the Cutthroat during early rearing is 160 fpp (2.6 inches) and these fish should achieve this size in October (Table 2-8). In this exercise, it is assumed that approximately 610,000 eggs are incubated, 366,000 fry are hatched from those eggs, and 235,000 juvenile fish are transferred to a raceway based on survival rates provided by the Hot Creek Hatchery staff. The production goal for the Cutthroat of 150,000 sub-catchable fish is achieved. Juvenile fish are transferred into a 500-foot section of a raceway; initially they may be crowded at the upstream end of the raceway if staff desires. As fish grow and biomass increases, they will require the entire 500-foot section. The Cutthroat will share a raceway with Rainbow Trout production; as the more sensitive species, Cutthroat production occupies the upstream portion of the raceway and serial reuse water is supplied to the Rainbow Trout. The Cutthroat will remain in the upper half of this raceway until they have reached their target size of 10 fpp in July yielding a total of approximately 150,000 sub-catchable Cutthroat weighing 15,000 pounds. In the Capacity Bioprogram in the Site Visit Report (Appendix A), the FI was calculated based on water flow for the raceways without including the benefit of the LHOs relative to oxygen levels. The calculation for the Production Bioprogram below utilized the FI limitations (Table 2-4) for early rearing to generate the maximum production.

Table 2-8. 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
Early Rearing Jun/Jul	Hat 2 Early Rearing Tanks	30	1,033.0	1.40	293,000	283.6	2.7	0.06	0.17
Aug	Hat 2 Early Rearing Tanks	30	489.0	1.80	273,667	559.6	2.7	0.10	0.26
Sep	Hat 2 Early Rearing Tanks	30	268.0	2.20	254,333	949.0	2.7	0.14	0.36
Oct	Hat 2 Early Rearing Tanks	30	143.0	2.70	235,000[a]	1,643.4	2.7	0.20	0.51
Nov	Raceway	0.5	95.0	3.10	223,125	2,348.7	2.9	0.08	0.58
Dec	Raceway	0.5	66.0	3.50	211,250	3,200.8	2.9	0.09	0.70
Jan	Raceway	0.5	48.1	3.90	199,375	4,145.0	2.9	0.11	0.82

Production Stage/Month	Tank Type	Tanks Occupied	fpp	Length (in)	Total Fish (#)	Biomass (lbs)	Max. Flow (cfs)	DI	FI
Feb	Raceway	0.5	35.5	4.30	187,500	5,281.7	2.9	0.12	0.94
Mar	Raceway	0.5	27.5	4.70	181,250	6,590.9	2.9	0.14	1.08[b]
Apr	Raceway	0.5	21.5	5.10	175,000	8,139.5	2.9	0.16	1.23[b]
May	Raceway	0.5	17.1	5.50	168,750	9,868.4	2.9	0.18	1.38[b]
Jun	Raceway	0.5	13.9	5.90	162,500	11,690.6	2.9	0.20	1.52[b]
Jul	Raceway	0.5	10.0	6.40	150,000	15,000.0	2.9	0.23	1.80[b]

[a] This is approaching the maximum capacity for fish at this size based on available rearing volume.

[b] Although flow is identified as the limiting factor for production in the raceways, production numbers for the Lahontan Cutthroat Trout were calculated based on limits of rearing volume during early rearing which determines the number of fish transferred into the raceways. LHOs are utilized at the head and mid-point of the raceways thus allowing for increased production of Rainbow Trout in the raceways.

2.2.3 Summary

The production strategy modeled in this report allows hatchery staff to maximize production while operating the hatchery within the DI and FI limits established for the facility during early rearing and within the DI limits for the raceways. The FI established for the raceways was based on water flows without consideration for the benefits provided by the operation of the LHOs. The LHOs provide saturated oxygen levels in the raceways allowing for increased production above the level identified in the Capacity Bioprogram in the Site Visit Report. This production strategy provides opportunities for cleaning and maintaining the two hatchery buildings between rearing cycles. There are opportunities to clean and maintain production raceways, and flexibility to hold cohorts of fish longer in the raceways if necessary due to lower-than-expected growth rates or limited access to stocking locations. Opportunities for maintaining broodstock raceways for both the Rainbow Trout and the Brown Trout remain unchanged (highlighted in red in Figure 2-1).

Total annual production for this bioprogram is 414,855 fish weighing 147,428 pounds with total pounds based on 2 fpp for catchable and 10 fpp for sub-catchable size fish. The annual production does not meet the goals for the Rainbow Trout and Brown Trout, but the Cutthroat production goal is achieved. However, the bioprogram demonstrates potential production within recommended DI and FI criteria for the water temperatures at the facility except for rearing areas that are supplemented with oxygen. For each species produced, once the fish reach the target stocking size, they should be stocked out relatively soon to open rearing space for the next cohort of fish. (Table 2-6, Table 2-7, Table 2-8). Tanks and raceways reserved for broodstock were not modeled in previous sections, but their water consumption is included in Figure 2-1. Extra fish reared that are not required for breeding or fish that are done breeding are stocked out for recreational fishing, adding to the total production of the facility. Water demand will be the highest from February through June as seen in 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 initially. This provides additional flexibility for water use in other rearing areas, or to account for periods when spring flows are lower. Note that the different colored blocks in the following figure correspond to the months for when each species is in early rearing in Hatchery 1 or 2, or in the raceways, along with noting when eggs are received and incubated and months for future broodstock.

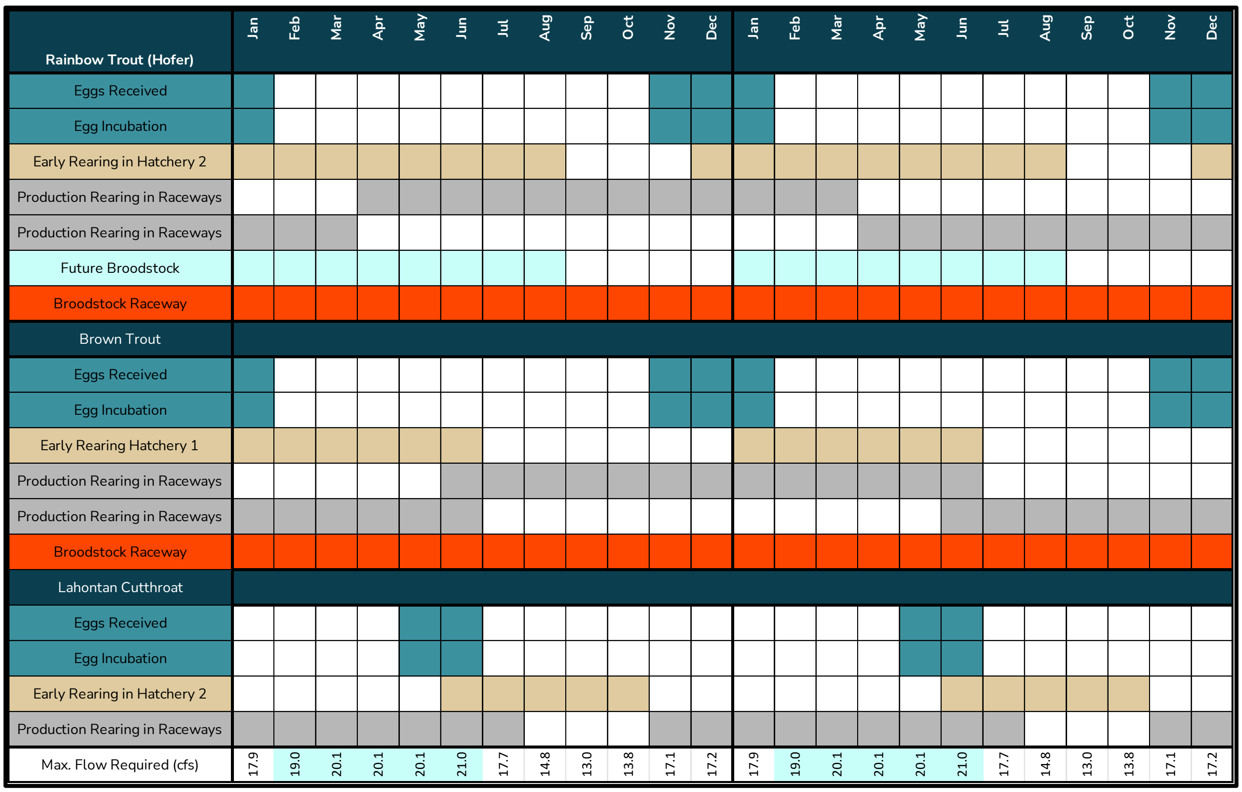

Figure 2-1. Production Rearing Schedule Over 2 Years with Peak Water Demand Occurring Annually from February through June (as highlighted in the Max Flow Required row).

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 water sources are a series of natural springs. Spring flow peaks in late May and starts declining in late July, running low from December through April. These low flows make fish production difficult, and in particularly low-flow years it limits the number of raceways that can be used. Seasonal low flows of 12 cfs are common, and during drought years flows as low as 1 cfs have been seen in some spring supplies. Water temperature has fluctuated seasonally between 52°F and 63°F.

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 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 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.

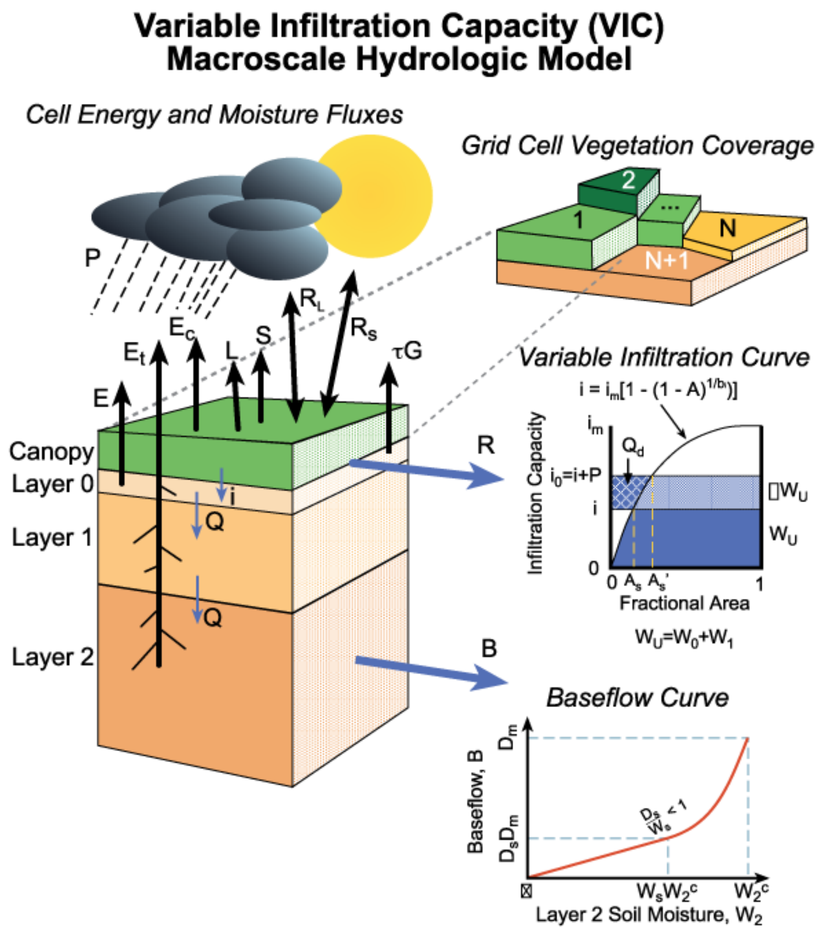

Figure 3-1. The VIC Hydrologic Model. Figure source: University of Washington.[1]

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

[1] https://vic.readthedocs.io/en/master/Overview/ModelOverview/

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 daily and seasonal snow accumulation and streamflow over a small local watershed,** which are presented to provide indication of future local conditions that may influence groundwater recharge and, therefore, spring flows, were obtained by aggregating over the watershed the grid cell-based snowpack and streamflow projections made available by the same research consortium as in item (1) above (Vano et al., 2020). These publicly available projections were obtained by driving the VIC hydrologic model with the CMIP5 daily climate projections.

3. **Projections of wildfire risk** at the 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 decreasing groundwater recharge.

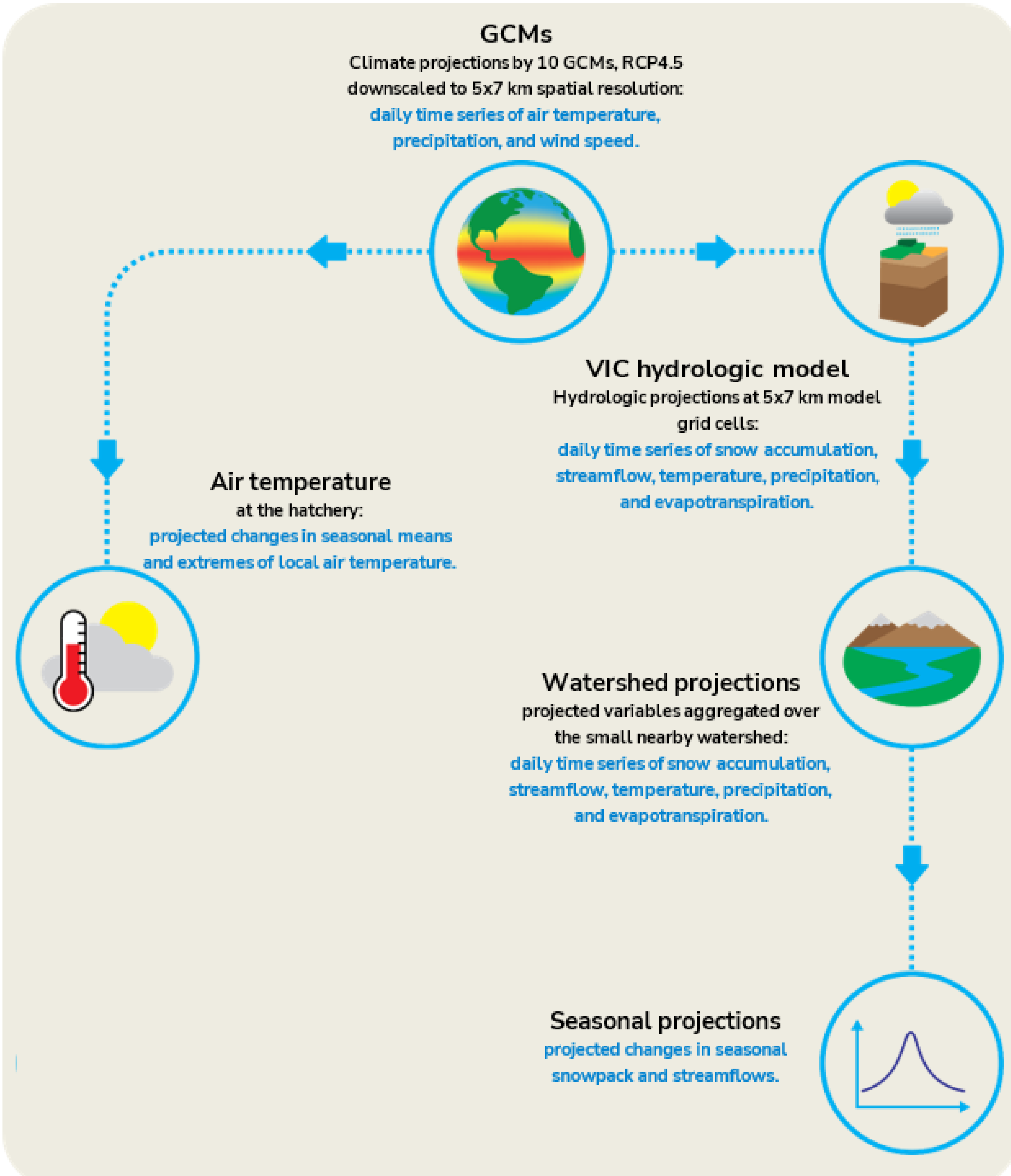

Figure 3-2. Methodology for Obtaining Projections.

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 it ranges 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 (1983-2003) 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. 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 2.8°F in the near future period compared to the reference period (1984-2003), and by an additional 1.2°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 3.0°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, 3.6°F, reaching 88.9°F.

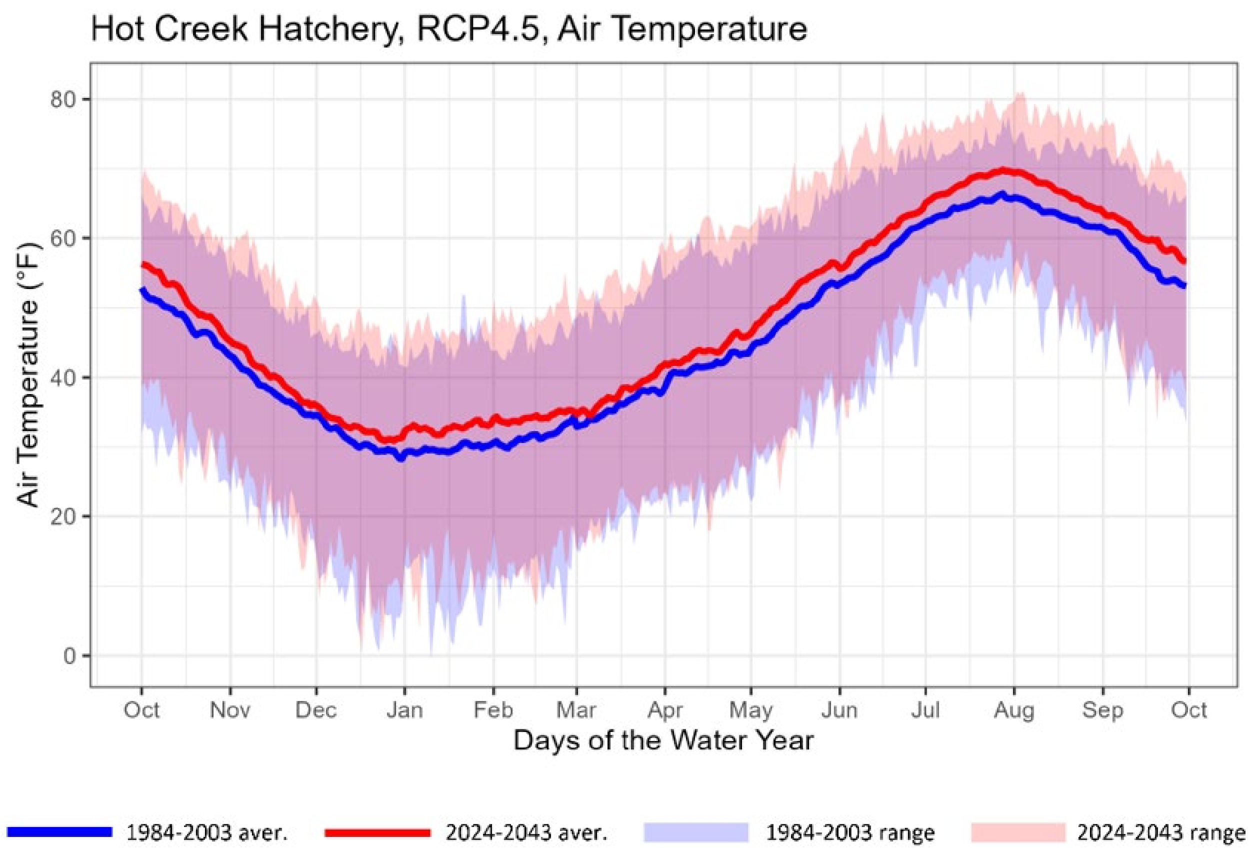

Figure 3-3. Mean Daily Air Temperature and Range for Each Day of the Year at the Hatchery Site.

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	48.5°F (+2.8°F)	33.2°F (+2.6°F)	44.6°F (+2.4°F)	65.1°F (+3.2°F)	50.7°F (+2.9°F)
Lowest	48.0°F (+2.3°F)	32.3°F (+1.6°F)	44.0°F (+1.8°F)	64.0°F (+2.1°F)	49.5°F (+1.8°F)
Highest	49.2°F (+3.5°F)	34.1°F (+3.4°F)	45.3°F (+3.1°F)	66.5°F (+4.6°F)	51.6°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	49.7°F (+4.0°F)	34.5°F (+3.8°F)	46.0°F (+3.8°F)	66.3°F (+4.4°F)	51.8°F (+4.0°F)
Lowest	49.1°F (+3.4°F)	33.5°F (+2.8°F)	45.5°F (+3.3°F)	65.4°F (+3.5°F)	50.5°F (+2.7°F)
Highest	50.7°F (+5.0°F)	35.2°F (+4.5°F)	46.6°F (+4.4°F)	68.0°F (+6.1°F)	53.5°F (+5.7°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	35.6°F (+2.4°F)	49.6°F (+2.2°F)	62.8°F (+2.7°F)	78.1°F (+3.0°F)	88.9°F (+3.6°F)
Lowest	34.0°F (+0.8°F)	48.6°F (+1.2°F)	42.0°F (+1.9°F)	77.5°F (+2.4°F)	87.1°F (+1.8°F)
Highest	37.6°F (+4.4°F)	50.3°F (+2.9°F)	63.3°F (+3.2°F)	79.2°F (+4.1°F)	90.2°F (+4.9°F)

Table 3-5. Projected GCM 2044-2063 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	37.1°F (+3.9°F)	50.8°F (+3.4°F)	64.2°F (+4.1°F)	79.3°F (+4.2°F)	89.9°F (+4.6°F)
Lowest	36.0°F (+2.8°F)	50.0°F (+2.6°F)	63.3°F (+3.2°F)	78.3°F (+3.2°F)	88.3°F (+3.0°F)
Highest	38.2°F (+5.0°F)	51.6°F (+4.2°F)	65.0°F (+4.9°F)	81.2°F (+6.1°F)	91.7°F (+6.4°F)

3.5.2 Projected Changes in Spring Water Temperature

Water temperature observations were made available by the hatchery for its water resources and these data are displayed in Figure 3-4. The points, which are connected by lines, represent a single measurement in each month, taken within approximately the first week of that month. Measurements started in December 2009 and extended through December of 2014. Seasonal differences are small, or are not clearly characterized by the limited measurement sample.

For S001-AB, measured temperatures are in the range of 55-63°F, with an average of 60.2°F. For S002-CD, measurements are in the range of 54-62°F, with an average of 58.6°F. For S003-1, measurements are in the range of 52-59°F, with an average of 54.6°F. Water source S003-1 is the cooler of the three. The year 2012 contains the lowest and also the highest temperature measurements. Investigating the cause is outside the scope of this work.

Shallow groundwater is expected to warm at the same rate as the rise in mean annual air temperature. Table 3-2 and Table 3-3 give the projected rise in mean annual air temperature to be 2.8°F between the reference period (1984-2003) and the future period (2024-2043) which corresponds to +0.07°F/year on average, and another 1.2°F rise from 2044-2063 which corresponds to +0.06°F/year on average. Based on these projected average rates of warming, the projected mean water temperature in 2024-2043 relative to the period of record from December 2009 to December 2014 will be higher by 1.5°F; and in 2044-2063 it will have risen by an additional 1.2°F.

For S001-AB, the average water temperature is thus projected to rise from 60.2°F (in the measurement period 12/2009-12/2014) to 61.7°F in 2024-2043, and 62.9°F in 2044-2063. For S002-CD, the average water temperature is projected to rise from 58.6°F in the measurement period to 60.1°F in 2024-2043, and 61.3°F in 2044-2063. For the cooler water source, S003-1, its mean temperature is projected to increase from 54.6°F in the measurement period to 56.1°F in 2024-2043, and 57.3°F in 2044-2063.

The cooler water source, S003-1, is expected to become increasingly important to the hatchery, as water temperatures for S001-AB and S002-CD are projected to surpass the 60°F threshold on average, and with occasional peaks significantly above 60°F.

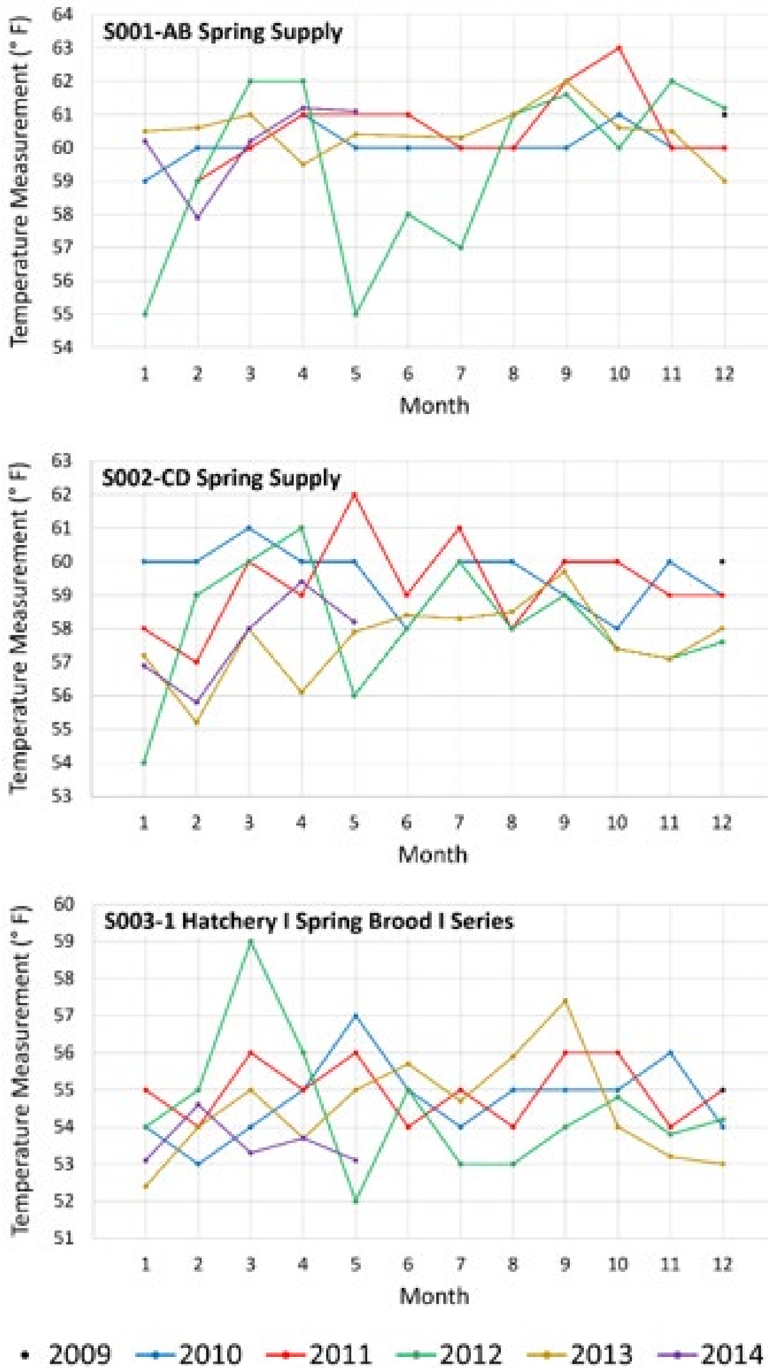

Figure 3-4. Water Temperature Observations at Water Sources.

3.5.3 Snow Accumulation and Streamflow

The recharge areas of the three springs that supply the hatchery are not known and projections of spring flow are beyond the scope of this work. As an indication of possible direction of groundwater recharge and seasonal spring flow, the VIC hydrologic model projections are summarized here for the small watershed in Laurel Mountain which is topographically above the hatchery's location (and includes road N1477). Figure 3-5 displays the projected mean daily snowpack (solid lines) and range from minimum to maximum (shaded areas) for each day of the year for the near future (red) and the reference time period (blue). All data in the figure are simulated by the ensemble of 10 GCMs for both the projected and reference time periods.

The shift from snowfall to rainfall in the cold months will result in diminished snowpack and earlier snowmelt (Figure 3-5) in future. Reflecting the increase in winter rain-to-snow ratio, the projected 2024-2043 snow accumulation – expressed as a snow water equivalent (SWE) and given in mm – is on average smaller and occurs about 2 weeks earlier on average. This is explained by the higher spring and summer temperatures. As a result, streamflow is projected to rise earlier, peak earlier in mid-May, and decline earlier as well (Figure 3-6). The SWE and streamflow values in these figures have not been verified for the historical period due to lack of observational data but are presented to provide an approximate indication of projected changes at different times of year.

Although spring flows were not simulated, it is possible that they too will experience a timing shift in their mean annual cycle, similar to the shift projected for streamflow. The projected decline in total snow accumulation and in the duration of snow on the ground may result in lower infiltration rates which could affect groundwater recharge and, therefore, could lead to lower spring flows.

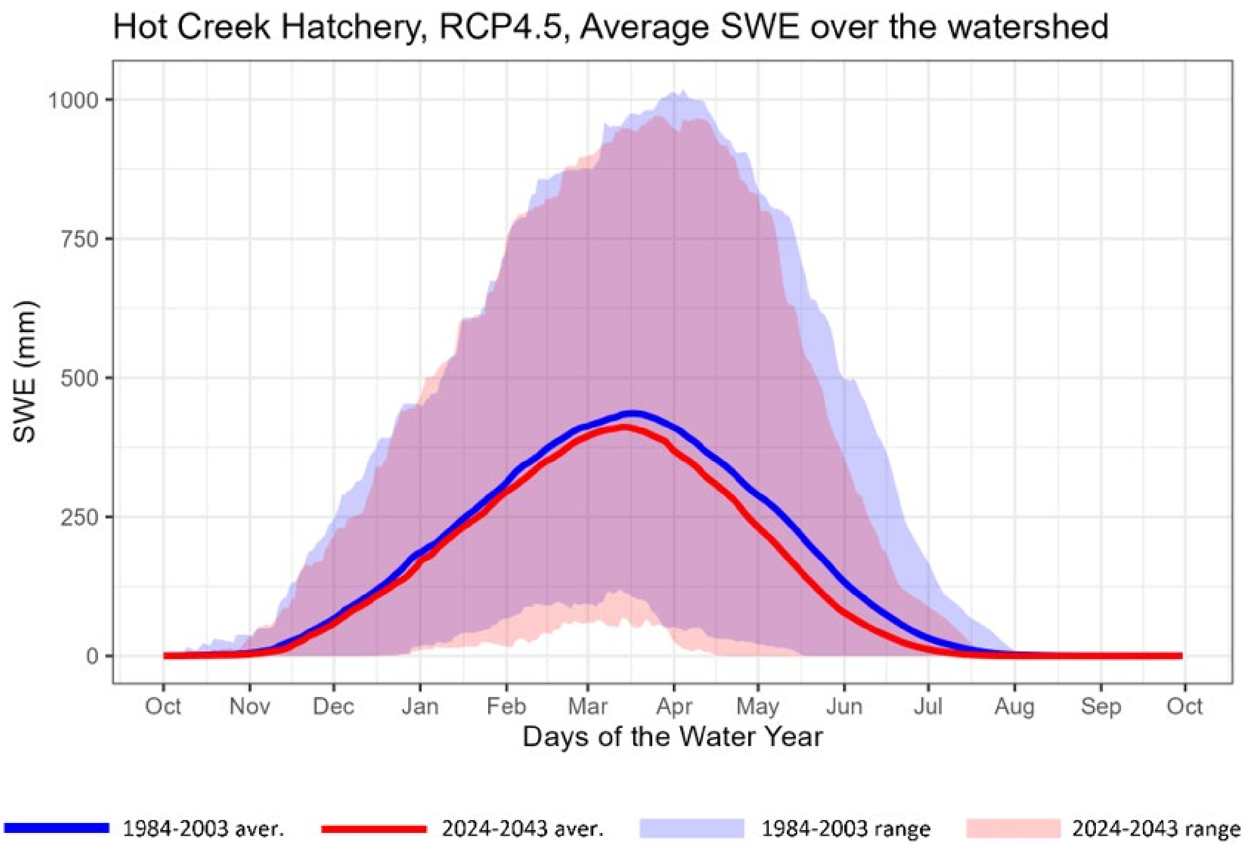

Figure 3-5. Mean Daily Snow Water Equivalent and Range for Each Day of the Year Over the Small Local Creek.

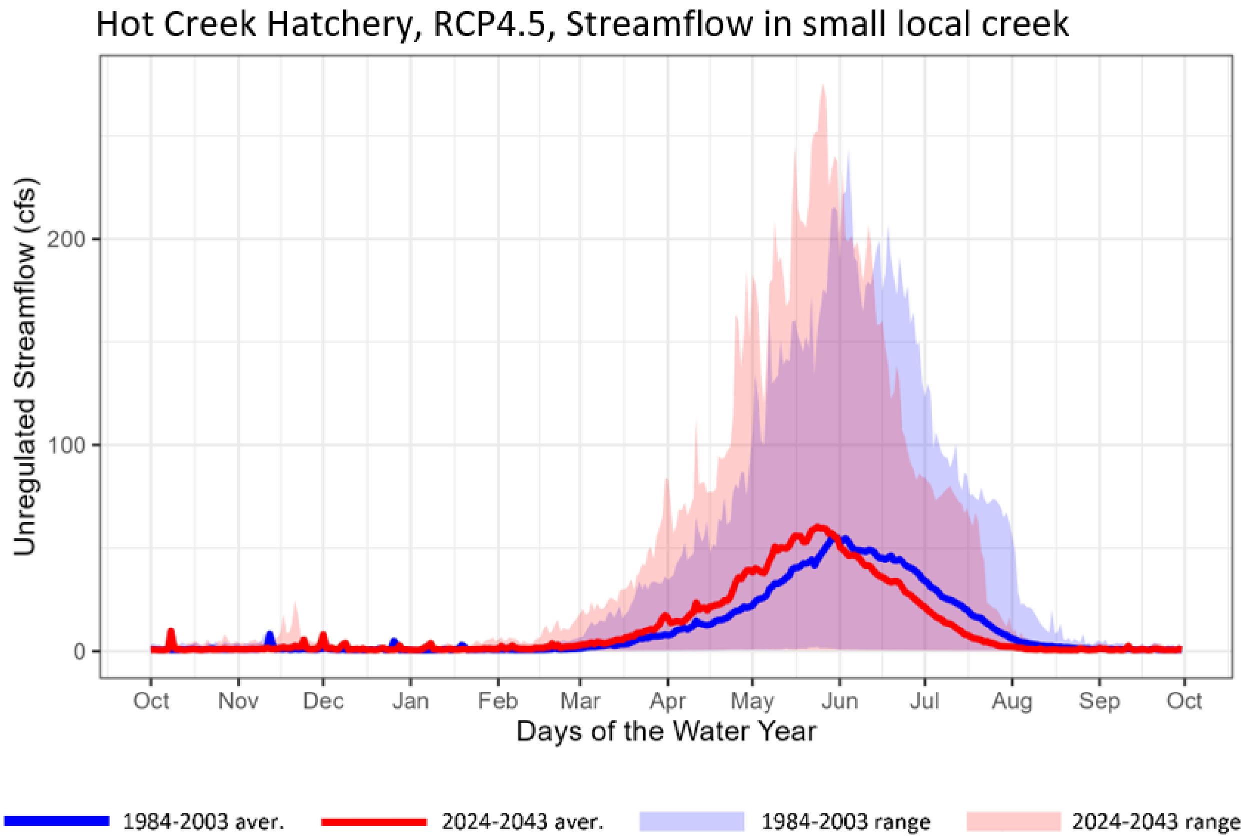

Figure 3-6. Mean Daily Streamflow and Range for Each Day of the Year in the Small Local Creek.

3.5.4 Fire Risk

Historical wildfires have not been documented in the vicinity of the hatchery since 1987, as mapped in Figure 3-7. The fires that have been documented in the watershed area and surrounding basins have been relatively small in size (less than 2,000 acres). Large fires have been documented within 20 miles of the hatchery, including the 380,000-acre Creek Fire, which burned within 16 miles of the facility in 2020. Given that the hatchery relies on groundwater springs, the recharge area is likely much larger than the watershed area at the hatchery itself.

Expressing wildfire risk as a percent chance of occurring at least once in a decade, the projected wildfire risk at the hatchery site is between 10 and 15% through mid-century. Across the watershed fire risk is the same (Figure 3-7).

The hatchery relies primarily on groundwater-fed spring water, which is less susceptible to wildfire impacts than surface water sources. However, if a fire were to occur in the surrounding area, then flooding potential would be expected to increase at the hatchery due to increased runoff contributing to overland flow. The hatchery itself is at a lower risk of infrastructure impacts from nearby fires due to its location within a mostly wetland area, but the risk increase during drought years when the springs can only supply 1 cfs or less.

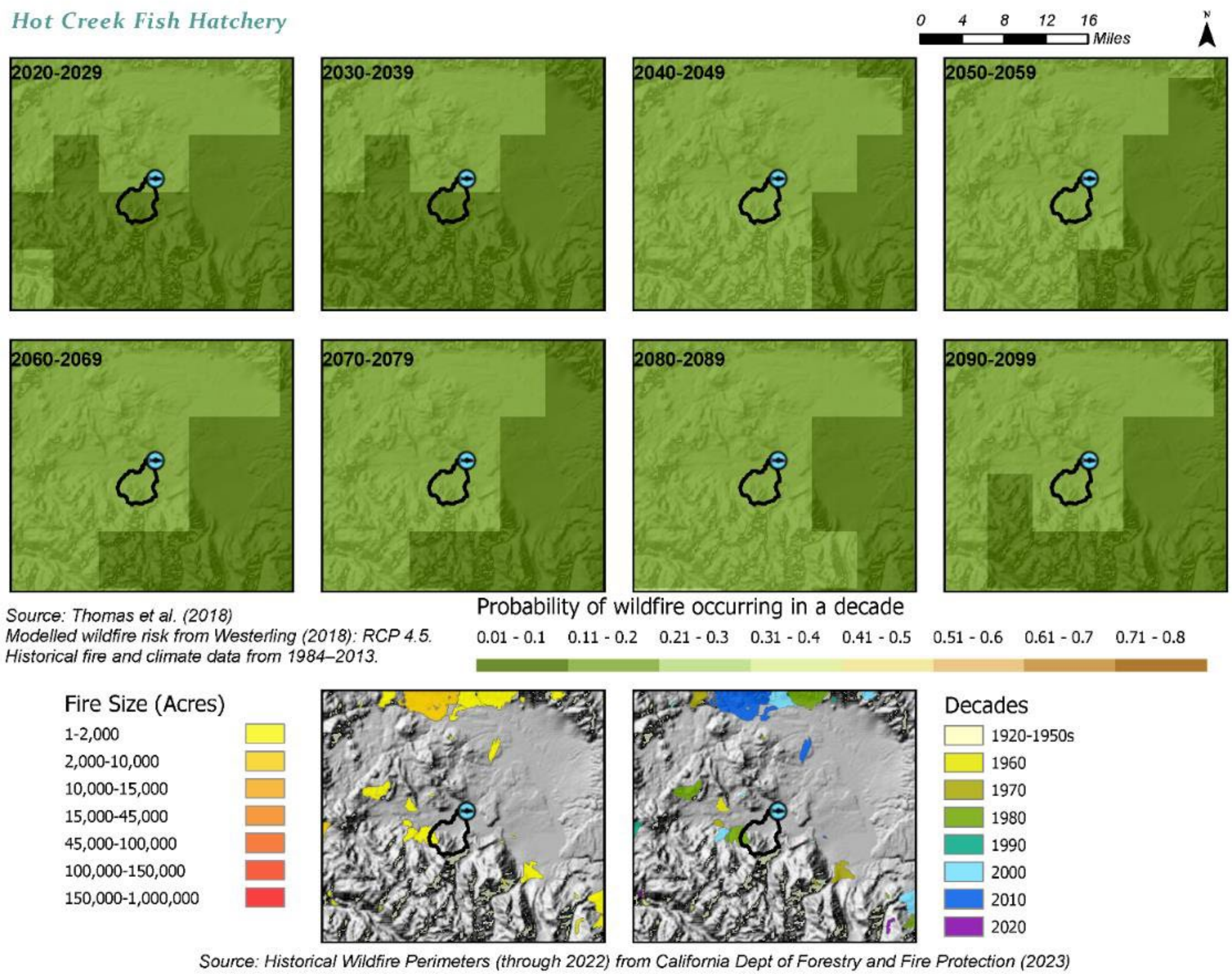

Figure 3-7. Wildfire Risk as Probability of Future Occurrence and Known Historical Fires.

3.6 Conclusions

Significant increases in air temperature are expected for the hatchery location. Mean annual air temperature is projected to rise by 2.8°F in the next 20 years (2024-2043) and by an additional 1.2°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 3.0°F and 3.6°F, respectively, in the next 20 years, relative to the reference period, reaching 88.9°F.

Low spring flows, especially in drought years, already represent a limiting factor for the hatchery. Although projected spring flows were not simulated directly, there is indication from snow and streamflow projections that spring flows may decline in future and experience a shift of their annual cycle towards earlier timing. Such future conditions may pose great challenges to the hatchery's operation. Additionally, water temperature has occasionally reached the upper end of the tolerable range for trout, hence any additional warming in response to air temperature rise, even if small, may require adaptation through cooling.

The hatchery is at a low 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 three decades, which increases the fire risk in the near future. This risk is heightened during drought years, which decreases spring flow contributions to the surrounding wetlands near the hatchery site. The projected chance of at least one wildfire occurring in a 10-year period at the hatchery site is estimated as 10-15% through mid-century.

4.0 Existing Infrastructure Deficiencies

While the Hot Creek 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. Biosecurity deficiencies and potential solutions for addressing these concerns were identified in Section 3.0 and 3.2 of the Site Visit Report, respectively. During the site walk and later discussions with CDFW employees, several deficiencies were identified throughout the site. Deficiencies include the following:

- Inadequate year-round water supply
- Hatchery Building 1 damage from heavy snow loads
- Insufficient space for early rearing
- Raceway deterioration
- Insufficient predator protection
- Site-wide asphalt concrete (AC) deterioration
- Lack of backup power generation
- Insufficient effluent treatment

The details of these deficiencies are further expanded upon in Sections 4.1 and 4.2.

4.1 Water Process Infrastructure

4.1.1 Unreliable Water Supply

The hatchery's natural springs provide inconsistent water supply, with flows fluctuating from season to season and year to year. Approximately 22 cfs are available from the springs during the higher flow periods, with flows decreasing during the late summer. December through April is typically the low-flow period, with 12 cfs common. However, during drought periods, the flows can decrease to around 1 cfs.

Since the site is fed by springs, the variability of available flows makes it difficult to plan and execute production on an annual basis. This reduces the operational flexibility of the hatchery and lowers annual production.

4.1.2 Water Treatment Limitations

The hatchery staff have reported several fish health concerns within the hatchery. This has included *Lactococcus garvieae*, bacterial gill disease (caused by multiple bacteria but primarily *Flavobacterium branchiophilum*), and bacterial coldwater disease (causative agent *F. psychrophilum*). Lactococcus is not generally common in Hot Creek but can occur during the warm summer months as water temperatures increase. Hatchery personnel inoculate the fish once they have reached the proper size. Bacterial gill disease is common during the low-flow period (December through March) and is typically treated with potassium permanganate or Chloramine-T (Halamid® Aqua). In the event bacterial coldwater disease occurs, hatchery personnel use antibiotic feed should it become severe.

There are no water treatment systems to treat incoming water to Hot Creek Hatchery except for a damaged solids filtration system (see Section 4.1.5) and aeration which provides small increases in dissolved oxygen concentrations. This leaves the facility susceptible to pathogen exposure, increased turbidity, and dissolved oxygen levels below saturation.

4.1.3 Inadequate Backup Power

The current backup generator at Hot Creek Hatchery is assigned to the oxygen generation system and the mid-pond aeration system and is undersized. The undersized backup generator is incapable of powering both systems simultaneously. An extended duration of power loss may result in catastrophic fish losses in the raceways due to inadequate backup power generation.

4.1.4 Inadequate Effluent Processing

The existing effluent ponds can become inundated with algae which has occasionally caused the hatchery to exceed the TSS limits established in their NPDES permit. Hot Creek Hatchery has also observed high nitrogen levels, but it is undetermined if this is due to the source water or hatchery operations. Additionally, there is no effluent treatment for Hatchery Building 2 and Rainbow Trout brood raceways. Effluent from these areas of the hatchery discharges into an open channel approximately 800 feet long, discharging directly into Hot Creek.

4.1.5 Aging Intake Infrastructure

Water captured from the natural springs flows through grizzly screens; one for springs AB (western side of site) and one for springs CD (south of the residential area). The AB spring grizzly screen is in acceptable condition, but the CD spring grizzly screen is damaged and in need of repair or replacement. Incoming water to the hatchery is not currently being treated with UV disinfection, which could introduce significant pathogens.

4.1.6 Aged Plumbing

The water conveyance piping and valves throughout the hatchery are functioning but should be inspected for replacement due to aging and insufficient water control valves. There have not been any catastrophic failures of the systems, but there is a need for preventative maintenance to avoid issues in the future.

4.2 Rearing Infrastructure

4.2.1 Insufficient Incubation and Early Rearing Space

The existing Hatchery Building 1 experienced recent damage from excessive snow accumulation. The damage included several windows being broken and in need of replacement. The building is insulated and heated but limited in use due to its current state.

Additionally, CDFW has implemented new fish vaccination programs due to emergent pathogen concerns as noted in Section 4.1.2. 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, which limits the building's production capacity. The limited early rearing space creates production challenges by having to balance maintaining fish welfare at the expense of reduced production levels. The vaccination requirements and subsequent challenges also affect early rearing production in Hatchery Building 2.

4.2.2 Deteriorating Raceways

Significant portions of the existing 1,000-foot production raceways, especially at the head end, are in various stages of disrepair evident by water visibly leaking from the raceways. The concrete is deteriorating, spalling, and splitting in areas of the raceways.

4.2.3 Exposure and Predation Issues in Raceways

The raceways are enclosed in chain-link fencing with bird wire strung across the top. However, this has not eliminated avian predation, where ravens and night herons continue to access the raceways and further affecting production.

With the continuing predation, there is a higher risk of spreading pathogens to the fish. Birds and other animals can carry diseases and cause stress in the fish which can result in fish loss. Hatchery staff must compensate for reduced survival by collecting more eggs and spending more time and resources maintaining the early life stages of fish. With only bird wire above, the raceways experience direct sunlight and UV rays warm the water, can cause sunburn on the fish, and further degrades the exposed infrastructure. Air temperatures at Hot Creek Hatchery are projected to increase with climate change in the future which will only worsen these concerns.

4.2.4 Dilapidated Asphalt Surfaces

The asphalt is significantly damaged throughout the facility. Extensive fatigue cracks, block cracks, rutting, and raveling are found on the access roads, driveways, walkways, and parking areas, which become a safety hazard to both the public and site personnel. Due to the poor condition of the asphalt, the hatchery is currently closed to the public. CDFW attempted to execute an emergency repair contract but was denied. The issues are currently being addressed with cold-patching, although cold-patching is generally considered a temporary repair. The damaged asphalt is typically caused by poor subgrade preparation and water intrusion.

5.0 Alternative Selected

5.1 Alternative Description

During the site visit and through meetings with hatchery staff, several deficiencies were identified that currently limit the hatchery's ability to meet fish production goals and the quality of fish produced. 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 fish condition, 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 provide resiliency to future climate change impacts described in Section 3.0. The conceptual layout of the alternatives described below is shown in Appendix C.

5.1.1 Water Supply Upgrades

5.1.1.1 Install Groundwater Well(s)

Due to the unreliable seasonal flows of the natural spring water supply and associated impacts to production and biosecurity, Hot Creek Hatchery would benefit from a supplemental water supply to assist with balancing the flows throughout the year, including during periods of drought. The installation of a supplemental well, with a backup power generator, would provide Hot Creek Hatchery with additional water while spring flows are low. This would allow staff to better support annual production plans during the variable low-flow periods and drought years. Using groundwater for supplemental purposes would help control and minimize operating costs when compared with facilities that rely on groundwater for their source.

The process of exploring and installing new groundwater wells is likely to require significant collaboration with other parties representing state, local, and tribal interests. Any water removed from the ground would eventually flow to the LADWP's system. An assessment of the local aquifer(s) would be required to evaluate potential well locations, taking into consideration distance from residential or commercial locations that may affect the water quality; deeper wells could be considered. The assessment would evaluate the available quantity, temperature suitability, and quality for fish culture.

5.1.1.2 Traveling Screens for Springs Intakes

The grizzly screen found at the CD spring is damaged and requires replacement and repair of associated structures. Additionally, while the grizzly screen at the AB spring is functioning, it is aged and would benefit from replacement to increase the life of the screen. Replacing the screens with automatic traveling screens would increase the water quality, reduce maintenance and operations, and increase the useful life for a minimum of 50 years.

5.1.1.3 Construct Water Treatment Facility for AB and CD Water Supply

There is currently minimal treatment of production water at Hot Creek Hatchery for the AB and CD spring water sources. The exposed spring supply can become overloaded with organic material that reduces the water quality for production fish. Without adequate treatment, there is the potential for pathogens to be introduced to the hatchery. Constructing a filtration, UV disinfection, and aeration system for water entering the proposed production systems (discussed in Section 5.1.4) would improve the rearing environment and increase biosecurity by reducing potential pathogen exposure. The recommended water treatment facility would consist of a head tank concrete vault built on a prepared foundation with adequate space to install the necessary treatment equipment and building. The water treatment facility would be designed to treat a flow rate up to 12 cfs (5,386 gpm), the current demand to operate the existing raceways. Treatment equipment would include drum filters for removing solids, UV treatment for pathogens, and counter-current packed columns for removing nitrogen and carbon dioxide and providing oxygen to the water flow.

For initial considerations, the drum filters would have a 40-micron drum screen and integrated backwash system, subject to adjustment based upon future water quality sampling and turbidity measurements. Each drum filter would be connected to a main pipe header within the head tank and receive a portion of the total flow for treatment. The amount of turbidity expected would determine the size of filter required, which would allow the UV reactors downstream to effectively provide the correct UV dose for the system. The system would consist of multiple drum filters to treat the total potential flow and would allow for one reactor to be offline for maintenance while maintaining treatment capacity during high turbidity events.

The UV disinfection would be through “U” or branch-style UV reactors. The target UV dose would be 126 mJ/cm^2, UV sizing would be based upon water quality testing and ultimate turbidity allowed through the drum filters. Multiple UV disinfection units would be incorporated into the design, allowing for redundancy and full flow treatment should a reactor be taken offline for maintenance. During normal operations, all UV reactors would be in operation to provide redundancy and better dosage to the water supply as needed. The water would then discharge into the packed columns found beneath.

Multiple packed columns would likely be required and would use a standard packed column design, where an average of 100 gpm flow would need 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. Once the water makes its way through the packed columns and is adequately degassed and aerated, it would discharge into the head tank concrete vault below where it would then be conveyed to each of the hatchery buildings.

The water treatment equipment would be enclosed in a pre-engineered metal building (PEMB) constructed on the head tank concrete vault. The PEMB would have insulated metal panels and an insulated roof for protection of the treatment equipment. Proper ventilation would be included to eliminate moisture build-up within the small building. A small HVAC system would be needed for the winter months to maintain a minimum temperature inside the building and prevent ice formation. Lights would be provided for maintenance activities.

5.1.2 Improve Hatchery Building 2 Water Supply

The spring-fed concrete supply pond for Hatchery Building 2 is aging, cracking, and leaking. This leads to added loss of water beyond climate impacts and requires replacement. The existing concrete retaining system would be replaced in-kind but would consider reducing water loss from percolation by installing a pond lining or constructing a prepared subgrade.

Additionally, hatchery staff have noted low dissolved oxygen levels from the Hatchery 2 spring source. The proposed improvements include a gas management tower that would strip dissolved nitrogen and carbon dioxide gases before supplementing dissolved oxygen gas through a low head oxygenator (LHO). This should significantly improve the water quality and rearing environment for fish in Hatchery Building 2.

5.1.3 Valving and Piping

Various valves and pipes across the hatchery are more than 50 years old. The preferred alternative would be to inspect/operate valves and pipes throughout the hatchery and replace infrastructure that is leaking, inoperable, heavily aged/worn, or likely to fail soon. Replacing the valves and pipes would allow for better flow control and would allow for the hatchery to continue operating into the future.

5.1.4 Replace the Raceways with Circular Tank PRAS

The existing four 1,000-foot production raceways are in poor condition as age and deterioration has created 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 clean and disinfect.

The preferred alternative would be to install circular tanks with a partial recirculating aquaculture system (PRAS) to replace the four existing concrete production raceways, which would allow the hatchery to meet the annual production modeled in Section 2.0. A standard size of larger dual-drain circulars is a 20-foot diameter tank with a 6-foot operating depth and 7-foot wall height. Each 20-foot tank provides 1,885 ft^3 of rearing volume. All tanks would be covered by a solid roof structure with fencing and netting enclosures to reduce predation and increase biosecurity. The structure would also be capable of supporting a solar array to provide energy-savings with associated equipment. By removing and replacing the raceways with tanks, the water supply piping and valves would be replaced, thereby restoring full function and water control to the new rearing tanks. Tanks would be organized into modules; each module would have eight tanks that share PRAS equipment. The equipment would include sump tanks, pumps, filtration, UV disinfection, degassing, and oxygenation to recirculate and recondition water to maintain optimal rearing conditions. More information about the potential technologies involved in PRAS is found in Appendix E.

The total flow for each tank is based on hydraulic retention times (HRT). Typical HRT for circular tanks is between 30 to 45 minutes to maintain water quality and ensure efficient solids flushing from the tank. For the proposed tank size, a process flow rate of 325 gpm will maintain an HRT below 45 minutes. For an entire module of eight tanks, the total process flow would be 2,600 gpm (5.8 cfs). It is suggested that CDFW begin operations with a 50% recirculation rate until staff are familiar with the systems. However, equipment would be sized to operate at recirculation rates up to 75%. At a 75% recirculation rate, the PRAS equipment for each module would be sized to recirculate and recondition 1,950 gpm (4.3 cfs) and the fresh make-up water flow requirement would be 650 gpm (1.4 cfs).

To maintain the modeled Rainbow Trout production, the system would include 3 modules or 24 tanks total. This provides sufficient space to rear 350,000 Rainbow Trout to a size of 10 fpp (6.3 inches) and 250,000 Rainbow Trout to a size of 2 fpp (10.8 inches) while maintaining a DI below 0.30. The fresh make-up water flow requirement for the Rainbow Trout PRAS modules would be 1,950 gpm (4.3 cfs).

For Brown Trout, a single module of eight tanks is proposed to maintain the production modeled in this report's bioprogram in Section 2.2.2.2. This provides enough space for up to

210,000 sub-catchable fish (10 fpp and 6.3 inches) and 90,000 catchable fish (2 fpp and 10.8 inches) while maintaining a DI below 0.30. For a single eight-tank module, the fresh make-up water requirement is 650 gpm (1.4 cfs).

For Cutthroat Trout production, another single module is proposed. This provides ample space for the production modeled in Section 2.2.2.3. A single module would provide rearing space for the 150,000 sub-catchable (10 fpp and 6.4 inches) production goal while maintaining a DI below 0.16. The reduced density is advantageous for a more sensitive species such as Cutthroat Trout. Additionally, proposing all modules with the same number of tanks and piping arrangement would allow for PRAS equipment to be used interchangeably among all modules, reducing complexity of the facility.

Table 5-1 shows the proposed alternative to update the raceways with circular tank PRAS modules, specified for each species' production. The systems would meet and maintain the production modeled in Section 2.2.2. The PRAS would also significantly reduce the water requirement for production occurring in raceways from 11.6 cfs to 7.2 cfs; a savings of 4.4 cfs. This provides resiliency to variable flow rates and the continued impacts from climate change. Other circular tank PRAS benefits include a homogenous mixture of water quality throughout the tank, self-cleaning properties, and more efficient effluent processing.

In the future, upgrading to a full recirculating aquaculture system (RAS) with a biofilter would further reduce the make-up water demand, since hatchery staff have reported a low flow of approximately 6.9 cfs for the water supply in drought years. Careful consideration must be given to make sure that effluent limits are maintained if full RAS is implemented, since there is less water to dilute the waste generated from aquaculture activities.

Table 5-1. Summary of Proposed Rearing Systems.

Species	PRAS Modules (total tanks)	Fresh Make-up Water Flow Requirement	Holding Capacity While Maintaining a DI below 0.3 Sub-catchable (10 fpp)	Holding Capacity While Maintaining a DI below 0.3 Catchable (2 fpp)
Rainbow Trout	3 (24 tanks)	1,950 gpm (4.3 cfs)	350,000 fish	250,000 fish
Brown Trout	1 (8 tanks)	650 gpm (1.4 cfs)	210,000 fish	90,000 fish
Cutthroat Trout	1 (8 tanks)	650 gpm (1.4 cfs)	210,000 fish	NA

Species	PRAS Modules (total tanks)	Fresh Make-up Water Flow Requirement	Holding Capacity While Maintaining a DI below 0.3 Sub-catchable (10 fpp)	Holding Capacity While Maintaining a DI below 0.3 Catchable (2 fpp)
Total	5 (40 tanks)	3,250 gpm (7.2 cfs)	770,000 fish (77,000 pounds)	340,000 fish (170,000 pounds)

5.1.5 Replace the Rainbow Trout Broodstock Raceway and Add a Roof Structure

The Rainbow Trout broodstock raceway is in various stages of disrepair and requires replacement. The preferred alternative would include the demolition of the existing raceway and construction of an in-kind concrete raceway with upgraded piping and valving to control the flow of water to the raceway. Existing drain and effluent piping would be inspected to confirm the new raceway is fully functional. The addition of a roof structure would protect the concrete raceway, prevent sunburn in the fish, and eliminate the need for avian predation wires or bird netting over the top. The sides would include fencing and netting designed to prevent predators such as night herons and ravens from harassing the fish and reduce the potential for pathogens to enter the system.

5.1.6 Brown Trout Broodstock Raceway Improvements

5.1.6.1 Skim Coat and Epoxy Paint

The concrete in the Brown Trout broodstock raceway has experienced abrasion erosion from decades of use. The cement has eroded along the surface, which has exposed the concrete aggregate in the floor and walls of the raceway. This condition creates an abrasive surface that can be harmful to fish as well as a surface that promotes algae growth. Algae growth is magnified due to the full exposure to sunlight. The exposed rough aggregate is difficult for hatchery staff to clean efficiently. Adding a coating to the concrete would alleviate abrasion erosion 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 application, the raceway would be emptied, cleaned, and completely dried. Any large cracks in the existing concrete would be fixed prior to coating. Once applied, the coating would need to be cured, which can take anywhere from 1-14 days depending on the coating selected and the manufacturer’s instructions. 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, reduces sun exposure, and eliminates the abrasion erosion currently damaging the raceway.

5.1.6.2 Cover Raceway with Permanent Roof Structure

Covering the Brown Trout broodstock raceway with a solid roof structure and enclosing the sides (e.g., fine mesh chicken wire) to reduce access from predators, ducks, etc. would improve biosecurity. The solid roof structure would also reduce the warming effects of the hot summer sun as the water passes through the 500-foot-long raceway. This would also provide protection for hatchery staff when working in adverse weather conditions. As mean and maximum ambient air temperatures continue to rise in the future, reducing the solar effects on water temperature in the hatchery would be critical to maintain temperatures within the range for salmonids.

5.1.7 Replace Hatchery Building 1

The preferred alternative would be to replace Hatchery Building 1 to address its current state of deterioration. This would offer the opportunity to increase the total capacity of the building to account for operational changes associated with *Lactococcus* spp. vaccination requirements. The proposed building would accommodate all existing rearing infrastructure in the existing building, and an added 26 deep tanks for a total of 38 deep tanks. This would provide approximately 1,875 ft^3 of added early rearing space. The added space would provide hatchery staff the ability to comfortably hold fish indoors for vaccination treatments. Another benefit would be during maintenance periods for Hatchery Building 2, which would offset the potential loss of production by using the added space in Hatchery Building 1. The added tanks, assuming a supply of 25 gpm per tank, would result in approximately 650 gpm (1.4 cfs) of additional flow demand; the increased demand would be available based on water savings associated with the PRAS modules replacing the production raceways.

The preferred alternative would be to modernize the hatchery building by constructing a new 4,810 square foot hatchery building to house Brown Trout incubation and early rearing tanks. The proposed new hatchery building would be a pre-engineered metal building (PEMB) 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 rearing system alternatives provide additional early rearing space to help maintain production while conforming to CDFW's vaccination program. Water savings, and therefore increased operational flexibility, result from upgrading the current production raceways to a PRAS with circular tanks even with the expansion of Hatchery Building 1. Table 5-2 provides a breakdown of current water demand compared to projected water demands of the proposed alternatives. The total water requirement decreases by 2 cfs compared to current maximum demand. Additionally, the PRAS would provide the flexibility and resiliency needed to maintain the modeled production into the future even as climate change impacts continue to worsen.

Table 5-2. Water Requirements for Current Operation Compared to Projected Water Requirements with Proposed Upgrades to Hatchery Building and Production Raceways.

Rearing System	Current Water Demand (gpm)	Proposed Water Usage (gpm)
All Egg Incubation Systems	456	456
Hatchery Building 1	330	980[a]
Hatchery Building 2	1,230	1,230
Rainbow Broodstock Raceway	1,300	1,300
Brown Trout Broodstock Raceway	1,300	1,300
Production Grow-out System	5,200	3,250[a]
Total	**9,816 gpm (21.9 cfs)**	**8,516 gpm (18.9 cfs)**

[a] Upgrades to these systems result in updated project flows, should alternatives be selected.

5.1.8 Repave the Entire Hatchery Property

Asphalt throughout the property is deteriorating and is currently unsafe for public use. The preferred alternative would be to repave all roads, parking lots, and work areas with hot mix asphalt. Since asphalt is a flexible pavement, the subgrade is vitally important since it is the structural foundation the pavement lies on. Therefore, the subgrade would require extensive preparation, including the addition of base course(s) should the existing underlying materials be unsatisfactory for structural support. Implementing this alternative would offer an additional opportunity to access and evaluate buried utilities to determine if they require preventative maintenance or replacement. Once completed, the new pavement would allow for the general public to again visit the hatchery and learn about CDFW's operations.

5.1.9 Combine Effluent Treatment Pond into a Single Larger Pond

The two northernmost effluent ponds are separated by an access road. Eliminating the road and combining the ponds would increase the total volume of effluent treatment area and retention time of the wastewater. Additionally, by constructing earthen baffles within the combined ponds, the retention time would be further increased, allowing for further settlement of suspended solids.

While combining the treatment ponds would help further treat the effluent, there may be other considerations depending on which alternatives are selected. The biggest impact on effluent treatment would be the addition of drum filters should the raceways be replaced with tanks and PRAS. The drum filters would concentrate the solids which could potentially affect the combined ponds. Should replacement of the raceways be selected, the ponds could potentially remain with few modifications, primarily adding an overflow from the western pond into the eastern pond. Concentrated effluent from the drum filters could be discharged into the western pond, which would then overflow the cleaner surface water into the eastern pond. The cleaner effluent from the PRAS could discharge directly into the eastern pond since it would require less retention time.

5.1.10 Install Backup Power Generation

The proposed alternatives will require increased power draws at the facility, primarily from the proposed water treatment and reuse equipment. The current backup power generation is insufficient at the Hot Creek Hatchery. The selected alternative would be to install necessary generators to ensure that backup power generators are appropriately sized to accommodate the water treatment equipment and maintain fish life support systems. Additionally, solar panels would be installed on each of the proposed roof structures to help offset the power requirements.

5.2 Pros/Cons of Selected Alternative

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

Table 5-3. Pros/Cons of Selected Alternative - Hot Creek Hatchery.

Description	Pros	Cons
Install groundwater well(s).	• Provides redundancy when the spring sources are experiencing low flows.	• Increases cost due to investigation. • May not have appropriate hydrogeologic characteristics and water quality. • May have permitting challenges.
Replace the traveling screens for the AB and CD Springs.	• Improves screening capabilities. • Extends the useful life.	• Increases cost. • Disrupts hatchery operations during replacement.

Description	Pros	Cons
Construct a water treatment facility for the AB and CD water supply.	• Improves biosecurity with increased water treatment. • Provides consistent water quality through the system.	• Increases cost due to purchasing new equipment and installation. • Disrupts hatchery operations during construction. • Increases cost due to the added power to operate the facility.
Replace the concrete supply pond for Hatchery Building 2.	• Reduces leakage. • Extends useful life.	• Disrupts the water supply to the hatchery building for several months during construction.
Inspect valving and piping and replace if leaking, inoperable, heavily aged/worn, etc.	• Improves operability and flow control. • Increases hatchery infrastructure lifespan.	• Increases cost due to resulting replacement. • Disrupts hatchery operations during evaluation and construction.
Replace raceways with circular tanks, PRAS, and roof structure.	• Reduces total water needed and provides flexibility. • Improves water quality within rearing vessels. • Replaces aging infrastructure. • Improves flow control. • Provides a healthier rearing environment for fish, increasing survivability. • Reduces labor because it is self-cleaning. • Allows for interchangeability due to modular design of the PRAS equipment, reducing system complexity. • Concentrates waste for effluent treatment to meet NPDES limitations. • Protects fish from sunburn and predation, reduces heat gain, and improves biosecurity because of the roof and enclosed sides.	• Increases cost due to system installation. • Requires additional staff training. • Increases on site pumping. • Requires addition of costly water treatment facility (e.g., drum screen, UV, LHO, CO_2 removal). • Increases complexity. • Disrupts fish production due to construction and completion of acceptance testing.

Description	Pros	Cons
Replace the Rainbow Trout broodstock raceway and add roof structure.	• Increases the life of the broodstock raceway. • Provides healthier rearing environment for fish as solids move to the tail end of the raceway more easily. • Reduces labor due to the ease of cleaning. • Reduces abrasion potential for fish. • Decreases potential algae growth. • Protects fish from sunburn and predation, while reducing heat gain because of the roof and sides.	• Increases cost. • Disrupts hatchery operations during construction. • Requires an alternative holding location for broodstock during construction.
Improve the Brown Trout broodstock raceway.	• Protects concrete from further abrasion, erosion, and deterioration, increasing the life of raceway. • Reduces potential for algae growth on smooth surfaces. • Provides a healthier rearing environment for the fish as solids move to the tail end of the raceway more easily. • Reduces labor due to the ease of cleaning. • Reduces abrasion potential for the fish. • Protects fish from sunburn and predation, while reducing heat gain because of the roof and sides.	• Increases cost. • Disrupts hatchery operations during construction. • Requires an alternative holding location for broodstock during construction.

Description	Pros	Cons
Replace Hatchery Building 1.	• Increases hatchery life. • Improves operations and worker conditions by supporting indoor vaccination. • Reduces leakage potential and helps control flows. • Increases early rearing capacity. • Maintains production due to the flexibility during maintenance of Hatchery Building 2.	• Increases cost due to a new PEMB and associated insulation, HVAC, and plumbing. • Disrupts hatchery operations and loss of production during construction, which impacts production goals.
Repave entire hatchery property.	• Restores roads, parking lots, and work areas to be aesthetically attractive and functional. • Addresses maintenance backlog. • Improves worker and public safety. • Allows hatchery access to the public again.	• Increases cost. • Disrupts hatchery operations during construction.
Combine effluent treatment pond into a single larger pond.	• May improve effluent quality to meet NPDES limits. • Reduces TSS in discharge water.	• Increases cost. • Disrupts hatchery operations during construction.

5.3 Alternatives for Short-Term Improvements

In the event that funding is not available to construct the preferred alternatives, the following short-term upgrades are recommended to aid with improved hatchery operation. The conceptual layout of the short-term improvements is shown in Appendix C.

5.3.1 Skim Coating and Epoxy Coating

The concrete in the raceways is aging, cracking, and shows signs of abrasion erosion. The abrasive surface can injure fish and promote algae growth. Adding a coating to the concrete can help reduce aging of the concrete while addressing both fish health and algae growth. Additionally, it will improve the flow of waste through the system, helping to keep the raceways cleaner. 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 be cured, which can take anywhere from 1-14 days depending on the selected coating and the manufacturer's instructions. 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.

5.3.2 Raceway Roof Structure with Side Enclosures

The raceways experience avian predation that not only affects production but increases the risk of pathogens entering the system. Covering the raceways with solid roof structures and enclosing the sides (e.g., fish mesh chicken wire) to reduce access for predators, ducks, etc. would improve biosecurity. The solid roof structures would also reduce the warming effects of the hot summer sun as the water passes through the raceways. As mean and maximum ambient air temperatures continue to rise in the future, reducing the solar effects on water temperature in the hatchery would be critical to maintain temperatures within the range for salmonids. Additional benefits include a reduction in fish sunburn and worker safety.

5.3.3 Replace the Backup Power Generator with a New Propane Generator

With the existing generator incapable of operating both the mid-pond aeration and oxygen generator, installing a new propane-fed backup generator would maintain full operation of both the mid-pond aeration and oxygen generator during power outages. The generator would be designed to meet current regional air quality standards.

5.4 Natural Environment Impacts

The proposed upgrades to the Hot Creek Hatchery should have negligible impacts on the natural resources in the surrounding area. All improvements would occur within currently developed areas except for a new water treatment system for Hatchery Building 2 and associated piping. The expansion of developed areas within the facility property is not expected to incur additional permitting requirements not outlined 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 the Hot Creek Hatchery will alter existing infrastructure and increase the number of rigid structures on site. This will increase the size of defensible areas that staff must maintain to protect infrastructure against potential fire danger. The risk of fires occurring in the vicinity of the Hot Creek Hatchery is projected to increase slightly in the future (Section 3.5.4). However, the risk of fire damage at the facility is anticipated to remain relatively low because the hatchery is situated in a wetland area. If any change to the area results in reduced groundwater recharge and further, consistent depletion of the springs, the risk of fire damage would increase.

The proposed upgrades would increase the potential failure points of hatchery infrastructure susceptible to fire damage. Additional pumps, filters, and disinfection systems rely on electrical power; if fires disrupt electrical supply infrastructure, the hatchery may have to rely on backup generators for extended periods of time.

The Hot Creek Hatchery is generally at a low risk of flooding; staff noted that the springs have never overwhelmed the intake structures in recent memory. Fires in the surrounding areas could lead to more overland flow during heavy rain events. All new or replaced structures included in the proposed alternatives would have grading to carry away any stormwater runoff present.

5.4.2 Effluent Discharge

The recommended changes to the hatchery provide additional flexibility for operations, which may be used by CDFW to increase fish production. Any increased production would be dependent on the available water flow from the various spring sources. The facility has issues maintaining effluent water quality within the NPDES guidelines and has violated several parameters including total suspended solids (TSS), settleable solids, and nitrate/nitrite. Staff have noted that the existing settling ponds are overgrown with algae which contributes to the NPDES violations. The proposed upgrades would aim to improve effluent water quality by dredging all effluent ponds to remove the existing algae build up. Additionally, the effluent ponds serving the production raceways would be combined, and earthen baffles installed to increase effluent retention time. Increased retention time will be vital to address high TSS levels, particularly because the discharge from the PRASs will have concentrated streams of solids from filter backwashes.

5.5 Hatchery Operational Impacts/Husbandry

Multiple groups (pulses) of Rainbow 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. Fish would be grown to the size required for vaccination against *Lactococcus* spp. (approximately 170 fpp, 2.5 inches). Shortly after vaccinations are complete, fish will be transferred into the PRAS circular tanks.

The distance from the existing raceways, the proposed site of the new PRASs, and the hatchery buildings is likely too far for fish to be pumped directly without requiring significant lengths of hosing. Instead, a fish pump could be used to load a fish transfer tank equipped with an oxygenation system. If enumeration of the fish is desired, a fish counter may be utilized in conjunction with the fish pump. The transfer tank could be mounted on a truck bed or other piece of equipment and fish would be driven to the grow-out circular tanks and discharged by gravity through a release pipe. Truck loading for fish stocking efforts 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.

5.5.1 Circular Tank Operations

The proposed alternatives would shift fish production from the raceways to PRASs which would reuse up to 75% of the total 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, water flow and velocity adjustments, and monitoring LHO and CO_2 systems to ensure a high-quality rearing environment. Staff must monitor the water velocity in each circular tank to avoid over-exercising fish while maintaining the self-cleaning benefits of the tanks. Based on experiences of other producers (Peterson et al. 2024), the maximum target water velocity is approximately 2 fish body lengths per second (BL/s). Sein nets, clamshell crowders or other crowder types can be used to concentrate fish for collection and handling.

Transfer of fish between tanks at the hatchery and final loading onto trucks for stocking 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

PRASs 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. The production cycle should account for maintenance windows and opportunities for cleaning and disinfection. All PRASs should be programmed into the facilities 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 staff preferences, production strategies, or other variables. 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 providing feed intermittently throughout the day including staff non-duty times to maximize growth, reduces staff labor, but reduces the staff's observations during feeding, requires adjustments to deliver the correct amount of feed, requires preventative and corrective maintenance, and ongoing costs associated with maintenance. 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 or invasive species entering the facility and spreading between rearing areas. The Hot Creek Hatchery has significant biosecurity concerns associated with New Zealand mudsnails in the water source and rearing areas which limits where the hatchery can stock its fish. Additionally, the hatchery has had severe fish mortality events associated with bacterial infections of *Lactococcus* spp. The most likely pathways for pathogens to enter the hatchery is through the incoming water supply or environmental exposure within the hatchery.

5.6.1 Incoming Water Supply

The hatchery is supplied by several springs, each spring source directs water to a specific area of the hatchery (production raceways, Hatchery Building 1 and Brood 1 raceways, or Hatchery Building 2 and Brood 2 raceways). The AB and CD springs are captured as surface flow, making the sources more prone to harboring pathogens and high organic loads.

According to CDFW, the springs sources for Hatcheries 1 and 2 are captured relatively close to the point of use and protected, maintaining relatively good water quality conditions. The spring source is captured and protected along its route to the rearing areas, with limited opportunities for pathogen introduction. The spring source for Hatchery 2 does have lower dissolved oxygen levels, which would be improved by the proposed addition of an LHO prior to directing water into Hatchery Building 2.

5.6.2 Environmental Exposure/Bio Vectors

The main source of environmental exposure for the facility's current production areas are the raceways. Bird predation causes significant losses for small fish in the raceways. The existing raceways have chain-link fencing along the sides, and bird wire overtop; these measures are ineffective at excluding predators from the rearing area. Predators can be a significant source of stress and are capable of transmitting pathogens into the rearing area. The recommended alternatives include a solid roof structure over the PRASs. The roof structures would include chain-link fencing and bird netting along the sides to more completely exclude predators from the rearing areas. The additional protection should significantly increase the production efficiency of hatchery operations by improving survival, ultimately requiring fewer eggs to be taken, and providing more flexibility for early rearing.

5.7 Water Quality Impacts

The recommended alternatives will result in improved water quality within production areas. The 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, and 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 recommended alternatives include upgrades that will increase the volume and retention times of the effluent ponds. These upgrades should help the facility maintain compliance with their existing NDPES permit.

The recommended alternatives also include improving the incoming water quality by upgrading the screening on the spring water intakes to prevent debris, algae, or other macrophytes from entering the water supply. Additional screening should reduce the amount of TSS in the water supply, aiding the hatchery's efforts to maintain NPDES compliance. Adding filtration, disinfection and aeration for the AB and CD spring sources will also improve the water quality for grow-out fish in the proposed PRASs.

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 our 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 application of appropriate overhead and profit markups have been included in the presented project pricing. The detailed cost estimate, 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 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 assumption 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 Hot Creek 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 $6,845,003 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 Hot Creek 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's energy strategy includes installing photovoltaic (PV) panels on newly proposed structures and other developed areas such as parking lots. Additionally, there is abundant barren land on site that could be used for additional PV panels. With careful planning and efficient use of available resources, the site is close to achieving its energy goals, currently reaching 81% of the estimated required capacity. To achieve net zero energy, an additional 35,000 square feet of green space would need to be covered with PV panels.

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

Item	Estimate	
Division 01 – General Requirements	$	6,764,000
Division 02 – Existing Conditions	$	1,397,000
Division 03 – Concrete	$	3,351,000
Division 05 – Metals	$	270,000
Division 07 – Thermal and Moisture Protection	$	20,000
Division 08 – Openings	$	20,000
Division 13 – Special Construction	$	17,967,000
Division 23 – Mechanical and HVAC	$	389,000
Division 26 – Electrical	$	5,000,000
Division 31 – Earthwork	$	1,495,000
Division 32 – Exterior Improvements	$	470,000
Division 40 – Process Water Systems	$	3,353,000
Division 44 – Pumps	$	88,000
2024 CONSTRUCTION COST	**$**	**40,584,000**
Construction Contingency	$	10,146,000
Overhead	$	2,435,000
Profit	$	3,247,000
Bond Rate	$	406,000
2024 CONSTRUCTION PRICE	**$**	**56,818,000**
Design, Permitting, and Construction Support	$	8,523,000
Geotechnical	$	25,000
Topographic Survey	$	60,000
PROJECT TOTAL	**$**	**65,426,000**
Accuracy Range +50%	$	98,139,000
Accuracy Range -30%	$	45,799,000
Photovoltaic (Full kW Required)	$	9,434,000
Photovoltaic (Proposed Rooftop Space kW)	$	3,964,000

7.0 Hot Creek Trout Hatchery Environmental Permitting

7.1 Anticipated Permits and Supporting Documentation

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 (U.S. Fish and Wildlife Service – [USFWS] Information Planning and Consultation [IPaC] and California Biogeographic Information and Observation System [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, National Oceanic and Atmospheric Administration (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

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
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 U.S. or wetlands are affected by the project area
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 Mono County Permits and Approvals for Selected Location

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

7.2 National Pollutant Discharge Elimination System (NPDES) Permitting

The Hot Creek Trout Hatchery is classified as a cold water Concentrated Aquatic Animal Production (CAAP) facility and is eligible to operate under General Order R6V-2021-0014 issued by the Regional Water Quality Control Board, Lahontan (Region 6) and NPDES Permit No. CA0102776.

Wastewater is discharged through the following discharge points:

- 001: Latitude 37°, 38', 31.4" N, Longitude 118°, 51', 14.3" W
- 002: Latitude 37°, 38', 31.5" N, Longitude 118°, 51', 11.5" W
- 003: Latitude 37°, 38', 31.3" N, Longitude 118°, 51', 9.8" W

- 004: Latitude 37°, 38', 36" N, Longitude 118°, 50', 48" W

The following limitations for effluent are specified:

- Nitrogen: 0.30 mg/L (annual average)
- Formaldehyde: 0.65 mg/L (monthly average), 1.3 mg/L (daily maximum)
- Potassium permanganate: 0.098 mg/L (monthly average), 0.197 mg/L (daily maximum)

7.3 Water Rights

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

8.0 Conclusions and Recommendations

The report provides valuable information on the impacts that the Hot Creek Trout Hatchery could experience as a result of climate change and provides modifications that can be made to increase the resiliency of the hatchery. The in-depth analysis of the available climate data performed by NHC provides projections to forecast changes that may be experienced. In general, significant increases in air temperature are expected at Hot Creek Hatchery. Flows from the hatchery's spring water sources can already drop to dangerously low levels, climate projections indicate that spring flows may decline even more in the future. The water supply is not expected to warm appreciably, but even slight warming would place the maximum temperatures in the upper range for fish rearing which may require future adaptation. The risk of wildfires at the facility is expected to remain relatively low, though heightened during drought years.

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. Increased 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:

- Investigating the feasibility of installing a new groundwater well. This would supplement flows during drought years but would require a significant permitting effort.
- Improving the AB and CD spring water sources by installing automatic traveling screens at the capture point and constructing a water treatment facility for the grow-out area.
- Replacing the concrete spring supply pond for Hatchery Building 2 and installing an LHO to improve dissolved oxygen levels for young fish.
- Replacing the flow-through style raceways with dual-drain circular tanks that will operate as partial recirculating aquaculture systems to maintain production and decrease water demand.
- 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.
- Refurbishing the existing raceway used for Brown Trout broodstock, replacing the existing raceway for Rainbow Trout broodstock, and constructing a roof structure over each raceway will improve biosecurity and provide better conditions for fish and staff.

- Replacing Hatchery Building 1 to provide additional space will allow staff to keep fish indoors for longer before operating at fish densities outside the optimal range. This will allow staff to vaccinate and treat fish prior to placing them in outdoor rearing areas.
- Replacing all existing asphalt with new paving to provide safe driving conditions and return the facility back to a condition that allows for public visitation.
- Cleaning existing effluent ponds and combining them into a single larger pond with earthen baffles to increase the residency time of the hatchery's discharge. This will help staff maintain effluent conditions that are compliant with the facility's NPDES permit.
- Installing solar panels atop new structures will offset some of the power demands associated with new hatchery equipment.

The proposed upgrades to the Hot Creek 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 is $65,426,000.

9.0 References

Cal-Adapt. 2023. *Wildfire Simulations Derived Products, RCP 4.5, Global Climate Models HadGEM2-ES, CNRM-CM5, CanESM2, MIROC5.* Cal-Adapt website developed by University of California at Berkeley's Geospatial Innovation Facility under contract with the California Energy Commission. Retrieved [1 September 2023], from https://cal-adapt.org/data/download/

California Department of Forestry and Fire Protection. 2023. *California Fire Perimeters (1950+).* https://gis.data.cnra.ca.gov/datasets/CALFIRE-Forestry::california-fire-perimeters-1950/explore (data access)

IPCC, Intergovernmental Panel on Climate Change. 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri, and L.A. Meyer (eds.)].* IPCC, Geneva, Switzerland, 151 pp.

Klontz, G.W. 1991. *Manual for Rainbow Trout on the Family-Owned Farm.* University of Idaho Department of Fish and Wildlife Resources. Moscow, ID.

Krantz, W., Pierce, D., Goldenson, N., and Cayan, D. R. 2021. *Memorandum on Evaluating Global Climate Models for Studying Regional Climate Change in California.* [online] Available from: https://www.energy.ca.gov/sites/default/files/2022-09/20220907_CDAWG_MemoEvaluating_GCMs_EPC-20-006_Nov2021-ADA.pdf.

Peterson, D. P., B.M. Kennedy, K.M. Hemeon and M.S. Piteo. 2024. Comparison of apparent survival and migration rate of steelhead smolts reared in raceways vs. partial reuse aquaculture systems (PRAS) at Hagerman National Hatchery during migration years 2022 and 2023. Abernathy Fish Technology Center. 2024 Project Report.

Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, and J.R. Leonard. 1982. *Fish Hatchery Management.* U.S. Fish and Wildlife Service. Washington, D.C.

Terracon Consultants, Inc. 2022. Facility Condition Assessment Report Hot Creek Fish Hatchery (Property Number 2213). Terracon Project No. FT20P020.

Thomas, N., Shruti Mukhtyar, Brian Galey, and Maggi Kelly. 2018. *Cal-Adapt: Linking Climate Science with Energy Sector Resilience and Practitioner Need. California's Fourth Climate Change Assessment.* University of California Berkeley, California Energy Commission.

University of Washington Computational Hydrology Group. 2021. VIC Model Overview. https://vic.readthedocs.io/en/master/Overview/ModelOverview/

Vano, J., J. Hamman, E. Gutmann, A. Wood, N. Mizukami, M. Clark, D.W. Pierce, D.R. Cayan, C. Wobus, K. Nowak, and J. Arnold. 2020. *Comparing Downscaled LOCA and BCSD CMIP5 Climate and Hydrology Projections – Release of Downscaled LOCA CMIP5 Hydrology. 96 p*. https://gdo-dcp-ucllnl.org/downscaled_cmip_projections/dcpInterface.html

Westerling, A.L. 2018. *Wildfire Simulations for California's Fourth Climate Change Assessment: Projecting Changes in Extreme Wildfire Events with a Warming Climate.* California's Fourth Climate Change Assessment, California Energy Commission. Publication Number: CCCA4-CEC-2018-014. https://www.energy.ca.gov/sites/default/files/2019-11/Projections_CCCA4-CEC-2018-014_ADA.pdf