United States Department of the Interior - Fish and Wildlife Service

Leavenworth Fisheries Complex

Alternatives Analysis

Final Draft Report

Prepared For: United States Department of the Interior – Fish and Wildlife Service

Prepared By:

McMillen Jacobs Associates

December 2015

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

ES-1.0 Introduction 1
ES-2.0 Existing Conditions – Site Reconnaissance 1
ES-3.0 Biological Criteria and Operations Schedules 2
ES-4.0 Geographically Separate Alternatives 2
ES-5.0 Existing Sites Alternative Evaluation 3
ES-6.0 Infrastructure Alternatives – Existing Complex Sites 5
ES-7.0 Conclusions and Implementation Recommendations 6

SECTION 1 INTRODUCTION, GOALS, AND DOCUMENT ORGANIZATION 1

1.0 Introduction 1
1.1 Goals 2
1.2 Document Organization 2

SECTION 2 EXISTING CONDITIONS – SITE RECONNAISSANCE 4

2.0 Introduction 4
2.1 Leavenworth National Fish Hatchery 4
2.1.1 Site Location and Layout 4
2.1.2 Summary of Existing Water Rights 8
2.1.3 Surface Water Supply System 8
2.1.4 Snow and Nada Lakes 9
2.1.5 Groundwater Supply System 11
2.1.5.1 Well No. 1 12
2.1.5.2 Well No. 2A 13
2.1.5.3 Well No. 3A 13
2.1.5.4 Well No. 4A 13
2.1.5.5 Well No. 5 13
2.1.5.6 Well No. 6 13
2.1.5.7 Well No. 7 13
2.1.6 Sand Settling Basin and Headworks 14
2.1.7 Distribution Piping 15
2.1.8 Adult Holding and Spawning Facility 15
2.1.9 Icicle Creek Historic/Hatchery Channel Structures 16
2.1.10 Hatchery Building 17

2.1.11 Support Buildings 17
2.1.12 Hatchery Housing 18
2.1.13 Outdoor Rearing 18
2.1.14 Drains, Effluent Pond, and Outfalls 20
2.1.15 Utility Services 21
2.1.16 Power, Lighting, Instrumentation, and Monitoring 22
2.1.17 Site Access and Constraints 23
2.1.18 NPDES/TMDL Compliance 23
2.2 Entiat National Fish Hatchery 24
2.2.1 Site Location and Layout 24
2.2.2 Summary of Existing Water Rights 27
2.2.3 Surface Water Supply System 28
2.2.4 Groundwater Supply System 30
2.2.5 Sand Settling Basin and Headworks 30
2.2.6 Distribution Piping 31
2.2.7 Adult Holding and Spawning 31
2.2.8 Hatchery Building 32
2.2.9 Outdoor Rearing 32
2.2.10 Drains, Effluent Pond and Outfalls 33
2.2.11 Support Buildings 33
2.2.12 Utility Services 33
2.2.13 Power, Lighting, Instrumentation, and Monitoring 34
2.2.14 Hatchery Housing 35
2.2.15 Site Access and Constraints 35
2.2.16 NPDES/TMDL Compliance 36
2.3 Winthrop National Fish Hatchery 36
2.3.1 Site Location and Layout 36
2.3.2 Summary of Existing Water Rights 40
2.3.3 Surface Water Supply System 40
2.3.4 Groundwater Supply System 41
2.3.4.1 Infiltration Gallery No. 1 42
2.3.4.2 Infiltration Gallery No. 2 42
2.3.4.3 Infiltration Gallery No. 3 42
2.3.5 Distribution Piping 43
2.3.6 Adult Holding and Spawning 44

2.3.7 Hatchery Building ... 44
2.3.8 Raceways ... 44
2.3.9 Drains, Effluent Pond, and Outfalls ... 45
2.3.10 Support Buildings ... 45
2.3.11 Utility Services ... 46
2.3.12 Power, Lighting, Instrumentation, and Monitoring ... 46
2.3.13 Hatchery Housing ... 48
2.3.14 Site Access and Constraints ... 48
2.3.15 NPDES/TMDL Compliance ... 48

SECTION 3 BIOLOGICAL PROGRAMMING AND OPERATIONS SCHEDULES ... 49
3.0 Introduction ... 49
3.1 Fish Production Targets ... 49
3.1.1 Leavenworth NFH Fish Production ... 50
3.1.2 Entiat NFH Fish Production ... 50
3.1.3 Winthrop NFH Fish Production ... 50
3.1.4 Mid-Columbia Coho Production Changes ... 51
3.2 Biological Criteria ... 51
3.2.1 Water Temperature ... 51
3.2.2 Fish Weight and Length ... 52
3.2.3 Density Indices (DI) ... 52
3.2.4 Flow Indices (FI) and Water Exchange Rates ... 52
3.3 Operating Schedules ... 52
3.3.1 Leavenworth NFH Fish Rearing Cycles ... 53
3.3.2 Leavenworth NFH Operating Summary ... 57
3.3.3 Entiat NFH Fish Rearing Cycles ... 59
3.3.4 Entiat NFH Operating Summary ... 62
3.3.5 Winthrop NFH Fish Rearing Cycles ... 64
3.3.6 Winthrop NFH Operating Summary ... 68
3.4 Water Supplies and Climate Change ... 70

SECTION 4 GEOGRAPHICALLY SEPARATE ALTERNATIVES EVALUATION ... 72
4.0 Introduction ... 72
4.0.1 Range of Magnitude Cost Evaluation ... 72
4.0.2 Essential Components of a Geographically Separate Leavenworth NFH Facility ... 74
4.1 Initial Screening Criteria ... 75

4.1.1 Land Issues 75
4.1.2 Water Quality and Quantity 75
4.1.2.1 Leavenworth NFH Water Supply Criteria 76
4.1.2.2 Obtaining New Water Rights 76
4.1.3 Biological Analysis 77
4.1.4 Policy and Legal 79
4.2 Alternative GS1 - Move Leavenworth NFH Spring Chinook Production to a New Hatchery in the Wenatchee River Basin Upstream of the Icicle Creek Confluence 79
4.2.1 Alternative GS1 – Land Issues 79
4.2.2 Alternative GS1 – Water Quantity and Quality 81
4.2.3 Alternative GS1- Biological Analysis 81
4.3 Alternative GS2 - Move Leavenworth NFH Spring Chinook Production to a New Hatchery in the Wenatchee River Basin Downstream of the Icicle Creek Confluence 82
4.3.1 Alternative GS2– Land Issues 82
4.3.2 Alternative GS2 – Water Quantity and Quality 84
4.3.3 Alternative GS2 – Biological Analysis 85
4.4 Alternative GS3 - Move present Leavenworth NFH Spring Chinook Production to a Facility on Mainstem Columbia River 85
4.4.1 Alternative GS3 – Land Issues 86
4.4.2 Alternative GS3 – Water Quantity and Quality 88
4.4.3 Alternative GS3 – Biological Analysis 89
4.5 Alternative GS4 - Move present Leavenworth NFH Spring Chinook Production to a Facility on the Entiat, Methow, or Okanogan River 90
4.5.1 Alternative GS4 – Land Issues 91
4.5.2 Alternative GS4 – Water Quantity and Quality 93
4.5.3 Alternative GS4 – Biological Analysis 94
4.6 Alternative GS5 - Maintain Spring Chinook Incubation and Over-winter Acclimation at Leavenworth NFH, Move Juvenile Rearing to a Geographically Separate Site 95
4.6.1 Alternative GS5 – Land Issues 95
4.6.2 Alternative GS5 – Water Quantity and Quality 95
4.6.3 Alternative GS5 – Biological Analysis 96
4.7 Geographically Separate Sites - Policy and Legal 97
4.7.1 Grand Coulee Mitigation 97
4.7.2 US v. Oregon 97
4.7.3 Tribal Usual and Accustomed Fishing Areas 99
4.7.4 NPDES Compliance 99

4.8 Initial Screening Summary 100
4.8.1 Land Issues Summary 100
4.8.2 Water Supply Quality and Quantity Summary 102
4.8.3 Biological Analysis Summary 103
4.8.3.1 Genetic Risks (pHOS) 103
4.8.3.2 Predation, Competition, Disease 104
4.8.3.3 Effects on Other ESA-listed Species 104
4.8.4 Legal Summary 104
4.8.5 Geographically Separate Feasibility Summary 105
4.9 Advanced Screening Criteria for Geographically Separate Sites 105
4.9.1 Socioeconomic Analysis 105
4.9.2 Capital Costs 106
4.9.3 Operating Costs 106
4.9.4 Environmental Compliance 106

SECTION 5 EXISTING SITES ALTERNATIVE EVALUATION 108
5.0 Introduction 108
5.0.1 Socio-Economic Introduction 108
5.1 Leavenworth NFH Analysis 110
5.1.1 Land Issues 110
5.1.2 Water Quantity and Quality 110
5.1.3 Biological Risks and Benefits 111
5.1.4 Policy/Legal 111
5.1.5 Socio-Economic (Includes Harvest) 112
5.1.6 Capital Costs 115
5.1.7 Operating Costs 115
5.2 Entiat NFH Analysis 116
5.2.1 Land Issues 116
5.2.2 Water Quantity and Quality 116
5.2.3 Biological Risks and Benefits 117
5.2.4 Policy/Legal 118
5.2.5 Socio-Economic (Includes Harvest) 119
5.2.6 Capital Costs 121
5.2.7 Operating Costs 121
5.3 Winthrop NFH Analysis 122

5.3.1 Land Issues 122
5.3.2 Water Quantity and Quality 122
5.3.3 Biological Risks and Benefits 122
5.3.3.1 Spring Chinook Program 123
5.3.3.2 Summer Steelhead Program 124
5.3.4 Policy/Legal 125
5.3.5 Socio-Economic (Includes Harvest) 125
5.3.6 Capital Costs 127
5.3.7 Operating Costs 127
5.4 Environmental Compliance – All Sites 128

SECTION 6 INFRASTRUCTURE ALTERNATIVES – 3 EXISTING SITES 131
6.0 Introduction 131
6.1 Modernization and Alternative Rearing Methods Discussion 131
6.1.1 Centralized Partial Reuse Aquaculture Systems 132
6.1.2 Decentralized PRAS - Optimized Airlift Pumps 133
6.1.3 Oxygen Supplementation 135
6.1.4 Circular Tanks 137
6.1.5 Roof Covers for Outdoor Rearing 137
6.1.6 Alternatives Comparison Criteria and Flow Schematics 137
6.2 Leavenworth National Fish Hatchery 142
6.2.1 Surface Water Supply 142
6.2.1.1 Snow and Nada Lakes 142
6.2.1.2 Surface Water Disinfection 142
6.2.2 Groundwater Supply 143
6.2.2.1 Geophysical Modeling 143
6.2.2.2 Well No. 10 and Infiltration Gallery Feasibility 145
6.2.3 Supply and Drain Piping 146
6.2.3.1 Reuse Pumps and Piping 147
6.2.4 Adult Holding and Spawning and Fish Ladder 147
6.2.5 Incubation and Indoor Rearing 149
6.2.6 Juvenile Rearing and Release 149
6.2.6.1 10 x 100 Ft Raceways 149
6.2.6.2 8 X 80 Ft Raceway Replacement 150
6.2.7 Alternative Rearing Strategies 152

6.2.7.1 Alternative Rearing - Existing 10x100 Ft Raceways 152
6.2.7.2 Alternative Rearing - Existing 8x80 Ft Raceways 154
6.2.7.3 Circular Tanks with Increased Rearing Densities 155
6.2.8 Effluent Treatment 157
6.2.8.1 Short Term Phosphorous Management Plan 157
6.2.8.2 Long Term Phosphorous Management Plan 159
6.2.9 Support Facilities 161
6.2.10 Power, Lighting, Controls, and Alarms 161
6.3 Entiat National Fish Hatchery 162
6.3.1 Surface Water Supply 162
6.3.1.1 Intake Modifications 162
6.3.1.2 Screening Structure/Sediment Basin Modifications 164
6.3.1.3 Surface Water Disinfection 165
6.3.1.4 Limekiln Spring Modifications 165
6.3.2 Groundwater Supply 165
6.3.3 Supply and Drain Piping 166
6.3.4 Adult Holding Pond and Fish Ladder 166
6.3.5 Incubation and Early Rearing 167
6.3.6 Juvenile Rearing and Release 167
6.3.7 Alternative Rearing Technologies 168
6.3.8 Effluent Treatment 169
6.3.9 Support Facilities and Access 169
6.3.10 Power, Lighting, Controls, and Alarms 170
6.3.10.1 Retrofit/Replace Engine-Generator 170
6.3.10.2 Provide Consolidated Electrical ‘Present Condition’ Drawings 170
6.3.10.1 Replace Flowmeters 170
6.3.10.2 Correct Clearance Problems 170
6.4 Winthrop National Fish Hatchery 170
6.4.1 Surface Water Supply 170
6.4.2 Groundwater Supply 171
6.4.3 Supply and Drain Piping 171
6.4.4 Adult Holding 172
6.4.5 Incubation and Early Rearing 172
6.4.6 Juvenile Rearing and Release 172
6.4.7 Alternative Rearing Technologies 176

6.4.7.1 Alternatives for Existing Rearing Units 176
6.4.7.2 Alternatives for New Rearing Units 176
6.4.8 Effluent Treatment 176
6.4.9 Support Facilities 176
6.4.10 Power, Lighting, Controls, and Alarms 176
6.5 Alternatives Summaries and Costs 177
6.5.1 Alternatives Costs 177

SECTION 7 CONCLUSIONS AND IMPLEMENTATION RECOMMENDATIONS 182
7.0 Introduction 182
7.1 Conclusions 182
7.2 Alternatives Prioritization 182
7.2.1 Leavenworth NFH Implementation Priorities 183
7.2.2 Entiat NFH Implementation Priorities 184
7.2.3 Winthrop NFH Implementation Priorities 185

SECTION 8 REFERENCES 189

LIST OF TABLES

Table ES-1. Estimated Regional Economic Impacts of LFC Operations 4
Table ES-2. FY2014 Operating Budget Summary for Leavenworth Fisheries Complex 4
Table 1-1. Document Organization and Purpose 3
Table 2-1. Index for Features Shown on Figure 2-2 6
Table 2-2. Leavenworth NFH Water Rights 8
Table 2-3. Index for Features Shown on Figure 2-3 26
Table 2-4. Entiat NFH Water Rights 27
Table 2-5. Summary of Average Yield by Source 28
Table 2-6. Index for Features Shown on Figure 2-6 39
Table 2-7. Winthrop NFH Water Rights 40
Table 3-1. Leavenworth Fisheries Complex - Production Targets and Biological Criteria 49
Table 3-2. Leavenworth NFH Spring Chinook Operations Schedule 55
Table 3-3. Leavenworth NFH Mid-Columbia Coho Operations Schedules 56
Table 3-4. Leavenworth NFH Water Supply and Rearing Volume Summary 58
Table 3-5. Entiat NFH Summer Chinook Operations Schedule 61
Table 3-6. Entiat NFH Water Supply and Rearing Volume Summary 62
Table 3-7. Winthrop NFH Spring Chinook Operations Schedule 65
Table 3-8. Winthrop NFH Summer Steelhead Operations Schedules 66
Table 3-9. Winthrop NFH Mid-Columbia Coho Operations Schedule 67

Table 3-10. Winthrop NFH Water Supply and Rearing Volume Summary 69
Table 4-1. Recent Hatchery Construction Costs 72
Table 4-2. Complex Geographically Separate Alternatives Evaluation Matrix 101
Table 5-1. Predicted Average Annual Harvest of Salmon and Steelhead Produced by Current Complex Hatchery Production Programs 109
Table 5-2. Estimated Regional Economic Impacts of Leavenworth NFH Operations 113
Table 5-3. Summary of the effects of the Entiat NFH summer Chinook program on Upper Columbia spring Chinook salmon and designated habitat (NMFS 2013) 118
Table 5-4. Estimated Regional Economic Impacts of Entiat NFH Operations 119
Table 5-5. Estimated Regional Economic Impacts of Winthrop NFH Operations 125
Table 5-6. Permits and Approvals / Submittal and Review Requirements 129
Table 6-1. Criteria for Alternatives Comparison 138
Table 6-2. Summary of Potential Pipe Replacements – Leavenworth NFH 146
Table 6-3. Summary of Potential Pipe Replacements - Entiat NFH 166
Table 6-4. Summary of Potential Pipe Replacements - Winthrop NFH 172
Table 6-5. Leavenworth NFH Alternatives Summary 179
Table 6-6. Entiat NFH Alternatives Summary 180
Table 6-7. Winthrop NFH Alternatives Summary 181
Table 7-1. Leavenworth NFH Implementation Plan 186
Table 7-2. Entiat NFH Implementation Plan 187
Table 7-3. Winthrop NFH Implementation Plan 188

LIST OF FIGURES

Figure 2-1. General Layout of the Leavenworth NFH 4
Figure 2-2. Features of the Leavenworth NFH 5
Figure 2-3. Features of the Entiat NFH 25
Figure 2-4. Entiat River at Entiat NFH Intake – January 26, 2014 (courtesy of Craig Chisam) 29
Figure 2-5. General Layout of the Winthrop NFH 37
Figure 2-6. Features of the Winthrop NFH 38
Figure 3-1. Leavenworth NFH Water Summary 59
Figure 3-2. Entiat NFH Water Summary 63
Figure 3-3. Winthrop NFH Water Summary 70
Figure 4-1. Upper Wenatchee River Vicinity 80
Figure 4-2. Dryden Dam Parcel 83
Figure 4-3. Peshastin Creek Parcel 84
Figure 4-4. Chief Joseph Hatchery Vicinity 86
Figure 4-5. CCT Resident Fish Hatchery 87
Figure 4-6. Wells Hatchery Vicinity 88
Figure 4-7. Entiat NFH 91
Figure 4-8. Winthrop NFH 92

Figure 6-1. Centralized PRAS at Eastbank Hatchery (Courtesy of PRAqua) 132
Figure 6-2. Aeroboost Performance (Courtesy of PRAqua) 133
Figure 6-3. Airlifts in Trout Raceway (Courtesy of FFS) 135
Figure 6-4. LHO's at Colville Resident Fish Hatchery 136
Figure 6-5. Existing Raceways – Alternative Rearing Flow Schematics 140
Figure 6-6. Centralized PRAS Flow Schematic 141
Figure 6-7. New 10 x 100 ft Raceway Conceptual Layout 151
Figure 6-8. Circular Tank Alternative Conceptual Layout 153
Figure 6-9. Circular Tanks – High Rearing Density Alternative 156
Figure 6-10. Entiat NFH Intake - Icing at Trash Rack 164
Figure 6-11. Slush Accumulation Clogging Fish Screens at Entiat NFH 164
Figure 6-12. Cleaning Waste Vacuum Pump and Grating Gap 167
Figure 6-13. Serial Reuse Discharge into Raceway Supply Channel 169
Figure 6-14. Crumbling Concrete at "C Bank" Raceways 173
Figure 6-15. Rough Walls at "D Bank" of 8 x 80 Raceways 174
Figure 6-16. Conceptual Layout of New Rearing Units 175

APPENDICES

Appendix A Facility Schematic Diagrams
Appendix B Water Supply Reports
Appendix C Meeting Notes
Appendix D Photographs
Appendix E Cost Details

EXECUTIVE SUMMARY

ES-1.0 Introduction

The Department of Interior through the Fish and Wildlife Service (FWS), in cooperation with the Bureau of Reclamation (Reclamation), is considering alternatives for meeting fish production targets at the Leavenworth Fisheries Complex (Complex). The Complex consists of three facilities: Leavenworth, Entiat and Winthrop National Fish Hatcheries, which are owned and operated by FWS to support four FWS anadromous fish production programs, and in addition support two Yakama Nation (YN) anadromous fish production programs:

Leavenworth National Fish Hatchery (Leavenworth NFH)

- Spring Chinook (FWS): 1,200,000 to 18 fish per pound (fpp)
- Mid-Columbia Coho (YN): Acclimate 550,000 to 600,000 to 16 fpp

Entiat National Fish Hatchery (Entiat NFH)

- Summer Chinook (FWS): 400,000 to 18 fpp

Winthrop National Fish Hatchery (Winthrop NFH)

- Spring Chinook (FWS): 400,000 to 18 fpp, and 200,000 eggs to Chief Joseph Hatchery
- Summer Steelhead (FWS): 200,000 to 4 fpp
- Mid-Columbia Coho (YN): Acclimate 350,000 to 16 fpp

These facilities were constructed in the 1940's to provide mitigation for the loss of natural fish production due to the construction and operation of Grand Coulee Dam. Rehabilitation of the aging infrastructure at these hatcheries will require significant expenditures in order to continue to meet fish production obligations related to the Grand Coulee Fish Mitigation Plan (GCFMP) and subsequent US v. Oregon and other Federal/ Tribal agreements. The alternatives analysis includes the following primary elements:

- Review, organize, and assimilate large amounts of data provided by FWS on existing Complex facilities, previous planning efforts, and operations.
- Verification of fish production goals and biological criteria to help confirm program water budgets and rearing facility requirements.
- Conduct a high level analysis of geographically separate alternatives for relocation of fish production to new sites or a combination of new and existing sites.
- Evaluate benefits and risks of maintaining fish production at the existing Complex facilities.
- Identify infrastructure improvement alternatives, including alternative rearing technologies that may be incorporated to prevent failure of critical infrastructure, make the best use of available water rights and supplies, and to cost effectively extend the service life of Complex facilities.
- Develop an implementation plan that includes conceptual level cost estimates and prioritization for recommended improvements.

ES-2.0 Existing Conditions – Site Reconnaissance

A condition assessment of each major element of each hatchery was conducted, beginning with the water supply systems, through pumping; rearing units; corresponding effluent systems; structural, mechanical, and electrical systems; utilities; and site access. In addition to infrastructure assessments, existing water

rights information is also summarized. All three Complex facilities have major issues with aging infrastructure and deferred maintenance items that would need to be addressed in order to maintain fish production, improve worker safety, assure fish health, and extend the service life of the facilities.

ES-3.0 Biological Criteria and Operations Schedules

Detailed fish production targets have been verified along with biological criteria and hatchery operations schedules for each of the fish production programs located at the Complex facilities. Critical parameters including water supply and rearing volume availability were assessed, and the potential impacts of climate change are discussed. It is concluded that in order to allow a reasonable amount of operational flexibility and preserve the ability to meet fish health and fish production targets in the face of increasing difficult environmental conditions, it will be advantageous for FWS to be proactive in maintaining and developing existing water rights for fish production at current locations.

ES-4.0 Geographically Separate Alternatives

There are several challenges confronting ongoing operations at the Complex that are driving the effort to consider fish production relocation. These factors include but are not limited to:

- Potential that future National Pollution Discharge Elimination System (NPDES)/Total Maximum Daily Load (TMDL) discharge limits for phosphorous cannot be met at Leavenworth NFH (could be an issue further in the future at Entiat NFH or Winthrop NFH).
- Declining groundwater production from the existing wells. (At Leavenworth NFH this is primarily related to changes in how the hatchery channel and historical channel flows are managed).
- Potential impacts of hatchery operations on in-stream flows and on ESA fish (Litigation is pending at Leavenworth NFH).
- The difficulty and cost of replacing the 75-year old infrastructure and modernizing the facilities while meeting fish production, mitigation and tribal trust obligations in a cost effective manner.

The relocation of any of the Complex fish production programs to geographically separate locations would require extensive consultation with NOAA, and re-negotiations of US v. Oregon harvest targets with tribes and other concerned entities. In addition, relocating the programs would entail substantial costs for planning, design, environmental compliance, and construction of the new facilities. Based on known costs of recently constructed hatcheries, total project costs were developed for hatchery replacements at new sites. These costs are approximately $12M for Entiat NFH, $24M for Winthrop NFH, and $36M for Leavenworth NFH. After analyzing these rough project costs compared to the costs of modernizing the existing Complex hatcheries, only Leavenworth NFH has a high enough modernization cost to warrant consideration of replacement at a geographically separate location. Five alternative production strategies to relocate all or part of the Leavenworth NFH spring Chinook program were identified for consideration. These five alternatives, including more than a dozen specific sites, were initially evaluated based on screening factors including potential land issues, water supply quality and quantity, effects on harvest (US v. Oregon) and mitigation (Grand Coulee mitigation) obligations, policy/legal (tribal access to usual and accustomed fishing areas), biological risks and benefits, and disease risks. After a review of the initial screening analysis, there was a consensus between the FWS, Reclamation and the consulting team that none of the geographically separate alternatives were viable enough to justify advanced screening. The potential fatal flaw factors in reaching this decision include:

- Difficulty in obtaining funding for the project cost of a new $35 to $40M hatchery facility

- Difficulty obtaining adequate new water rights and supplies that also meet water quality criteria at a reasonable cost.
- The risks of hatchery fish straying and spawning with wild fish would be a major concern to FWS, NOAA, and regional fisheries managers
- Even minor changes to stock, abundance, run timing, Endangered Species Act (ESA) risk, or alteration in composition of mixed stocks could have a negative impact on usual and accustomed fishing areas locally and throughout the Columbia River generally and may be inconsistent with tribal rights.
- Potential that the problems presently facing the Complex would not be resolved by relocation of fish production to new sites.

ES-5.0 Existing Sites Alternative Evaluation

A more rigorous evaluation to verify the efficacy of the alternative to maintaining fish production at the three existing Complex hatchery facilities was then conducted. The same initial screening categories used for the geographically separate alternatives; land issues, water quality and quantity, biological risks and benefits, and policy/legal considerations were applied along with additional factors, including socioeconomics, capital, operations and maintenance costs, and environmental compliance.

Land Issues: Leavenworth NFH consists of 157 acres of land which provides adequate space for modernization without interruption of fish production and for the development of additional groundwater supplies. The 29.48 acre land area at Entiat NFH may become a limiting factor on groundwater supply development, and is otherwise adequate for meeting fish production targets. The 42 acre site at Winthrop NFH appears to be adequate for ongoing operations and could accommodate expansion.

Water Quality and Quantity: All three Complex hatcheries utilize untreated surface water from rivers that have spawning salmon above the intakes. A treatment facility to filter and disinfect at least a portion of the surface water supply at each facility should be considered. Groundwater at all three facilities is good quality, though degassing should be considered at Winthrop NFH. Icing in the winter causes flow reductions and impedes fish feeding at all three facilities. Entiat NFH in particular has severe icing problems that interrupt surface water supply flow. Separate studies and investigations are underway to determine groundwater source expansion feasibility at Entiat NFH. Similar investigations were conducted at Leavenworth NFH as part of this study.

Biological Risks and Benefits: Genetic effects of Leavenworth NFH hatchery-origin fish spawning naturally with natural-origin spring Chinook are negligible as adult stray rates are within acceptable limits as defined by the ICTRT and HSRG. Biological effects of the Entiat summer Chinook hatchery program on ESA-listed salmonid populations and their habitat are described in detail in the programs' 2013 BiOp (NMFS 2013). The NMFS BiOP for the program concluded the following:

- The program is not likely to jeopardize the continued existence of the Upper Columbia River spring-run Chinook salmon endangered species unit (ESU), or destroy or adversely modify designated critical habitat.
- The program is not likely to adversely affect Upper Columbia River steelhead and their designated habitat.

A finding of "not likely to adversely affect" an ESA-listed species or its designated critical habitat indicates that effects of the action (i.e. the program) are expected to be "discountable, insignificant or completely beneficial".

The effects the Winthrop NFH spring Chinook and steelhead programs may have on ESA-listed salmon are described in the HGMP's for each program (FWS 2012b and FWS 2012c). Program effects on bull trout are described in the FWS Biological Assessment (FWS 2014). ESA consultation with FWS and NMFS is in process and not complete yet. A description of effects each program may have on each of these species is lengthy and is not summarized here, (See Section 5.3 below).

Socioeconomics: As summarized in Table ES-1, the Complex provides harvest benefits to both tribal and non-tribal fisheries in local stream and in the Columbia River. Local food banks benefit from surplus fish that are trapped and are in excess of hatchery broodstock needs. It is important to note that salmon produced by the Complex and caught by tribal members in ceremonial and subsistence fisheries cannot be assigned a monetary value. The Complex also provides significant economic value in terms of direct and indirect jobs within local communities.

Table ES-1. Estimated Regional Economic Impacts of LFC Operations

Impact Category	Commercial Ex-Vessel Value	Sport Angler Spending	Jobs[1]	Personal Income[2]
Leavenworth NFH - Spring Chinook Program				
Fishery Benefits	$20,100	$568,100	12.7	$435,300
Hatchery Operations	NA	NA	30.9	$2,182,200
Entiat NFH – Summer Chinook Program				
Fishery Benefits	$158,400	$494,700	17.7	$646,100
Hatchery Operations	NA	NA	9.7	$612,700
Winthrop NFH –Spring Chinook Program				
Fishery Benefits	$6400	$577,600	13.0	$434,800
Hatchery Operations	NA	NA	17.0	$1,034,700

Notes:
Values are shown in 2013 dollars.
N/A = not applicable.
[1] Includes full- and part-time jobs.
[2] Includes direct and secondary (indirect and induced) effects.
Source: Project team estimates generated using fishery harvest estimates, operations budget expenditures, impact factors, and IMPLAN input-output model software and data files for Chelan and Okanogan counties.

Operating Costs: The annual operating cost data provided by the FWS for the full Leavenworth Fisheries Complex is included as Appendix E-1 through Appendix E-3. Table ES-2 provides the fiscal year 2014 operating budget for the overall Complex.

Table ES-2. FY2014 Operating Budget Summary for Leavenworth Fisheries Complex

Expense Area	Hatcheries Operations Cost	MCRFRO Cost[1]	Olympia FHC Cost[2]	Total
Salaries	$2,115,102	$574,289	$207,516	$2,896,907
Travel	$0	$33,413	$10,989	$44,402
Utilities and Rent	$168,400	$11,852	$50,500	$230,752
Supplies and Materials	$514,000	$45,270	$31,529	$590,799
Marking and Tagging	$0	$353,500	$0	$353,500

Vehicles	$153,500	$12,743	$9,720	$175,963
Facilities Maintenance	$701,000	$0	$0	$701,000
Subtotal	*$3,652,002*	*$1,031,067*	*$310,254*	*$4,993,323*
Overhead (26.0874%)	$952,712	$268,979	$80,937	$1,302,628
TOTALS	$4,604,714	$1,300,046	$391,191	**$6,295,951**

[1] Mid-Columbia River Fishery Resource Office
[2] Olympia Washington Fish Health Center

#

Policy/Legal: Currently the Complex programs meet US v. Oregon obligations (see section 4.7.2) and GCFMP objectives. The U.S. v. Oregon Management Agreement is a binding Order of the District Court of Oregon. Reference to Table B1 and its associated Footnote 5 illustrates that release location changes will require the agreement of all parties to that proceeding, and ultimately a modification to the Court Order that is in force through 2017. Additionally, these terms make it clear that those parties have agreed that many issues associated with the Leavenworth NFH will be addressed "collaboratively" and no one party is expected to make changes to the current program parameters unilaterally. Alternatives need to consider impacts to the fishery at Icicle Creek and also to all other treaty reserved fishery areas in Zone 6.

Even minor changes to stock, abundance, run timing, ESA risk, or alteration in composition of mixed stocks could have a negative impact on usual and accustomed fishing areas locally and throughout the Columbia River generally, and be inconsistent with tribal rights.

Environmental Compliance: A list of permits, agency review time, submittal requirements, and supporting documentation for obtaining the permits to support project construction activities at Leavenworth NFH, Entiat NFH and Winthrop NFH were developed to inform the planning process. The alternatives analysis includes short term and long term phosphorous management recommendations which address the treatment of hatchery effluents.

ES-6.0 Infrastructure Alternatives – Existing Complex Sites

Alternatives for cost effective and programmatically viable infrastructure improvements to the existing fish production facilities at the Complex hatcheries were developed. The alternatives include recommendations that address the following:

1) Development of water supplies to improve operational flexibility and preserve existing water rights,
2) Deferred maintenance items,
3) Replacement or modernization of obsolete or poorly functioning fish culture facilities and supporting infrastructure,
4) Alternative fish culture technologies that may increase fish health, and the efficiency of fish production, and energy, and water use.

Alternative Rearing Technologies: The need for long term planning to address the effects of climate change, declines in aquifer productivity, effluent management, and difficulty in fully developing available water rights is driving FWS to considering alternative rearing technologies for potential implementation at Complex hatcheries. These technologies may enable FWS to meet full production targets and maintain fish health under increasingly difficult environmental conditions. Alternative technologies may also be used to improve effluent (phosphorous) management and increase the redundancy in the water supply in case of mechanical failures. Each of these rearing methods has the potential to reduce water demand by 50% to 75%. It should be noted that pathogen free groundwater is the recommended make-up water

source for systems that employ water reuse technology in order to minimize disease concerns. Therefore, increased availability of groundwater would likely improve the success of water reuse systems. If surface water were to be used as the make-up water source for a reuse system, central filtration and UV disinfection would generally be recommended prior to use. The use of circular tanks as an alternative to the rectangular raceways presently used at the Complex is also discussed along with roof covers and refurbishing costs for outdoor rearing units. The study discusses phosphorous management as a component of alternative rearing technologies in detail. Lists of potential infrastructure improvement alternatives were prepared for each hatchery.

ES-7.0 Conclusions and Implementation Recommendations

The alternatives analysis concludes that the Complex is currently meeting its core mission with regards to the GCFMP and US v. Oregon, and related mitigation commitments. Aging infrastructure and declining water supplies at the existing hatcheries threatens their ability to continue meeting these legal obligations while also meeting FWS fish health criteria. Hatchery water supplies are of primary importance. In consideration of climate change and its impact on water supplies, improvements that allow FWS to effectively utilize existing water rights at Complex facilities will become increasingly critical. Groundwater supply improvements are underway at Leavenworth and Entiat NFH, and surface water improvements are highly recommended at both facilities. Winthrop NFH has an adequate water supply that would benefit from aeration treatment of groundwater and disinfection of surface water. The major issue at Winthrop is replacement of failing outdoor rearing units and pipelines.

The Complex is providing cost effective interim support for the YN Mid-Columbia coho program. The YN program would benefit from water supply and rearing unit improvements at Leavenworth and Winthrop NFH, however, permanent improvements may be difficult to justify since the approved master plan for the coho program indicates drastically reduced production at both hatcheries within the next five to ten years.

Implementation Plans: The alternatives developed in Section 6 are prioritized with the highest priority for implementation assigned to life/worker safety items and water supply improvements which are critical to achieving fish production and fish health goals. Medium priority ratings are assigned to important infrastructure improvements that should be planned and budgeted for in order to increase service life, comply with regulatory and best management practices, and to avoid failures that could impact fish production commitments. This includes items such as pipe or rearing vessel replacements that will eventually become high priority or even emergency items if they are not accomplished prior to further degradation or failure. Alternative rearing technologies that address water availability issues also fall into the medium priority category. There are a few low priority items that have been included in this analysis, most of which involve deferred maintenance of support infrastructure. The tables at the end of Section 7, (Tables 7-1, 7-2 and 7-3), illustrate preliminary expenditure schedules for alternatives implementation at each hatchery, in consideration of the assigned priority. An overall implementation timeline of 20 years is shown with costs in 2014 dollars escalated at 3% per year. These implementation schedules are loosely based on a guideline provided by Reclamation that the Complex may receive replacement project funding in the range of $5 to $10M per year over the next 15 to 20 years.

Leavenworth NFH Implementation: The recommended capital spending plan at Leavenworth NFH is front loaded with $2.5 to $5M per year in expenditures over the next ten years to address high priority, mission critical projects that have been identified. These projects include rebuilding the surface water intake to incorporate NOAA compliant screens, surface water transmission pipe upgrades, groundwater

supply development, spawning facility replacement, new rearing vessels with roof covers, and effluent management improvements that may be needed to comply with future discharge permit conditions.

Entiat NFH Implementation Plan: The recommended capital spending plan at Entiat NFH averages $0.5 to $1.0 M per year over a 20 year period. The highest priority projects include groundwater supply development, surface water intake and fish screen improvements, surface water disinfection, grating replacement at raceways, and an effluent pump back system.

Winthrop NFH Implementation Plan: The recommended capital spending plan at Winthrop NFH includes a single, large, high priority expenditure for the replacement of obsolete and failing outdoor rearing units and associated piping at a cost of nearly $4.0M. Annual spending for the remainder of the 20-year cycle varies from $0.2M to $1.0M. These smaller projects include pipe replacements, a gas stabilization headbox, surface water disinfection, and refurbishment of outdoor raceways.

SECTION 1
INTRODUCTION, GOALS, AND DOCUMENT ORGANIZATION

1.0 Introduction

The Fish and Wildlife Service (FWS), in cooperation with the Bureau of Reclamation (Reclamation), is considering alternatives for meeting fish production goals at the Leavenworth Fisheries Complex (Complex). The Complex consists of three facilities: Leavenworth, Entiat and Winthrop National Fish Hatcheries, which are owned and operated by FWS to support four FWS anadromous fish production programs, and in addition support two Yakama Nation (YN) anadromous fish production programs:

Leavenworth National Fish Hatchery (Leavenworth NFH)
- Spring Chinook (FWS)
- Mid-Columbia Coho (YN)

Entiat National Fish Hatchery (Entiat NFH)
- Summer Chinook (FWS)

Winthrop National Fish Hatchery (Winthrop NFH)
- Spring Chinook (FWS)
- Summer Steelhead (FWS)
- Mid-Columbia Coho (YN)

These facilities were constructed in the 1940's to provide mitigation for the loss of natural fish production due to the construction and operation of Grand Coulee Dam. Rehabilitation of the aging infrastructure at these hatcheries will require significant expenditures in order to continue to meet fish production obligations. Building upon previous infrastructure assessment work by Reclamation and FWS, this report considers alternatives for potentially relocating fish production to new sites and/or updating existing infrastructure and potentially incorporating alternative rearing technologies at new or existing facilities to allow FWS to achieve its mission over the long term. While the focus of this alternatives analysis is on fish production infrastructure, FWS considers the following to be necessary functions in meeting mitigation responsibilities:

- Evaluation of Fish Produced: This is primarily accomplished by the Mid-Columbia River Fisheries Resource Office (MCRFRO) which is based at Complex facilities.
- Fish Health Monitoring: Complex staff are assisted by the Olympia Fish Health Center (OFHC) and are essential to meet requirements identified in ESA consultations, including Biological Assessments, Hatchery Genetic and Management Plans or Biological Opinions.
- Tribal Trust: The Complex helps to fulfill federal obligations to Native American communities.
- Visitor Services and Public Outreach: Over 155,000 people visit the Complex hatcheries each year. The Complex provides a venue for a variety of public events and educational opportunities, in line with Department of Interior public policy goals.

1.1 Goals

The primary goal of this document is to conduct an alternatives analysis and advance a long term planning effort to determine how to modify or relocate Complex facilities to best meet on-going mitigation, tribal trust, and US v. Oregon responsibilities in the most beneficial and cost effective manner. In consideration of climate change and regulatory conditions, a top FWS priority is to make the best use of available water rights and supplies which will increase operational reliability, flexibility and efficiencies.

1.2 Document Organization

The major section headings and purpose of each section of this document are shown in Table 1-1. Following this introduction, Section 2 provides an overview of the existing facilities at the three Complex sites. It is supplemented by newly prepared site piping schematics (Appendix A), water rights and supply reports (Appendix B), and photographs from recent site visits (Appendix D). Section 3 presents fish production targets and biological criteria given by FWS. These criteria were then applied to the six Complex fish production programs and two year operating schedules were developed to provide recommended water supply flows and rearing unit volumes for use in the alternatives analysis. These recommendations were then compared to the present water and rearing unit availability in order to identify potential deficits or surpluses to be considered in the planning effort. Section 4 provides a broad look at potential geographically separate sites for relocating fish production. An initial screening process looks at land availability, water supply quantity and quality, biological risks and benefits, and policy and legal considerations pertaining to the geographically separate alternatives.

Based on the initial findings, a more detailed analysis of geographically separate sites was not authorized; however a rationale for performing the detailed analysis is included in Section 4. Section 5 provides an analysis of broad factors considered for maintaining fish production at the existing Complex facilities. In addition to the factors that were considered for geographically separate sites, socioeconomics, capital and operating costs and environmental compliance are discussed. Section 6 provides infrastructure improvement alternatives, recommendations, and costs for modernizing the three existing Complex hatcheries. The results of a separately authorized phosphorous management plan for the Complex is summarized in Section 6 with the full plan included as Appendix C. Operating costs for the Complex and implementation costs are also documented and supported (Appendix E). Alternative rearing technologies and water reuse strategies are discussed and costs are developed for alternatives comparison. Section 7 provides an overview of findings, implementation priorities and a preliminary 20-year budgeting plan. Section 8 includes a list of the reference documents used in the preparation of this report.

Table 1-1. Document Organization and Purpose

Section	Description	Purpose
1	Introduction	Summarizes the project authorization, goals and document organization
2	Existing Conditions	Summarizes the data collection and site reconnaissance and existing conditions at Complex facilities
3	Biological Programming and Operations Schedules	Presents FWS biological criteria and resulting water supply flows and rearing volume recommendations for use in alternatives analysis
4	Geographically Separate Alternatives Evaluation	Describes and evaluates alternatives for relocating fish production to geographically separate sites
5	Existing Site Alternative Evaluation	Describes and evaluates the alternative of maintaining fish production at existing Complex facilities
6	Infrastructure Alternatives – 3 Existing Sites	Provides infrastructure alternatives, recommendations, and conceptual costs for modernization of existing Complex facilities
7	Implementation Recommendations	Provides a preliminary priorities and long term facility infrastructure investment plan
8	References	Provides list of referenced published documents used in the study preparation.
Appendices		
A	Facility Schematic Diagrams	Existing conditions drawing showing site features and piping that were prepared as part of this study
B	Water Supply Reports	Reports that were prepared for this study documenting water rights and water use at the existing Complex facilities, and feasibility work on developing additional supplies at Leavenworth NFH
C	Cost Estimate Details	Provides back-up detail and unit costs for conceptual level cost estimates developed for the alternatives analysis and implementation plans.
D	Photographs	Photos of existing Complex facilities
E	Meeting Notes	Notes from meetings and teleconferences conducted in the course of the project completion

SECTION 2
EXISTING CONDITIONS – SITE RECONNAISSANCE

2.0 Introduction

This section provides descriptions of existing conditions and data provided by FWS and information gathered during site visits to each of the three existing Complex hatcheries. A condition assessment of each major element of each hatchery is provided, beginning with the water supply systems, through pumping; points of use; corresponding effluent systems; structural, mechanical, and electrical systems; utilities; and site access and circulation. In addition to infrastructure assessments, existing water rights information is also summarized.

2.1 Leavenworth National Fish Hatchery

2.1.1 Site Location and Layout

The Leavenworth NFH is located on 157.69 acres of land, approximately 2 miles south of the city of Leavenworth Washington. Figures 2-1 and 2-2 provide aerial images of key facility features. Site topography is relatively flat, with Icicle Creek to the south and east and private land holdings to the north and west.

Figure 2-1. General Layout of the Leavenworth NFH

Figure 2-2. Features of the Leavenworth NFH

Table 2-1. Index for Features Shown on Figure 2-2

	Features
A.	Raceways, 8-feet by 80-feet
B.	Covered Raceways, 10-feet by 100-feet
C.	Small Foster Lucas Ponds (SFLs)
D.	Large Foster Lucas Ponds (LFLs)
E.	Fish Viewing Pond
F.	Adult Hold Ponds
G.	Pollution Abatement Pond - 2010
H.	Pollution Abatement Pond - 1995
I.	Fish Ladder
J.	Water Re-use Pumpstation No. 1
K.	Water Re-Use Pumpstation No. 2
L.	Water Re-Use Pumpstation No. 3
M.	Spawning Area
N.	Coho Pump House
O.	Hatchery Building
P.	Discovery School
Q.	FRO Equipment Storage Building
R.	Fueling Station
S.	Shop and Vehicle Building

	Features
T.	Cold Storage Building
U.	Vehicle Building
V.	Septic Drain Field
W.	North 40 (and previous shooting range)
X.	Helipad
Y.	Walkway to Handicap Fishing Platform
Z.	Bridge over Hatchery Channel
AA.	Aeration Chamber for Wells Nos. 4, 5, and 6 and River Water Screen Chamber
AB.	Aeration Chamber for Wells No. 1, 2, 3, and 7
AC.	Icicle Creek Screen Chamber
AD.	Sand Settling Basin
AE.	Water Valve House
AF.	Nasikelt Information Office (former Residence No. 5)
AG.	Residence No. 6
AH.	Residence No. 7
AI.	Residence No. 9
AJ.	Hatchery Entrance Gate

The site has many features of historic significance and it was listed as the Leavenworth NFH Historic District, on the National Register of Historic Places in 1998. A plan was recently completed help guide operation and preservation of the facility; *Leavenworth National Fish Hatchery Preservation Plan, October 2014(Sneddon and Miller 2014).* Any potential modifications to Leavenworth NFH will need to take into account the stewardship of these historic resources under Department of Interior policies.

2.1.2 Summary of Existing Water Rights

The FWS holds four active water right certificates and two water right claims to supply the hatchery for fish propagation purposes. These rights include a combination of groundwater (14.9 cfs) and surface water (42 cfs) rights. Attributes of these water rights, including instantaneous (Qi) and annual (Qa) limits on diversions/withdrawals as currently certificated, are summarized in Table 2-2. For a more detailed discussion of the water rights, see the Leavenworth National Hatchery Water Source Assessment Memo (Aspect Consulting, 2014) in Appendix A.

Table 2-2. Leavenworth NFH Water Rights

			Authorized Withdrawals/Diversions			
Water Right	Source(s)	Priority Date	Instantaneous (Qi)	Units[1]	Annual (Qa)	Units
Certificate 1824	Icicle Creek	3/26/1942	42	cfs	---	afy
Certificate 1825 (storage)	Snow and Nada Lakes	3/26/1942	---	---	16,000	afy
Certificate 3103-A	Well No. 1	10/16/1957	1,200	gpm	1,120	afy
Claim 016378	Well No. 3	June 1940	700	gpm	570	afy
Claim 016379	Well No. 2	August 1939	900	gpm	730	afy
Certificate G4-27115C	Wells No. 4 through 7	10/20/1980	3,900	gpm	5,257	afy

[1] cfs = cubic feet per second. gpm = gallons per minute. afy = acre-feet per year.

2.1.3 Surface Water Supply System

Currently, the Leavenworth NFH obtains surface water from a diversion dam and intake at River Mile (RM) 4.5 on Icicle Creek. The intake is a shared diversion that also provides irrigation water for the Cascade Orchard Irrigation Company (COIC). The combined water right for the intake is 54cfs, which includes 42cfs to the hatchery and 12cfs to COIC. The diversion dam is a low cobble/boulder masonry structure with a concrete weir crest. Water backed up by the dam flows down a diversion channel on the left bank, through a heavy steel trashrack to an intake structure. Water in the intake structure flows through a lighter steel trashrack into a 33-inch pipeline (Station 2+76.57). Flow into the pipeline is controlled by a slide gate. The outer trashrack has bars on a 6-inch spacing, while the inner trashrack has 1 ¼-inch space between bars. Due to improved adult returns and fish passage improvements, there are increasing numbers of spawning adult Chinook and coho salmon in Icicle Creek above the intake according to Leavenworth NFH staff. Dead and diseased fish accumulate on the intake trash rack at the end of the spawning season and there are corresponding outbreaks of *Icthyophthirius* (Ich), in the hatchery rearing units.

The diversion dam was modified in 1989 with the concrete crest added, along with a basic fishway constructed adjacent to the trashrack structure. The fishway does not function well as a fishway, but can be used as a sluice to move bedload material away from the trashrack structure if the weir boards are removed. The existing slide gate that is used for sluicing is not currently functional.

In the winter, icing of both the exterior and interior trashrack screens can be a problem. The interior trashrack in particular is susceptible to plugging with frazzle ice due to its close bar spacing. Hatchery staff must, in these conditions, manually chip ice from the trashracks to maintain flows to the hatchery. During these periods, the hatchery is not able to maintain its full flow of 42cfs and must switch to partial re-use and maximize groundwater use. The hatchery rearing and incubation water effluent is pumped back up to the head end of the 10x100 raceways at approximately 2000 gpm to sustain the fish during these periods. The reuse pump utilized for this process is antiquated and requires an oil drip system which requires the hatchery personnel to manually fill the oil reservoir daily. There are no additional backup systems if the pump fails. These periods typically occur 3 to 5 times a year for a week or so at a time.

The existing gatehouse structure at the intake dates from the original construction and appears to be poor condition. A Reclamation inspection found the structure to be structurally unsound and in danger of potential collapse. The operating stem for the 24-inch clean-out sluice gate has been bent, straightened, and rebent on several occasions. Due to the intake structure and gate layout, debris and bedload material frequently gets stuck in the bottom seal area and prevents the gate from completely closing. Forcing the gate closed in these situations results in the gate stem bending. In addition, the concrete around the gate is failing, allowing water to undermine and exit from underneath the structure.

Downstream of the intake and gatehouse structure, the 33-inch supply pipeline continues along the left bank of Icicle Creek to a bifurcation structure at Station 15+38.26. One leg of the bifurcation leads to the COIC diversion fish screen structure. The other leg consists of approximately 4,000 feet of buried 30-inch pipe which conveys the Leavenworth NFH supply via an easement through an RV park and the adjoining Bullit property, to a sand settling basin on the hatchery site at approximately Station 56+91. The portion of the pipeline between the intake and the bifurcation was inspected using a video camera equipped robot in 2008. Reclamation added two access tees and manholes to the pipeline in 2012 to allow for inspection access to the pipeline downstream of the bifurcation. The portion of the pipeline downstream of the bifurcation was video inspected in 2012. The existing pipeline is a concrete cylinder pipe that replaced the original wood stave pipe in 1965. The inspections revealed continuous steel liner exposure along the invert where the cement mortar lining had deteriorated or broken off. In two locations, the steel liner was worn completely through and the exterior rebar matting was exposed, which indicates a serious condition that could eventually result in pipe failure.

2.1.4 Snow and Nada Lakes

Upper Snow Lake is actively managed by FWS as part of their management of Leavenworth NFH, primarily to store and release cold water to Icicle Creek upstream of the Leavenworth NFH surface water intake during late summer low flow periods.

The dams at Upper and Lower Snow Lakes are simple fixed crest masonry gravity structures constructed with native cobbles and mortar. Upper Snow Lake Dam is located between the two lakes and is approximately 10-feet high and has a crest length of 119-feet. When the water level in Upper Snow Lake exceeds the dam crest, water overflows into Lower Snow Lake. A small low level outlet with a flap gate allows water in Lower Snow Lake to flow back into Upper Snow Lake when the water level in the upper lakes drops below the level of the outlet. Lower Snow Lake Dam is located at the north end of the lake at the outlet to Snow Creek. The dam consists of a 6-foot high by 42-foot wide cobble masonry overflow section and a 2-foot high by 70-foot long earthen berm which extends to the right abutment.

Water is released from Upper Snow Lake into Nada Lake via a tunnel. The tunnel taps into the bottom of Upper Snow Lake about 175-feet below the water surface. Water is discharged through a 30-inch steel

pipe that penetrates a concrete bulkhead at the downstream end of the tunnel. A 30-inch cast iron gate valve, just downstream of the bulkhead, acts as a guard gate. A 20-inch butterfly valve mounted at the end of the pipe acts as the control valve. The control valve is typically opened in mid-July and operated until mid-October, with a target discharge flow of 50 cfs according to FWS water supply reports.

The control valve is manually operated and a staff member must hike several miles up to the outlet structure to make changes to the valve setting as the lake level drops and the resulting valve discharge drops with the lower head. Due to its location, it is not possible to put in a direct SCADA link to provide control. A repeater could potentially be placed on Wedge Mountain to provide communication and remote controls from the hatchery. There is, however, a lot of resistance from both the Forest Service and the Wilderness Society to the concept according to FWS staff.

The outlet works were inspected in 2000 by Reclamation. Ultrasonic thickness gauge measurements of the pipe were taken to determine the actual material thickness of the pipeline. The visible corrosion and rusting of the pipe was found to be superficial with minimal degradation of the pipe walls. The pipe between the tunnel bulkhead and the guard gate is made from rolled ½-inch steel plate with longitudinal welds. The axial joints are joined with rivets and butt straps. The pipe between the guard gate and the control valve consists of 41 sections of welded and flanged pipe. The pipe is made from ¼-inch steel plate with longitudinal weld joints. The ends of each section of pipe have slip-on welded flanges. A sleeve type coupling is provided to allow for some expansion and contraction in the pipe between the tunnel bulkhead and a downstream bulkhead just before the control valve.

The cast iron 30-inch guard gate shows an accumulation of rust and corrosion, but the corrosion was again found to be superficial. According to staff, the valve still works well, although it has with time become more difficult to operate. A 4-inch bypass line and valve is used to fill the pipe downstream of the guard gate so that the guard gate can be opened under balanced head conditions. It takes about 15 minutes to fill the section of pipe between the guard gate and butterfly valve. The bypass valve still works, although it is also becoming more difficult to operate.

The original tube valve used to control outflow was replaced about 10-years ago with a 20” butterfly valve mounted at the end of the discharge pipe. The butterfly valve is only cracked open a little ways to pass the typical flow of 50cfs. The valve vibrates significantly in this condition. High velocities through the valve, produce vibration and cavitation which is resulting in wear on the valve body and seals. This valve is approaching the end of its projected service life. In the 2000 Reclamation inspection report, it was recommended that the original tube valve be replaced with a jet-flow gate. Jet-flow gates are specifically designed for the modulation of high head flows with free air discharge. A hollow-jet valve (Howell-Bunger valve with integral hood to limit the spray pattern) would also work well for this application. Butterfly valves are not suited for this type of service.

In the summer of 2014, when the guard gate was opened, rocks could be heard rolling down the inside of the steel pipe. Upon opening the butterfly valve, one rock temporarily jammed in the valve before eventually breaking free. This should be monitored closely by staff whenever the valves are being operated. A steady occurrence of rocks coming down the pipe could be indicative of rockfall issues in the upstream tunnel or lake tap.

FWS currently has a storage right of 16,000 ac-ft which applies to Upper Snow Lake, Lower Snow Lake, and Nada Lake. In addition, the Icicle Irrigation Company has storage rights of 3,000 ac-ft. The total storage rights of 19,000 ac-ft exceed the estimated active storage capacity of Upper Snow Lake, which is

12,450 ac-ft. The average annual runoff within the Upper Snow Lake watershed is estimated to be 8,600 ac-ft, based on data from 1994 to 2005. In 2001, a drought year, the estimated annual runoff was only 4,400 ac-ft. The current average release volume from the lake is about 6,500 ac-ft.

In the 2008 Inspection Report (W.W. Wheeler and Assoc.), Upper Snow Lake Dam was classified as being in poor condition based on the deteriorated condition of the masonry and due to inadequate factors of safety under normal pool ice loading conditions. Recommendations at the time included performing some maintenance to the masonry and the flap gate, restrictions to assure the lake level is not more than half full at the start of winter to reduce ice loading on the dam, and performing additional risk assessment to determine the need for additional structural measures. Lower Snow Lake Dam was also classified as being in poor condition. The deficiencies listed included: inadequate stability under ice loading conditions, moderate to severe deterioration of the masonry structure, lack of a low level outlet, seepage through the masonry and earthen berm section, and insufficient capacity to pass in the design flood. The recommendation at the time was to remove one foot from the overflow section of the dam which would result in the structure becoming a Non-Inventory Dam (6-foot or higher). As outlined in Washington Department of Ecology Water Resources Program Policy 5105, dams which impound more than 10 acre-feet, but are l6 feet or less in height may be exempted from the state dam safety regulations if the dam is classified as a low hazard. Moving the structure to this category would eliminate the need to address the structural deficiencies.

Nada Lake Dam is a concrete structure that controls the outflow and level of Nada Lake. The dam was rehabilitated in 2009 and is in good condition. The flash boards at Nada Lake Dam are not currently being used in an agreement with the Forest Service. The Forest Service likes the additional shoreline created with the water level in Nada Lake about 4-feet lower than it was previously with the flash boards in place.

2.1.5 Groundwater Supply System

A total of 18 water supply type wells have been constructed at the hatchery since the 1940's, although not all were put into production. Seven wells are currently active and are capable of producing a combined, simultaneous supply to the hatchery of 3,500 to 4,000 gpm for limited time periods, with flow availability gradually reducing over time due to aquifer drawdown. The facility is typically able to use less than half of its 14.9 cfs groundwater right due to drawdown. At times, production is limited to less than 1 cfs to allow aquifer recharge. The well pumps were recently equipped with variable frequency drive (VFD's) to allow the pumps to be operated efficiently at lower flow rates to maintain more uniform, sufficient water levels within the wells.

The wells tap unconsolidated alluvial and glacial deposits in hydraulic continuity with Icicle Creek and, when hydrated the hatchery channel. Hydrogeological modeling of the site describes a shallow, unconfined aquifer present under the southern half of the site with a more localized deep, confined aquifer underlying a silt and clay unit in the northern portion of the site. (The deeper aquifer was not confirmed by the geophysical modeling completed in early 2015). The depth to bedrock ranges from 200 to 330 feet. The glacial and alluvial materials appear to be highly variable over relatively short distances and the aquifers are likely laterally discontinuous. This variability has complicated efforts to successfully site well and develop groundwater at the facility. Aspect Consulting has recently been authorized to conduct some additional geophysical modeling to help better characterize the site and provide recommendations on how to improve groundwater supplies.

The pumps in the active wells appear to be in reasonable operating condition. Available data suggests that there has been a decline in well efficiency over time in many of the wells. Investigations by Aspect Consulting (Flynn pers. comm.), indicate that the existing wells have inefficient well screens that contribute to reduced production.

All seven wells produce water with measurable levels of phosphorous according to limited monitoring data. Wells 1, 2, 3, and 7 are spread out along the hatchery channel and have colder temperatures and lower levels of phosphorous than wells 4, 5, and 6 which are located farther from the river and closer to lawn and drainfield areas that may be sources of phosphorous. Transmission pipes from the wells deliver groundwater to aeration facilities at the hatchery headworks

At the cold water aerator, the combined flows from Wells No. 1, 2, 3, and 7 typically do not exceed 3.5 cfs. This flow is routed into a concrete chamber, through two 12-inch steel pipe wall thimbles, over a horizontal perforated plate and down through a series of baffles into a concrete settling basin. The perforated screen is 5'-3" wide and approximately 6 feet long, providing roughly 30 square feet of aeration plate and a vertical fall of approximately 4 feet. At a maximum loading rate of 0.5 cfs/sf, this system would have a capacity of approximately 15 cfs. This system is not designed to function efficiently over a wide range of hydraulic loading rates. From the settling basin, the aerated well water flows over a weir and into the distribution piping. A pair of slide gates allows for Icicle Creek surface water from the inside screen chamber to be mixed with the well water. A simple wood framed roof is provided over the aeration chamber. The roof appears to be in reasonable condition. The above ground concrete of the chamber shows some cracks and spalling.

At the warm water aeration chamber, up to 5 cfs of combined flow from Wells No. 4, 5, and 6 well water is routed through modern packed column aerators, three 30-inch diameter and one 24-inch diameter units into a concrete settling chamber. The packed column aerators were installed in 1990 and replaced the previous venturi type aerators. The packed columns provide 18 square feet of distribution plate with a total capacity of approximately 8 cfs. The isolation valves on each packed column unit allow them to receive optimized hydraulic loading rates. A wood framed structure is provided over the aeration basin and was also built in 1990 along with other small improvements. The aerators appear to be in reasonably good condition with just some small corrosion evident on some of the piping and metalwork. The building appeared to be in satisfactory condition as did the concrete basin.

In summary, the cold water aeration system has significant spare capacity of at least 10 cfs and the warm water aeration system could treat an additional 3 cfs at the hydraulic loading rate of 0.5 cfs per sf of distribution plate. Reconfiguring the cold water aerator may reduce total gas pressure and increase dissolved oxygen levels.

2.1.5.1 Well No. 1

Well No. 1 is equipped with a 1,000 gpm pump and 40hp motor with a variable speed drive. A new metal building was constructed over the pump in 2010 and new electrical equipment and panels were installed. The pump, building and associated equipment appear to be in good condition. The well was drilled in 1958 to a depth of 80 feet and has a screened casing between 40 and 80 feet below ground. The well typically produces between 400 and 725 gpm with a water temperature between 42.3°F and 53.9°F.

2.1.5.2 Well No. 2A

Well No. 2A is equipped with a 1,100gpm 40hp pump and variable speed motor. The pump, building and associated equipment appear to be in good condition. Reclamation noted in their inspection that no grout pad was installed beneath the pump and anchor bolts were missing. The well was drilled in 1991 and replaced Well No. 2 which was drilled for the original construction in 1940. The well was drilled to a depth of 203 feet and has a screened casing between 70 and 90 feet below ground. The well typically produces between 250 and 325 gpm with water temperatures between 44°F and 49.8°F.

2.1.5.3 Well No. 3A

Well No. 3A is equipped with a 600gpm, 25hp pump and motor with a variable drive motor. The pump, building and associated equipment appear to be in good condition. Reclamation noted in their inspection that no grout pad was installed beneath the pump and anchor bolts were missing. The well was drilled in 1991 and replaced Well No. 3. The well was drilled to a depth of 120 feet and completed to a depth of 98 feet and has a screened casing between 63 and 98 feet below ground. The well typically produces between 250 to 325 gpm with water temperatures between 47.2°F and 49.4°F.

2.1.5.4 Well No. 4A

Well No. 4A is equipped with a 60hp pump with variable drive motor. The well is provided with a metal building and the pump, building and associated equipment are all in good condition. The well was drilled in 2010 and replaced Well No. 4 which was drilled in 1976. The well was drilled to a depth of 333 feet and completed to a depth of 105 feet with a screened casing between 64 and 94 feet below ground. The well typically produces between 315 and 500 gpm with water temperatures between 43.1°F and 48.3°F.

2.1.5.5 Well No. 5

Well No. 5 is equipped with a 75hp pump and motor with a variable speed drive. The well is housed in a wood framed building with a metal roof and the building, pump and associated equipment appeared to be in satisfactory condition. The well was drilled in 1979 to a depth of 300 feet and has a screened casing between 250 and 300 feet below ground. The well typically produces 800 to 1,100 gpm in the winter months and is then shut off in late May or early June. The well is then typically run for a period in late summer and produces between 450 to 900 gpm. The water temperature is typically just below 52°F.

2.1.5.6 Well No. 6

Well No. 6 is equipped with a 1,200 gpm pump and motor with variable speed drive. Reclamation noted in their inspection that the several electrical panels and cabinets in the well building should be consolidated to eliminate confusion and minimize potential safety concerns. The well was drilled in 1976 to a depth of 195 feet and completed to a depth of 170 feet and has two sections of screened casing at depth between 102 and 112 feet and again between 150 and 170 feet below ground. The well produces between 550 and 850 gpm with temperatures between 50.5°F and 52.5°F.

2.1.5.7 Well No. 7

Well No. 7 is equipped with a 1,200 gpm pump and motor with variable speed drive. The well is housed in a wood framed building with a metal roof and the building, pump and associated equipment appeared

to be in satisfactory condition. The well was drilled in 1976 to a depth of 192 feet and completed to a depth of 110 feet and has two sections of screened casing between 102 and 112 feet and again between 92 and 110 feet below ground. The well typically produces 260 to 330 gpm with water temperatures between 43.3°F and 46.7°F.

2.1.6 Sand Settling Basin and Headworks

The sand settling basin is a 287-feet long and 25-foot wide concrete structure that was built in 1993 to help deal with the heavy load of sand and gravel being carried down in the surface water pipeline. The concrete basin is covered with a pre-engineered steel building. The structure is located near the end of the Icicle Creek supply pipeline and immediately upstream of the screen chamber. A bifurcation off of the pipeline routes flow into the upstream end of the basin. A collection trough at the downstream end of the basin routes the cleaner water into a 36-inch steel pipe which wyes back into the Icicle Creek pipeline. The Icicle Creek pipeline adjacent to the settling basin was maintained in place and can act as a bypass during times when the sand settling basin is dewatered. The concrete in the basin appears to be in good condition. The interior of the building is somewhat dimly lit and the addition of more light fixtures and/or skylights has been suggested to improve safety.

There are two separate screen chambers located immediately downstream of the sand settling basin, an inside screen chamber and an outside screen chamber. The 30-inch supply pipeline downstream of the sand settling basin tees, with one 24-inch branch routed into the inside screen chamber and the other 24-inch branch routed into the outside screen chamber. Both screen chamber structures have been modified a few times over the years and the original concrete is in poor condition as are some of the associated gates, valves, piping and structural steel. The screening chambers are not compliant with current National Marine Fisheries Service (NMFS) criteria. FWS is taking the lead on providing NMFS compliant fish screens for the facility and addressing fish passage concerns at the diversion dam as a separate project.

There are two aeration chambers provided at the screen chamber structure. One aeration chamber is provided for the cold water (42° -46°F) wells 1, 2, 3 and 7 and is located immediately adjacent to the inside screen structure. The other aeration chamber is provided for the warm water (48°-51°F) wells 4, 5 and 6 and it is located immediately adjacent to the outside screen chamber.

At the cold water aerator, the combined flows from wells 1, 2, 3, and 7 typically do not exceed 3.5 cfs. This flow is routed into a concrete chamber, through two 12-inch steel pipe wall thimbles, over a horizontal perforated plate and down through a series of baffles into a concrete settling basin. The perforated screen is 5’-3” wide and approximately 6 feet long, providing roughly 30 square feet of aeration plate and a vertical fall of approximately 4 feet. At a maximum loading rate of 0.5 cfs/sf, this system would have a capacity of approximately 15 cfs, however the system is not designed to function efficiently over a wide range of hydraulic loading rates. From the settling basin, the aerated well water flows over a weir and into the distribution piping. A pair of slide gates allows for Icicle Creek surface water from the inside screen chamber to be mixed with the well water. A simple wood framed roof is provided over the aeration chamber. The roof appears to be in reasonable condition. The above ground concrete of the chamber shows some cracks and spalling.

At the warm water aeration chamber, up to 5 cfs of combined flow from wells 4, 5, and 6 is routed through modern packed column aerators, three 30-inch diameter and one 24-inch diameter units into a concrete settling chamber. The packed column aerators were installed in 1990 and replaced the previous venturi type aerators. They provide 18 square feet of distribution plate with a total capacity of approximately 8 cfs. The isolation valves on each packed column unit allow them to receive optimized

hydraulic loading rates. A wood framed structure is provided over the aeration basin and was also built in 1990 along with other small improvements. The aerators appear to be in reasonably good condition with just some small corrosion evident on some of the piping and metalwork. The building appeared to be in satisfactory condition as did the concrete basin.

In summary, the cold water aeration system has significant spare capacity of at least 10 cfs and the warm water aeration system could treat an additional 3 cfs at the hydraulic loading rate of 0.5 cfs per sf of distribution plate. Reconfiguring the cold water aerator may improve total gas and dissolved oxygen levels.

2.1.7 Distribution Piping

This section covers the water supply distribution system. Schematics of the piping system are provided in Appendix A.

Surface water is supplied from the outdoor screen chamber to a 42-inch steel supply main and a 20-inch steel supply main. The 42-inch pipe originally supplied water to the three banks of small Foster-Lucas ponds. A 30-inch tee off of the 42-inch pipe supplies surface water to the 8-foot by 80-foot raceways. The 20-inch pipe enlarges to 24-inch pipe and supplies surface water to the 10-foot by 100-foot raceways. Two separate steel pipes from the inside screen chamber, a 20-inch steel pipe and an 18-inch steel pipe, connect into the 42-inch pipe off of the outdoor screen chamber. The 18-inch pipe has a cross connection with the groundwater from the cold water aeration chamber. This allows the groundwater to be blended in directly with the surface water, or if there is a problem with the groundwater supply, for surface water to be supplied to the hatchery building.

Groundwater is supplied from the two aeration chambers to the hatchery building as well as the raceways. A 14-inch steel pipe routes groundwater from the cold water aeration chamber to the hatchery building. A 14-inch steel pipe tees off of the first pipe and routes groundwater to the headbox of the first bank of 8-foot by 80-foot raceways. That pipe continues down and connects into a 14-inch surface water supply pipe supplies water to the adult holding ponds. A 14-inch steel pipe from the warm water aeration chamber tees into the main pipe from the cold water aeration chamber. A 20-inch steel pipe from the cold water aeration chamber is routed down to connect into the main surface water supply line for the small Foster-Lucas ponds. A 20-inch tee off of this line routes groundwater to the 10-foot by 100-foot raceways. A 14-inch steel pipe from the warm water aeration chamber tees into this 20-inch pipe from the coldwater aeration chamber.

While some of the piping and valves have been replaced during improvement projects over the years, much of the water supply system is at the end of its expected life and is in poor condition. The design for a pipeline replacement project has just been completed to replace groundwater and surface water delivery pipes and valves downstream of the screen chamber and will be going to construction in spring of 2015.

2.1.8 Adult Holding and Spawning Facility

A concrete weir and orifice fish ladder allows fish to swim up to the adult holding ponds. The fish ladder entrance is located below the west end of the bridge over the hatchery channel. The fish ladder concrete appears to be in generally good condition, with only a few areas of spalling near the entrance noted by Reclamation in their inspection. There have been some issues with leakage at some of the construction joints. Some of these have been repaired with the remaining larger leaks requiring more involved work.

The existing fencing and handrailing provided along the eastside of the entrance walkway does not meet current safety standards. Due to high flood flows and debris, the fence and handrail are damaged periodically. Reclamation has recommended that removable railing that meets current safety standards be installed.

The existing adult holding ponds and fish handling facilities were constructed in 1978 and have several functional issues. The facility consist of two 162-feet long by 15-feet wide concrete ponds. A wood framed spawning shed is located to the west of the upstream end of the holding ponds. A motorized crowder is provided in each pond to crowd the fish to the upstream ends of the ponds. Originally, fish would need to be individually netted and lifted out of the ponds to be spawned. In the 1980's, a fish elevator was added to the upstream corner of the west pond, adjacent to the spawning shed. Fish are now crowded to the upstream end of the west pond and staff then hand crowd the fish into the fish elevator. Fish in the east pond are crowded partway down the pond, then individually caught and moved to the west pond through a large hole cut in the divider wall between the ponds. Fish in the fish elevator are lifted and crowded out of the elevator onto a dewatering flume and onto a sorting table to be spawned.

The facility holds adult spring Chinook in July, August and September, and adult coho from mid-September through November, with warm surface water and limited cold groundwater available. In addition to the water temperature and groundwater availability issues, there are issues with sunburn, weather exposure, and limited ability to sort fish. There have also been some poaching issues out of the adult ponds every year. In 2006 a large number of adults were stolen from the holding ponds. The staff would like an enclosed adult holding and spawning facility, similar to that built at Winthrop NFH, to improve fish handling efficiency and bio-security, and reduce weather exposure.

2.1.9 Icicle Creek Historic/Hatchery Channel Structures

Structure 2 is a 36-foot long concrete gravity dam with two steel radial gates, ogee crest, stilling basin, 11-foot wide vehicle bridge, and gate operating deck. The structure spans across the Icicle Creek historic channel and is located at the upstream end of the Icicle Creek hatchery channel. Trashracks were originally provided along the upstream end of the structure. However, debris routinely blocked the bays and debris removal was problematic and the trashracks were removed. The structure controls the water level in the hatchery channel and the flows directed down the historic channel.

Concrete cracking and spalling is evident on the deck, curbs, wingwalls and abutments and should be repaired if the structure is to remain in place for any extended time. The radial gates appear to be satisfactory condition at this time. The rehabilitation of Structure 2 was completed and gate operators were replaced in 2015 which now provides independent operation of each gate. A 2010 bridge inspection by FWS personnel rated the structure as SATISFACTORY. An approximately 4,085-foot long asphalt paved road connects Structure 2 with Structure 5 downstream. Pavement cracking is prevalent along most of the road and the Reclamation recommended in their 2011 inspection that the road be chip sealed.

Structure 5 is a 145-foot long by 10-foot wide bridge over the historical Icicle Creek channel just upstream of the hatchery channel outlet. The bridge is supported on concrete piers spaced about 12-feet apart. A steel trashrack used to be supported off of the upstream sloping face of the piers. The trashracks have since been removed, although some metal guides remain in place. Slots are provided in the piers along the center axis of the bridge to allow for the placement of stoplogs. Basic fishways are provided at both bridge abutments. Previously, during periods of salmon returns, stoplogs would be placed in the slots and fish traps installed at the upstream end of the fishways. In this way, salmon could be prevented from migrating up the historical channel past the hatchery. Although this has not happened in several years, the

FWS still has the ability and authorization to utilize stop logs and fish traps (one at each end of the bridge) to manage hatchery origin spring Chinook passage under certain conditions.

The bridge deck was replaced in 1991 with precast concrete panels and appears to be in relatively good condition. Reclamation in their 2011 inspection did not some minor concrete spalling around some of the guardrail posts. The upstream sloping faces of the bridge piers show some significant erosion and spalling of the concrete and exposed rebar. While not a threat to the structural integrity of the dam, the damage should be repaired. A 2010 bridge inspection by FWS personnel rated the structure as GOOD. Due to the close spacing of the piers, woody debris collects on the upstream face of the bridge and must be removed periodically with a backhoe.

An 88-foot long by 20-foot wide steel truss bridge is provided across the downstream end of the hatchery channel. The bridge deck consists of wood 2 x 10 boards on edge covered with asphalt pavement. The bridge is supported by the walls of the hatchery channel spillway. The entrance to the fish ladder is located at the base of the left abutment. Some cracking and spalling of concrete is evident on the bridge abutments. A 2008 bridge inspection by FWS also noted that rehabilitation of the structure would require cleaning and sealing of the truss bearing areas.

2.1.10 Hatchery Building

The hatchery building is a two-story concrete structure with a steel framed roof. The main portion of the building is approximately 223-feet long and 86 feet wide and there are north and south wings that are about 36-feet wide by 45-feet long. The building contains office, storage, fish incubation and rearing space and a visitor center. The visitor center is located on the first floor of the south wing of the building. The middle part of the building is referred to as the nursery and extends the full length of the building from east to west. An open loft extends over part of the nursery and is currently used for storage. The windows in the nursery are of original construction and are single paned glass. During winter months, snow accumulates below the roof eaves and falls onto the windows. Metal shutters are in place to cover the windows in the winter to prevent window breakage, however, the weight of falling snow has damaged the majority of the shutter hinges and the shutters are not fully operable. Reclamation has recommended that the shutters be repaired or replaced and designed to accommodate the snow loads.

A seismic evaluation of the hatchery building and the assorted hatchery support structures and residences was performed in 2003. Several structural deficiencies under seismic load were identified in the hatchery building.

The irrigation system around the hatchery building has several leaks and is in need of rehabilitation.

2.1.11 Support Buildings

Support buildings consists of a shop and vehicle building, cold storage building, and Mid-Columbia River Fisheries Resource Office (MCRFRO) offices.

The shop and vehicle building is a concrete building with a metal framed roof. Several vehicle bays with overhead doors are provided along the north side of the building. The majority of the south half of the building is used as a wood and metal shop. The southeast corner of the building is used for office space. A few deficiencies have been noted with the building. The building windows are the original construction and are of single pane construction and not energy efficient. Since the building is also registered as a historic building, replacement windows would need to meet State Historic Preservation Office

requirements. Shop activities in the building can create a large quantity of dust which enters the offices at times. FWS would like to build new office space that is better isolated from the shop activities. There has been some damage to the metal roofing during wind storms and missing roof metal flashing was noted in several places. The 2003 seismic evaluation also noted several structural deficiencies under seismic load in the building.

An uninsulated steel building was constructed in 1999 to store large motorized vehicles and equipment. The building is located between the cold storage building and the pollution abatement pond. An open garage bay is attached to the west end of the building. The building appears to be in good condition.

The cold storage building is a concrete building with a metal framed roof. When the hatchery was first constructed, fresh fish feed that required refrigeration was used. Several thick-walled insulated rooms cooled by several compressors are located in the building. Currently the fish are fed dry feed that does not require refrigeration and the cold storage equipment is no longer needed and has not been used in many years. FWS have suggested that the compressors and associated equipment be removed and the space be converted to needed office space.

The MCFRO has several buildings located on the hatchery grounds. The MCFRO equipment storage building is a steel structure located adjacent to the fuel storage tanks and west of the shop and vehicle building. The west and east halves of the building consist of open vehicle bays and enclosed vehicle bays with overhead doors respectively. MCFRO buildings Nos. 1 through 4 are located about one mile south of the hatchery building. Buildings Nos. 1 through 3 are office buildings and Building No. 4 is a garage. The buildings are of wood framed construction with metal roofs. The 2011 Reclamation inspection found the structures to be in generally good condition. A couple of improvements suggested include replacing the fluorescent light fixtures with more energy efficient fixtures, and constructing a covered walkway between buildings No. 2 and No. 3. It has also been suggested that a biological station for coded wire tag retrieval be constructed in one of the buildings.

2.1.12 Hatchery Housing

There are several wood framed residential housing buildings (Nos. 5, 6, 7 and 9) at the hatchery site. The residences are located to the southwest of the hatchery building. Residence No. 5 is used as office space. The buildings are in generally good condition. Various improvements have been made to the buildings over time, including replacement of windows, rehabilitation of the septic system, replacement of siding, and seismic upgrades. Remaining suggested improvements include plumbing improvements to residence No. 5 and replacement of siding and exterior doors to Residence No. 9.

2.1.13 Outdoor Rearing

There are two banks of seven 10-foot wide by 100-foot long concrete raceways (fourteen total) covered with a metal roof structure and three banks of fifteen uncovered concrete raceways 8-foot wide by 80-foot long (forty-five total) used to rear juvenile spring Chinook. The facility originally used thirty large and fifty-three small open concrete Foster-Lucas ponds for juvenile rearing. All of the small Foster-Lucas (SFL) ponds and half of the large Foster-Lucas (LFL) ponds remain on site. One of the LFL ponds is used as fish viewing pond and another is used for a kids fishing derby once a year. The drain for the fish viewing pond currently does not connect into the hatchery drain to the pollution abatement pond and just discharges into the drain to the river. This is a violation of the hatchery's discharge permit and a new effluent drain needs to be installed. A couple of the large ponds and a few of the small ponds are also used by the YN for coho rearing. All of the Foster-Lucas ponds are considered to be obsolete for fish rearing

due to poor hydraulics and are in very poor condition with rough and severely cracked and spalling concrete. The Foster Lucas ponds will not be connected to the new surface water and groundwater main delivery pipes that are scheduled to be replaced in 2015.

The 8 x 80-ft raceways were constructed in the late 1970's. The raceway walls and floor are showing signs of wear and erosion with rough surfaces and some cracking, and some of the above water concrete is showing signs of surface spalling. In addition, sealant in a number of the construction joints is either missing or damaged and should be repaired or replaced. Most of the valves are now over thirty years old and in need of significant maintenance or replacement. To provide some shade cover and to prevent predation, aluminum frames with shade cloth and netting are lowered over the tops of the raceways. These frames and netting require constant maintenance.

Surface water is supplied to the west end of the headbox supply channel at each bank of raceways. Groundwater is supplied to the west end of the upper and middle banks of 8 x 80 ft raceways. Water flows out of the headbox supply channels over wooden flash boards, through screens and into the individual raceways. A 30-inch pipe connects the tailbox of the first bank of raceways to the headbox supply channel of the second bank of raceways, and again from the tailbox of the second bank to the headbox supply channel of the third bank. These two pipes allow for unconditioned serial reuse of water from one bank to the next in the case of problems with the water supply. Wooden flashboards control flow out of the individual raceways into the tailbox. Screens are provided just upstream of the flashboards. In the space between the end screens and the flashboards, an overflow standpipe is provided. During cleaning operations, the standpipe is pulled and the fish waste directed into an effluent drain and routed to the pollution abatement ponds. Two 24-inch drains are provided out of the raceway tailboxes. The drain in the center connects into the original drain from the old Foster-Lucas ponds and is routed to the main drain to the river. A second drain is provided in the east end of the tailbox and allows overflow water to be directed to the adult holding ponds.

The 10 by 100 ft raceways and metal roof structure were constructed in the late 1990's. The metal roof structure and the concrete raceways are in generally good condition. It has been noted that some of the concrete expansion joints are in need of repair. Re-use pumps at the lower end of each 10 x 100 ft bank supply the large Foster Lucas ponds, two of which are presently used for juvenile rearing/acclimation by the YN mid-Columbia coho program.

Surface and groundwater are individually supplied to the west end of the headbox of both banks of 10 x 100 ft raceways. Water flows out of the headboxes over wooden flash boards, through screens and into the individual raceways. Two gated 30-inch openings connect the tailbox of the first bank of raceways to the headbox of the second bank of raceways. These two openings allow for serial reuse of water from one bank to the next in the case of problems with the water supply. Wooden flashboards control flow out of the individual raceways into the tailbox. Screens are provided just upstream of the flashboards. In the space between the end screens and the flashboards, an overflow standpipe is provided. During cleaning operations, the standpipe is pulled and the fish waste directed into an effluent drain and routed to the pollution abatement ponds. A 30-inch drain is provided out of the east end of the raceway tailboxes. These drains combine and are routed to the main drain to the river.

The adult holding ponds are used to rear juvenile spring Chinook from late November through April in order to reduce rearing densities.

2.1.14 Drains, Effluent Pond, and Outfalls

The main outfall for the hatchery is the 48-inch diameter pipe which discharges to Icicle Creek near the entrance to the fish ladder. During normal operations most flow passing through the hatchery discharges through this pipe. This includes both first and second pass process water from the hatchery building, and raceways. A smaller portion of flow is directed to the adult holding pond with the discharge flowing out the fish ladder. Flow from the 48-inch outfall pipe and fish ladder combine in a concrete structure at the fish ladder entrance on the left bank of Icicle Creek prior to discharging to the creek. This discharge point is designated as Outfall #1 for monitoring purposes.

The second outfall (Outfall #2), is from the pollution abatement ponds. A pollution abatement pond was constructed in 1995 to help settle sediments and organic material from the hatchery effluent prior to discharge to Icicle Creek. In 2010, an additional pollution abatement pond was constructed adjacent to the 1995 pond. The two pollution abatement ponds are located to the north of the small Foster-Lucas ponds. A concrete vault with two slide gates is provided at the upstream end of the 1995 pond to allow water to be released to either or both ponds. The slide gates are manually operated with a handwheel. An overflow structure is provided at the downstream end of the ponds. Slide gates are provided in the discharge structure to allow the ponds to be completely drained. The 4-inch slide gate used to drain the 1995 pond does not open and should be replaced.

The 2010 pollution abatement pond was constructed as a replicate of 1995 pond. Detailed pond information was developed using the 1995 design drawings and is summarized in below.

Bottom Elevation	1109.5 ft
Overflow Weir Elevation	1116.5 ft
Top of Pond Elevation	1126.5 ft
Volume of Pond at Overflow Weir	65,800 ft^3
Surface Area at Elev. 1116.5	15,000 ft^2

Currently only one pond is used while the other is off-line. Transition from using one pond to the other occurs when the pond in use requires solids removal.

Current methods of raceway cleaning at the Leavenworth NFH are to pull stand pipes and sweep the bottom of the raceways towards the stand pipe openings. This method is effective at cleaning the raceways, however, it generates a large amount of flow directed at the pollution treatment system. The current standpipes are 14-inch diameter in the 10 by 100 foot raceways and 12-inch diameter in the 8 by 80 foot raceways. From monitoring data at the effluent of the pollution abatement pond the peak flows rates through the pond are 6-cfs.

The cleaning waste from the 8 x 80 ft and 10 x 100 ft raceways enter the waste stream in the 36-inch pipe which flows north between the small Foster-Lucas ponds and adult holding pond and discharges to the pollution abatement pond. Cleaning waste from the adult holding ponds and small Foster-Lucas ponds also enter the 36-inch pipe. The adult holding ponds have a dedicated standpipe and pipe that is used for waste. Changing a valve setting is required on the east end of the small Foster-Lucas ponds to direct flow to the abatement ponds.

The hatchery building waste is collected in an 18-inch pipe that flows north between the small Foster-Lucas ponds and the hatchery building and connects to the same 36-inch pipe prior to discharging into the

abatement ponds. The east and west end of the Hatchery each have a dedicated effluent pipe that exit on the south side of the building. Outside of the hatchery each pipe enters a manhole with 2 gated effluent pipes. These gates can direct flow either to the pollution abatement pond or the re-use pump station No. 1 located on the west end of the small Foster-Lucas ponds. From here the flow can be directed to the 48-inch outfall or sent to the upstream end of the 10X100 raceways for reuse. From a review of as-built drawings it appears the waste from the large Foster-Lucas ponds flow east in a series of pipes and is discharged directly to Icicle Creek.

2.1.15 Utility Services

Domestic Water: Potable water is supplied to the hatchery and residences from a city water main located in Icicle Creek Road. The original wood stave distribution piping was replaced with cement asbestos piping in 1961. The cement asbestos piping is likely near the end of its expected life.

Domestic Wastewater: The domestic wastewater system for the hatchery dates from the original construction. It consists of a 2,000 gallon septic tank and drainfield located north of the cold storage building. Given its age, it is likely that the system will need to be replaced in the future. The domestic wastewater system for the residences was rehabilitated in 1992. The residences are connected into a 6-inch PVC sewer line that runs behind the residences and connects into a 4,000 gallon septic tank. The septic tank connects into a pump chamber and drainfield located below the houses in the meadow area to the west of the large Foster-Lucas ponds.

Power: Incoming primary power to the site is provided through overhead and underground lines rated at 12 kV. Service is provided by Chelan County PUD. There are several utility services including a main underground feed to a 300 KVA pad-mount transformer rated at 480Y/277 volt. That main utility transformer is located next to the Garage-Warehouse near the N.W. corner of the building. Another service to the site is an overhead feed to a pole-mounted transformer providing 120/240 volts to the FRO equipment Storage Building. In addition there is underground PUD primary voltage cables routed throughout the main hatchery site feeding pad-mount transformers for all of the Wells and at the screen chamber. The PUD also provides single-phase power services from pole mounted transformers at the Intake Structure and also at the Screening Building. It was stated during the site visit that the facility does not experience very many power outages. The few outages that occur tend to be short lived.

An emergency generator is located in the northwest corner of the Shop and Vehicle Building. The generator is equipped with an automatic transfer switch in the event of a power outage. The generator is brand new and was installed in the summer of 2014. The generator is able to supply power to the Hatchery Building, Shop and Vehicle Building, the Cold Storage Building, and to wells No. 4 through 6. The generator operates automatically every week. In order to provide power to wells No. 1, 2A, 3A, and 7, in the event of a power outage, two diesel generators mounted on a diesel truck are used. The associated electrical equipment and transfer switch to hook up to the truck mounted generators are located near well No. 2 on a concrete pad. The truck leaks fuel and the FWS would like to replace it with a permanent pad mounted generator inside a small building. Communications: Telephone/communications service to the site is standard landlines provided by the local telecommunications service provider. The service enters the site off of Icicle Creek Road, adjacent to the facility entrance. Phone lines are provided to each of the hatchery housing residences and to the main hatchery buildings.

Fire Protection: Two fire hydrants are provided by the hatchery building, one in front near the southwest corner of the building and the other behind the building and directly opposite the Cold Storage Building.

Two fire hydrants are provided up by the residences. Fire protection sprinkler systems are provided for both the north and south offices in the Hatchery Building.

2.1.16 Power, Lighting, Instrumentation, and Monitoring

Power: The power service at the Garage-Warehouse Building feeds the majority of the site. It is fed from the utility transformer rated at 300 KVA, 480Y/277 volts, 60 Hz. That service feeds power to the Hatchery Building, the Cold Storage Building, the spawning area and the various pumps, etc. throughout the pond and raceways.

This entire service is alternately provided with standby power from a 300 KVA generator. The diesel generator is new having been installed in July of 2014. The emergency generator is housed in the NW corner of the Garage-Warehouse Building. A diesel storage tank is located outdoors under a covered space just NW of the building.

A second power service onsite is located outdoors at the well pump area and is rated at 225 amps, 480Y/277 V, 3-phase. The service/disconnect and utility meters are located next to the well access road. At that location is the distribution panel feeding 480 volt power to the well sites. In addition, that site contains the manual transfer switch plus disconnects and a transformer. The disconnects and transformer are used to accept the output of the trailer-mounted generator (which is assumed to be rated at 240 V, 3-phase) and transform it up to the required 480 volts.

A third hatchery area site power service is shown on the drawings as being located in the vicinity of Valve House, Sand Settling Basin and Aeration Chambers. This serve the major loads located in that general area.

Off –site, there are separate 120/240 volt, single phase power services at the surface water intake and at the screening structure. These services did not have standby power.

After the 480 volt power is routed to a building or well house, it is utilized for major loads such as motor operation and also transformed down to 120/240 volts or 208Y/120 volts for utilization at convenience outlets and other small electrical loads.

Lighting: The Main Hatchery Building, the Garage-Warehouse Building and the Cold Storage are generally illuminated by fluorescent fixtures. Most of the smaller buildings, including the older water re-use pump stations and the well pump houses are lit by incandescent fixtures. Site lighting generally consist of some small building mounted security lights or a wall pack type fixture. The covered raceways (i.e. – 10’ x 100’) area is illuminated by low-bay HID (High Intensity Discharge) fixtures.

Instrumentation & Monitor/Alarm System: The facility has a computer/PLC – based monitor and alarm system. It is relatively new and works well. The SCADA system is approximately 2-3 years old. It monitors parameters such as flows, low water levels, other alarms and site security. There appears to be no remote control capability. The main Operator Interface Terminal is located in the Hatchery Building. It is connected to a telephone dialer in order to notify hatchery personnel of an alarm during unoccupied hours. It is also connected to a building mounted antenna for communication to the remote I/O (input/output) stations. The well pump sites, Diversion Structure, Intake Structure and Screenings Building also have building mounted antennas for direct communication with the main workstation.

Several buildings near the sand settling area are interconnected with Fiberoptic cable for a common wireless input.

The hatchery monitoring and alarm system monitors pressure levels in the supply mains, water levels in the raceways, adult holding pond and fish ladder, other alarms and site security. The system does not record historical or trending data. Pressure gauges are provided at each of the pumps and flowmeters are provided on the well line and Icicle Creek supply pipeline. There have been reliability issues with some of the flowmeters.

2.1.17 Site Access and Constraints

The site is accessed by a paved county road, Donovan Street, off of Icicle Creek Road. There are no access constraints.

2.1.18 NPDES/TMDL Compliance

The Leavenworth NFH operates and monitors its water discharge in compliance with its NPDES permit No. WA-000190-2. In November 2005, the Leavenworth NFH submitted an application to the EPA for a new NPDES discharge permit. On June 26, 2006, EPA issued a draft NPDES Permit and associated fact sheet for the Leavenworth NFH. A refined draft permit was developed by the EPA in December 2010, however, during the review process it was determined that the Leavenworth NFH had made significant changes to its operations since the 2005 submittal and that a new permit application would need to be submitted to address these changes.

In 2009 the state of Washington completed a TMDL for the Wenatchee River, including Icicle Creek, for pH and dissolved oxygen (DO). The TMDL was approved by EPA on August 25, 2009. In the TMDL study, Icicle Creek is identified as a water quality limited waterbody and the Leavenworth NFH was assigned a waste load allocation (WLA) for phosphorus.

On January 7, 2010 the DOE issued a Water Quality 401 Certification (Order No. 7192) to the FWS for the Leavenworth NFH in which the waste load allocation for total phosphorous (TP), was defined as 0.52 kg/day. The Order also requires the development of a monitoring and reporting plan for TP that monitors both effluent and upstream TP levels and reporting in both concentration and total mass.

The Leavenworth NFH submitted a new CWA 401 certification application to address significant changes to hatchery operations to the DOE in October 2011. Both of the new 2011 permit applications included an additional discharge location (Outfall #6, located at ~RM 3.3) in the hatchery channel of Icicle Creek. If permitted and feasible, this newly proposed discharge location would be used to pump-back hatchery overflow discharge water to the hatchery channel for aquifer recharge. Currently, potential effects of this action on groundwater are being analyzed. Final decisions on both permit applications are still pending. In the interim, the Leavenworth NFH continues to operate and monitor its water discharge in accordance with NPDES permit No. WA-000190-2.

2.2 Entiat National Fish Hatchery

2.2.1 Site Location and Layout

The Entiat NFH facility is located on the Entiat River, in unincorporated Chelan County, approximately 8 miles northwest of the town of Entiat, Washington. Figure 2-3 provides an aerial image of major site features and layout.

Figure 2-3. Features of the Entiat NFH

Table 2-3. Index for Features Shown on Figure 2-3

	Feature
A.	Raceways A, 8-feet by 80-feet
B.	Raceways B, 8-feet by 80-feet
C.	Raceways C, 8-feet by 80-feet
D.	Fish Holding Ponds
E.	Pollution Abatement Pond
F.	Public Fishing Pond
G.	River Screen Chamber Building
H.	Pre-Settling Basin
I.	Aeration Chamber Building
J.	Heavy Equipment Storage Building
K.	Limekiln Spring Building
L.	Valve House
M.	FRO Storage Building
N.	Spawning Building
O.	Hatchery Building
P.	Generator Building
Q.	Freezer Building
R.	Visitor’s Kiosk
S.	Fish Ladder

T.	FRO Office
U.	Residence No. 3
V.	Residence No. 4
W1.	Well No. 1
W2.	Well No. 2
W3.	Well No. 3
W4.	Well No. 4
W5.	Well No. 5
W6.	Well No. 6
X.	Surface Water Intake

2.2.2 Summary of Existing Water Rights

The FWS holds four water right certificates to supply the hatchery for fish propagation purposes. These rights include a combination of groundwater and surface water rights. Attributes of these water rights, including instantaneous (Qi) and annual (Qa) limits on diversions/withdrawals as currently certificated, are summarized in Table 2-4. For a more detailed discussion of the water rights, see the Entiat Hatchery Water Supply Memo (Aspect Consulting, 2014) in Appendix A.

Certificate 3058 originally authorized diversion only from the Entiat River. In 1996, DOE approved a change to this water right, adding the six wells as additional points of withdrawal. Certificate 3059 authorizes use of Limekiln (also known as Packwood) Spring, and Certificates 4584-A and G4-25874C authorize use of Well No. 1 and Wells No. 2, 3, and 4, respectively.

Table 2-4. Entiat NFH Water Rights

			Authorized Withdrawals/Diversions			
Water Right	**Source(s)**	**Priority Date**	**Instantaneous (Qi)**	**Units[1]**	**Annual (Qa)**	**Units**
Certificate 3058	Entiat River and Wells No. 1 through 6	6/4/1943	22.5	cfs	---	afy
Certificate 3059	Limekiln (Packwood) Spring	6/4/1943	7	cfs	---	afy
Certificate 4584-A	Well No. 1	8/25/1960	800	gpm	800	afy

Certificate G4-25874C	Wells No. 2, 3, and 4	4/19/1978	1,300	gpm	699	afy

[1] cfs = cubic feet per second. gpm = gallons per minute; afy = acre-feet per year.

Average water yield by source over the past 5 years, based on water use data provided by hatchery staff, is summarized in Table 2-5. Over this period, the wells have sustained an average withdrawal of approximately 1,300 gallons per minute (gpm). This supply is supplemented with water from Limekiln Spring and seasonally with surface water from the Entiat River.

Table 2-5. Summary of Average Yield by Source

	Water Source and Average Production when Operating in gpm							
Year	**Entiat River**	**Limekiln Spring**	**Well No. 1**	**Well No. 2**	**Well No. 3**	**Well No. 4**	**Well No. 5**	**Well No. 6**
2009	0	560	312	295	250	246	186	0
2010	0	536	292	226	208	243	141	100
2011	0	782	332	212	204	276	110	156
2012	5,072	555	427	215	191	207	250	128
2013	5,760	532	444	207	193	207	168	119

Separate from water rights, there are NOAA conservation measure restrictions on the amount of surface water flow Entiat NFH is allowed to divert as follows:

- Maximum 5% of Entiat gage flow when stream flow is less than 200 cfs May - October
- Maximum of 10% of gage flow when stream flow is less than 100 cfs for November - April.

These restrictions effectively reduce the surface water flow available to the hatchery to 5 to10 cfs during low flow periods or drought years. Hatchery staff are required to monitor the Entiat River gage daily and make flow diversion adjustments accordingly. These adjustments typically involve 11 valves and are quite time consuming to make.

2.2.3 Surface Water Supply System

The surface water supply system consists of a low diversion dam, intake structure, surface water pipeline, screen chamber, water treatment structure, and spring intake and pipeline. The hatchery currently uses Entiat River water only in the fall and winter. The facility had stopped using surface water back in 1991 due to the presence of pathogens in the water (*Myxobolus*). Pathogen levels in the river peak around mid-April through the summer, and appears to be closely related to water temperature and turbidity. Surface water is currently used from November through mid-April. Other issues with the surface water supply include icing problems in the winter, reduced flow availability during low streamflow periods noted above, and algae issues in the summer. There is moderate to heavy turbidity in the surface water in May and June, and also occasionally in winter due to rapid snowmelt or landslide events. A lot of sand enters the hatchery in the via the surface water intake in the late winter, especially as anchor ice breaks up.

The diversion dam consists of a low concrete sill across the river. The original design provided for the use of wooden flashboards to create a small pool behind the weir. Wooden flashboards are not currently used.

The intake is a simple concrete box structure with an angled high density polyethylene (HDPE) trashrack, an adjustable HDPE skimmer weir, and 30-inch slide gated controlling flow into the surface water pipeline.

During winter freeze-up low flow periods, the full width of the river is iced over and water depth at the intake entrance is only 6 to 12 inches which does not provide adequate flow to the hatchery. See Figure 2-4 for a typical view of the intake during winter. There are also problems with entrained frazil ice entering the hatchery intake, traveling through the main supply pipeline and clogging the fish screen and fish bypass pipe at the hatchery headworks as discussed in Section 2.2.5 below.

Figure 2-4. Entiat River at Entiat NFH Intake – January 26, 2014 (courtesy of Craig Chisam)

There are also a number of safety issues with the manual control of icing at the intake. The staff have to put on waders and break up ice in front of the trashracks in order to keep water coming into the intake. This is often required during the night, and may occur when only one staff member is available. This is a significant safety concern. During severe icing, the trashrack is typically raised to create a one-foot gap above the floor of the intake to help keep water flowing. This operation can be difficult to perform and allows debris to enter the supply pipe. The facility has routed some well water from Wells No. 5 and 6 (~200gpm) to the intake to help with deicing. The warmer groundwater helps increase the surface water temperature by approximately 0.2°F, which is sometimes enough to keep the water supply flowing.

Water from Limekiln Spring is used year-round, with the quantity dependent on seasonal variability in flow. Peak flows of up to 2,000 gpm (about 4.5 cfs) typically occur in May or June and low flows on the order of 200 to 400 gpm occur from early September through March. The facility had lots of algae problems in the past. The spring source is from a limestone deposit, and it is possible that high pH from the lime in the water is helping to contribute to the algae growth. The FWS staff would like to route the

spring water to the public fishing pond and stop using it for rearing. A simple wood framed structure covers the spring intake, with the spring pool itself being uncovered.

2.2.4 Groundwater Supply System

The hatchery operates six water supply wells that were constructed between 1961 and 1994 using cable tool drilling methods. The wells all tap sand, gravel, and cobble alluvial deposits. Based on the geologic conditions and location near the river, the wells all tap the same body of groundwater and are in hydraulic continuity with the river. The wells vary in depth from about 65-feet to 116-feet deep. The water temperatures stay about 48-50º F year round.

Based on data provided by the staff, sustainable well yields have declined by 50 percent or more since they were installed. The sub-optimal well yields may be due to a combination of well screen fouling and/or water level drawdown interference between pumping wells. To address screen fouling, the hatchery hires a contractor to rehabilitate one well per year using the Aqua Freed CO_2 method. Hatchery staff report rehabilitation efforts typically result in a temporary increase in yield on the order of 100 gpm per well, which remains well below the original capacity.

An infiltration gallery is scheduled to be installed in 2015 near Well No. 4 in the hopes of increasing the groundwater supply. If successful, the hatchery may consider an additional gallery, with goal of obtaining up to 4,500 gpm of additional groundwater supply. One location observed for potential additional groundwater supply is on FWS land across Roaring Creek Road, south of the facility.

The well pumps all have fixed speed drives and are typically not throttled much. Well No. 1, installed in 1961, is the best producing well and has not had any significant maintenance issues. The structures housing Well No.1, 2 and 4 are all in poor condition and should be replaced. New doors and locksets for all of the pump houses is recommended.

2.2.5 Sand Settling Basin and Headworks

Water from the Entiat River intake and from the Lime Kiln Spring intake is routed by pipes to the water treatment structure, which consists of a screen chamber and sand settling basin for the surface water, and an aeration chamber for the groundwater. This structure was built in 1980 and replaced the original screen chamber and mixing chamber. The river water is conveyed to the upstream end of the structure where it upwells over a weir and flows across an inclined horizontal perforated plate screen. Water drops through the fish screen and flows directly into the sand settling basin. Debris and bypass water flow off the end of the screen into a trough and then into an 18-inch fish bypass line that discharges into the river near the pollution abatement pond outfall. Surface water in the sand settling basin overflows a side weir into a channel and then into the main 30-inch distribution pipe. Water from Lime Kiln Spring is directed into a chamber where it is mixed with aerated well water and distributed to the hatchery building or raceways.

When Entiat River water is not being used, the sand-settling basin is drained and the accumulated sediment removed. In the winter, during prolonged cold weather, slush and frazil ice can be conveyed down to the water treatment structure and pile up on the screens. Staff must work continuously to keep water flowing down through the screens. Under these conditions, the sand settling basin then tends to turn to slush and ice, and the fish bypass pipe becomes clogged with slush and ceases to function effectively.

2.2.6 Distribution Piping

This section covers the water supply distribution system. Schematics of the piping system are provided in Appendix A.

Entiat River water is conveyed from the intake structure to the screen chamber via a 36-inch reinforced concrete pipe. The pipe was originally a wood stave pipe, then was replaced in the 1978 with concrete. There is some plugging of the pipe in winter when the river is full of slush and ice. There has been some speculation from staff that perhaps there is some root intrusion through the pipe joints, which is helping to hang up the slush and ice in the pipe. The pipeline has not been videoed to confirm if there are any intrusions into the pipe.

Groundwater piping is routed from the wells to an aeration chamber adjacent to the sand settling basin. The water is run through packed column aerators and into a mixing chamber where the groundwater is mixed with water from the spring. A 16-inch main supply line then delivers the water from the mixing chamber to the hatchery building and raceways.

Much of the main supply yard piping was replaced in 1978 when the original Foster-Lucas ponds were replaced with the 8 by 80 ft raceways and the existing water treatment structure was constructed. There is still some original piping in use, and there is a substantial amount of original piping that was abandoned in place. The existing piping has not been videoed by remote camera to assess condition.

Both river water and groundwater are routed to the supply channels of each raceway bank. During the November to April period when river water is being used there is sufficient water available for single pass flow through the raceways. For the May to October period when river water is not being used, serial reuse of groundwater is used through three banks of raceways via a buried 24-inch reuse pipe. Overflow water from the raceways is routed through the adult holding and then through the fish ladder. During vacuum cleaning operations, waste flows are pumped via buried pipes to the pollution abatement pond.

Currently, only mixed groundwater and spring water is supplied to the hatchery building for incubation and early rearing. While not required currently, staff would like to have the flexibility of having river water also supplied to the hatchery building to support a lamprey culture program. Staff would also like the ability to supply pressurized groundwater to the raceways for use by the tagging trailers, or for tagging trailers to be able to put their intake hoses into the headbox.

2.2.7 Adult Holding and Spawning

A weir and orifice fish ladder leads up into the adult holding facility. The ladder and holding facilities were constructed in 1979. The holding facilities were then modified in 1991.The fish ladder is started on July 1st and runs through November 1st. Most fish return in July and August when flows are still up. When flows drop later in the summer, the fish tend to stay in deep pools in the river, or drop back to the Columbia. A second wave of adult returns occur in October. The entrance to the ladder is somewhat shallow, especially when the river level starts to drop. Staff have identified the possibility of dredging a deeper channel from the entrance to the deep water area under the bridge. There is no current intention of installing a barrier weir, unless they were to see more hatchery strays, which would trigger NMFS to require a barrier. The facility will not see its first full summer Chinook returns until 2016. The facility is required to harvest all hatchery fish that come up the ladder.

The holding facility consists of two concrete ponds approximately 16 x 108-ft long and a spawning shed. One pond is typically used for holding brood fish to be spawned and the other pond holds excess adult fish. A manual push crowder is used to crowd fish in the ponds down to the spawning shed. Fish are then manually lifted up into the shed and spawned. The facility currently spawns fish only two days a year, so there is not a strong need to replace the existing spawning shed with a more modern facility.

2.2.8 Hatchery Building

The hatchery building consists of a 132-foot by 45-foot main structure which provides incubation, early rearing, storage and office space. There is an attached 35-foot by 21-foot shop at the back and a 29-foot by 24-foot garage that was added in 1959 at one end. The main structure and shop has reinforced concrete walls and a wood framed roof, the garage has CMU block walls and a wood roof.

Presently, incubation is accomplished in stacks of Heath tray incubators. A water chilling system was added relatively recently. The chiller is run October through May. There have been only minor issues with the chiller, and it has generally worked well. The Heath trays were recently retrofitted with spillway kits to improved water circulation. Formalin is used for anti-fungus and algae control on the eggs. Staff would like to eliminate the use of spring water to see if that helps alleviate the issue.

2.2.9 Outdoor Rearing

There are three banks of ten 8 by 80 ft concrete raceways. These were constructed in 1978 and replaced the original Foster-Lucas ponds. There was an earthquake at the facility in 2010 that cracked some raceways such that they were losing almost 30% of the water flowing into them. A polyurethane lining (Lifelast) was applied last year and now there is little or no leakage. To prep the raceways for the lining, the staff had to pressure wash all surfaces at 400 psi three times to get down to good firm material. Cementall mortar was then applied to smooth out the surfaces. With the new linings the staff spends 50% less time cleaning and is able to use a vacuum system instead of brushing the raceways. There have been 3 or 4 small earthquakes since the lining was applied with no issues developing.

The facility has fabricated predator exclusion structures with nets and shadecloth to cover the raceways. The staff does not have any real issues with the bird netting and shade cloth they are using, but a solid overhead roof structure would be preferred. The facility would like to get rid of the galvanized steel gripstrut grating on the raceways and replace it with textured fiberglass grating. The gripstrut tears up the vacuum hoses used for raceway cleaning, and is difficult to shovel snow off of in the winter. In addition, at the tailbox ends of the raceways, there is a 4-inch wide gap between gripstrut panels which is a potential hazard for staff.

River water and groundwater are separately piped into one corner of each raceway headbox. This arrangement does not allow the two separate sources to be well mixed prior to flowing into the individual raceways. Another concern of the staff relates to spraying of a pear orchard immediately adjacent to the facility and staff residences. The 90-acre orchard is part of a large corporate operation which uses hatchery property for access. The orchard operation does a fair bit of spraying of insecticide and fungicide, which is a concern for both the staff and their families, as well as for the fish in the adjacent raceways. The facility staff has done some water sampling and quality tests from the raceways after spraying and hasn't detected contamination yet. There are also conflicts and safety issues with agricultural truck traffic and hatchery operations on a shared access drive according to hatchery staff.

2.2.10 Drains, Effluent Pond and Outfalls

The main outfall for the Entiat NFH is the 24-inch concrete pipe that discharges into the Entiat River at the entrance to the fish ladder. There are two other outfalls, one from the pollution abatement pond and the other a small drain from the hatchery building that conveys incubation effluent.

The process drains from the incubation and early rearing raceways are routed into a sump outside of the hatchery building. Under normal operations, the flow is directed out a 12-inch pipe that outfalls directly to the river. Pumps in the sump can also pump the drain water back up to either the screen chamber, directly to the headbox of Bank A of the raceways for reuse, or to the manhole that discharges to the pollution abatement pond. The valves are currently set so when the pumps are activated the water is discharged to the pollution abatement pond. This is how cleaning waste or chemically treated water from the building is directed to the abatement ponds.

The tail box of raceway Banks A, B and C contain two main overflow drains. During periods of serial reuse, the drain at the west end of the tail box is used that routes water to the headbox of the adjoining raceway bank. From the tail box of Bank A or C, reuse groundwater is routed into adult holding pond No. 2. When sufficient water is available for single pass flow, the drain at the east end of the tail boxes is used and overflow water from all three raceway banks is routed into the 36-inch drain that outfalls into the river just upstream of the fish ladder. Water for the adult holding pond No.1 in this case is provided directly from the surface water supply line.

During vacuum cleaning operations, the waste flow from all three raceway banks is pumped into a separate drain that flows to the pollution abatement pond.

Flow that enters the adult holding raceway discharges to the river through the fish ladder. Since the broodstock are not fed, cleaning is not necessary. At the downstream end of each adult raceway is a 48 ft^2 quiescent zone. If cleaning is necessary there are mud valves that direct effluent to the pollution abatement pond.

The pollution abatement pond is an earthen pond, approximately 320-feet long with a 30-foot bottom width and 2:1 side slopes. Two 7.5 hp pumps, located inside well house No. 2, pump water from the pollution abatement pond to supply water for the trout pond. An 8-inch drain from the public fishing pond discharges to the wetland area between Well No. 4 and Well. No. 1.

2.2.11 Support Buildings

A pre-engineered metal building located adjacent to the water treatment structure was completed in 2009 to provide shop and storage space. The buildings all appear to be in relatively good condition with no significant upgrades or repairs required at this time.

2.2.12 Utility Services

Domestic Water: Potable water is supplied to the hatchery and residences from a separate covered intake at the Lime Kiln spring. The domestic water line is routed from the spring to the screen chamber where two 2-hp pumps pump that water up the adjoining hillside to a 15,000 gallon concrete domestic water reservoir. A 6-inch PVC pipe delivers water from the reservoir to the residences and to the hatchery building. The existing piping was installed in 1994.

Domestic Wastewater: The domestic waste water system consists of separate septic tanks and drainfields. The three hatchery housing residences are connected to individual septic tanks and drainfields located between the residences and the hatchery. The host RV wastewater line connects into the septic and drainfield for Residence #4. The septic tank and drainfield for the hatchery building is located in the grassy area between the hatchery building and the adult holding facility.

Electrical Power: Incoming primary power to the site is provided through overhead lines rated at 12 kV. Service is provided from PUD #1 of Chelan County. The Hatchery incoming overhead utility service transitions to underground at the SE area of the site and then is routed north to a pad mount transformer. The unit is located just north of the Generator Building. The transformer was upgraded last year, and so far power has been reliable. The emergency generator is housed in a 14-foot by 16-foot CMU block wall building located behind the hatchery building. A second utility service is located next to the new Maintenance/Storage Building. It is an underground service fed from a pole mounted transformer on the west side of the site. Lastly, a third utility power service to the Hatchery is provided for the residence septic pump.

Communications: Telephone/communications service to the site are standard landlines routed overhead from Roaring Creek Road, adjacent to the facility entrance. Service is provided by Localtel. Phone lines are provided to each of the hatchery housing residences and to the hatchery building.

Fire Protection: There are two fire hydrants provided for the facility supplied by the domestic water supply. One hydrant is located in front of the residences, and the other hydrant is located adjacent to the hatchery building. If the 15,000 gallon reservoir were full it would provide a fire flow of 250 gpm for a one hour period, which is a reasonable level of protection for a remote facility where strict fire codes are not applicable.

2.2.13 Power, Lighting, Instrumentation, and Monitoring

Power: The power service at the Entiat NFH was recently upgraded to a 400 amp, 480Y/277 volt, 3-phase, 60 Hz service. The main service panel is located on the outside north wall of the emergency generator Building. That panel feeds several loads including a 100 amp feeder to the main hatchery building, a freezer, the fish tagging trailer outlets and a heater in the emergency generator building. None of these loads are on standby power.

The main panel also feeds the 200 amp, 480V, 60 Hz panel located in the emergency generator building. This panel radially supplies all major loads throughout the site including Wells 1-6, chiller, hatchery building, emergency generator building and the screenings structure. All of these loads are connected to the standby generator and all have KWH energy monitoring meters.

The standby generator was manufactured by Cummins and is rated at 125 KW, 480 volt, 3-phase. It supplies limited standby power to hatchery loads, including the water chiller, shop and emergency lighting. The unit is very old but has been extremely reliable. However, the unit appears to require special expertise to operate. The speed of the generator must be manually adjusted in order to obtain the mandatory 60 hertz and 480 volts. Adjustments are required whenever the connected load changes such as when a pump comes on line or when some automatic load is energized.

Power is distributed underground throughout the site. Over the history of the facility, there has been several upgrade and changes. Several instances of digging up undocumented conduit/wire or direct buried cables were noted. Whenever this occurs, the cable is replaced with new conduit and wire.

Once the 480 volt power is routed to a building and/or well house, it is utilized for major loads such as motor operation and also transformed down to 120/240 volts or 208Y/120 volts. Most well sites appear to have adequate 480 volt power and equipment, however the outdoor motor starter for Well #1 appears very old and is at the end of its useful life.

Electrical power to the surface water intake is very limited due to the long run or secondary power which causes a voltage drop. Power to this area starts at the emergency generator building, is routed to the screening building and is then routed to the intake structure.

Lighting: Most of the out buildings, including the well houses, intake screenings and intake structure have incandescent lighting. The main hatchery building is general illuminated by fluorescent fixtures. Site lighting generally consist of a few building mounted floodlights and/or HID (High Intensity Discharge) wall packs.

Instrumentation & Monitor/Alarm System: The existing monitor/alarm system is very basic and simple. A computer/PLC –based system was installed in the mid 1990's, however it was removed. Low level alarms (supply, raceways and ladder) are wired to a telephone dialer. The dialer is programmed to automatically call up to 8 phone numbers in the event of an alarm.

Analog instrumentation (flows and temperatures) are indicated at the local device (flowmeters are generally located at the Screenings Building). Recordings are manually taken at least twice a month by either writing down the flow information or driving by the instrument and wirelessly recording the temperature data. Several flowmeter manufacturers/models are utilized at the site including Sierra, Elster Amco, Sparling and Grayline). Most are very hard to maintain. The Sparling meter is broken, obsolete and spare parts are generally unavailable. One of the pipelines had the flowmeter fail. The meters was replaced with a unit that had to be mounted on the inside of the River water intake pipe. In order to service the meter, hatchery personnel have to shut the water flow off and access the meter by crawling up the pipe from the Screenings Building, which is a confined space concern.

2.2.14 Hatchery Housing

There are three wood framed residences on site for staff: Residence #1, #3 and #4. The original residence #2 was removed. Minor improvements and repairs have been made over the years, including: electrical rewire, siding replacement and window replacement. Recommended improvements listed by the Reclamation in their 2011 report included some plumping improvements for residences #1 and #3.

2.2.15 Site Access and Constraints

The site is accessed by a driveway off of the Roaring Creek Road. The Roaring Creek Road is accessed from milepost 6 of the Entiat River Road by a fairly modern two-lane concrete bridge. The access road to the hatchery is shared with the adjoining privately operated orchard property. This results in heavy agricultural traffic through the hatchery site and hatchery housing areas which at times interferes with hatchery operations and creates a safety/biosecurity issue.

2.2.16 NPDES/TMDL Compliance

Under 40 CFR §122.24, EPA defines Concentrated Aquatic Animal Production (CAAP) facilities as point sources subject to the NPDES permit program. Facilities with cold water fish species or other cold water aquatic animals in ponds, raceways, or other similar structures that discharge at least 30 days a year must obtain converge under the NPDES program. Facilities are not considered CAAP if the operate under the following minimum thresholds:

a. Produce less than 20,000 harvest weight pounds of aquatic animals per year, and
b. Feed less than 5,000 pounds of food during the calendar month of maximum feeding.

In 2013, Entiat NFH slightly exceeded the minimum threshold for harvest weight with a harvest weight production of 22,291 pounds. The maximum monthly food use was 3,560 pounds for the month of September.

The Entiat NFH is covered under the NPDES General Permit WAG-13-000 issued to cover Federal Aquaculture Facilities and Aquaculture Facilities located in Indian Country within the boundaries of the State of Washington. This general permit was issued on August 1, 2009. The General Permit expired on July 31, 2014, however the EPA has extended the coverage under this permit until a new permit is issued. Section I.E.6 of the general permit does not allow discharges to "impaired waters" pursuant to Section 303(d) of the Clean Water Act (CWA). The wording of I.E.6 is as follows:

"The General Permit does not apply to discharges to (a) *impaired waters*, designated pursuant to Section 303(d) of the Clean Water Act (CWA), which are water-quality limited for a pollutant of concern evaluated in the development of this permit (BOD5, total suspended solids, settleable solids, nutrients, ammonia, chlorine), unless a wasteload allocation has been assigned to the discharge and is applied in this permit, or to (b) receiving waters that are one mile or less upstream from an impaired water that is designated as such pursuant to Section 303(d) of the CWA, unless a specific effluent limit based on a WLA has been applied in this permit."

The Entiat River is currently on the State of Washington's 303(d) list of impaired waters for temperature and pH and has been identified as a waterbody requiring a detailed TMDL study for the watershed. In discussion with Washington DOE staff the timing for this study is unknown. It should be assumed that phosphorus will eventually be identified as a cause for the Entiat River not meeting state water quality standards for pH. A future TMDL will identify waste load allocation for point sources within the watershed. Although the Entiat NFH is covered under the General Permit, if the hatchery is identified with a waste load allocation in the TMDL study, the hatchery could be required to develop and implement a source control implementation plan and may be required to develop an individual permit similar to Leavenworth NFH at some point in the future.

2.3 Winthrop National Fish Hatchery

2.3.1 Site Location and Layout

The Winthrop NFH facility is located on the Methow River, in unincorporated Okanogan County, just to the south of the town of Winthrop, Washington. Figure 2-5 and Figure 2-6 provide aerial images of major site features and layout.

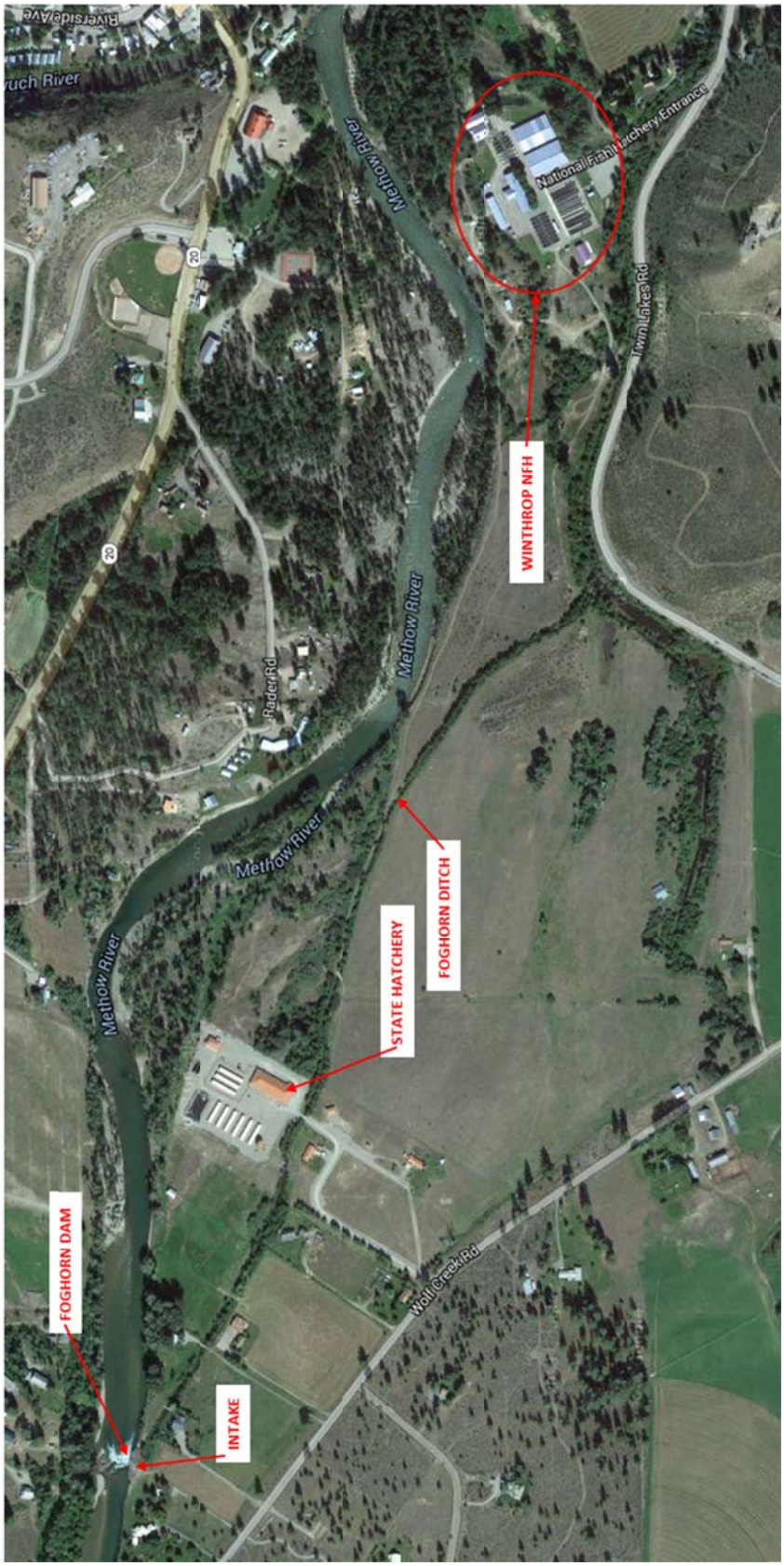


Figure 2-5. General Layout of the Winthrop NFH

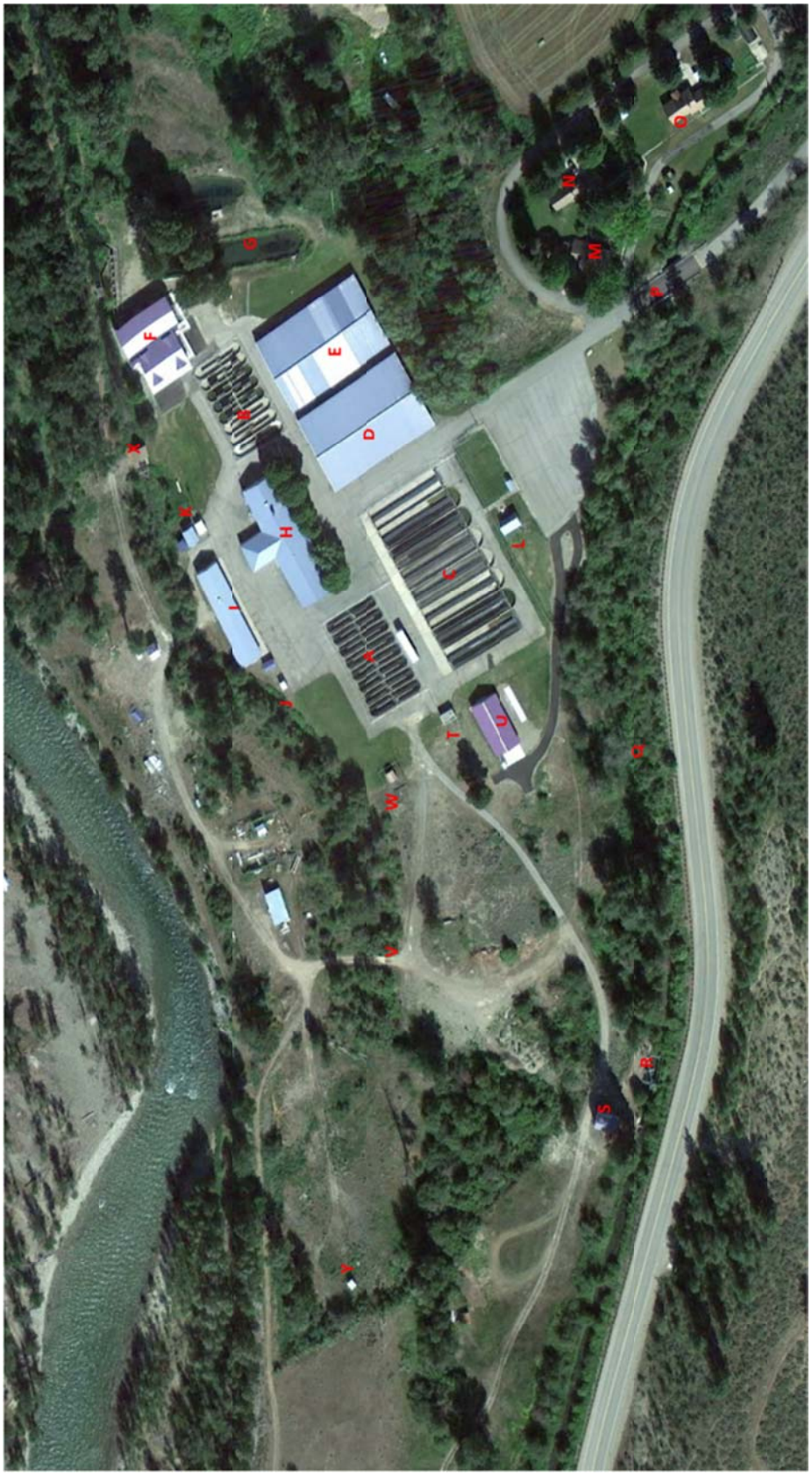


Figure 2-6. Features of the Winthrop NFH

Table 2-6. Index for Features Shown on Figure 2-6

	Features
A.	Foster Lucas Ponds A
B.	Foster Lucas Ponds B
C.	Foster Lucas Ponds C
D.	Raceways D
E.	Raceways E
F.	Adult Holding Ponds and Spawning Building
G.	Pollution Abatement Pond
H.	Hatchery Building
I.	Storage (Feed) Building
J.	Fueling Station
K.	Generator Building
L.	Comfort Station
M.	Residence No. 5
N.	Residence No. 4
O.	Residence No. 2
P.	Entrance Road
Q.	Foghorn Ditch
R.	Foghorn Ditch Screens
S.	Screen Chamber

T.	Valve Chamber
U.	Steelhead Kelt Reconditioning Building
V.	Overflow Canal Bridge
W.	Infiltration Gallery No. 1
X.	Infiltration Gallery No. 2
Y.	Infiltration Gallery No. 3

2.3.2 Summary of Existing Water Rights

The FWS holds four active water right certificates to supply the hatchery for fish propagation purposes. These rights include a combination of groundwater and surface water rights. Attributes of these water rights, including instantaneous (Qi) and annual (Qa) limits on diversions/withdrawals as currently certificated, are summarized in Table 2-7. For a more detailed discussion of the water rights, see the Winthrop Hatchery Water Supply Memo (Aspect Consulting, 2014) in Appendix A. FWS is presently working to formalize water rights for Infiltration Gallery No. 2.

Table 2-7. Winthrop NFH Water Rights

			Authorized Withdrawals/Diversions			
Water Right	**Source(s)**	**Priority Date**	**Instantaneous (Qi)**	**Units[1]**	**Annual (Qa)**	**Units**
Certificate 848	Methow River and Infiltration Gallery 3	1/10/1922	50	cfs	---	afy
S4-CV1P206	Unnamed Spring	1/10/1922	10	cfs	---	afy
Certificate 7209	Infiltration Gallery 1	4/6/1967	1,500	gpm	2,420	afy
Certificate 7590	Infiltration Gallery 1	2/17/1971	1,500	gpm	2,400	afy

[1] cfs = cubic feet per second. gpm = gallons per minute. afy = acre-feet per year.

2.3.3 Surface Water Supply System

Winthrop NFH is supplied by 1,000 to 7,000 gpm of surface water diverted from the Methow River at a low boulder diversion weir (timber crib dam built in 1949) located about one mile upstream of the hatchery. The water right allows for withdrawals of up to 50 cfs (22,441 gpm) in combination with water pumped from a shallow aquifer at Infiltration Gallery #3. Surface water is directed through the intake into the Foghorn Ditch, which flows approximately one mile downstream to the Winthrop NFH screen chamber. The Foghorn Ditch also conveys water to the Washington Department of Fish and Wildlife

(WDFW) fish hatchery located upstream and to irrigators located downstream. Water temperatures in the summer can reach 70° F which requires that the surface water use be discontinued or blended with groundwater to meet water temperature criteria in hatchery rearing units.

The existing intake structure was designed and constructed in 1996 by FWS to function as a surface water diversion for Winthrop NFH, Methow State Fish Hatchery, and Foghorn Ditch Company. The Methow Hatchery is located about 1,500 feet downstream of the intake structure. FWS maintains the intake and the irrigation ditch up to the Winthrop NFH. The boulder weir is not a barrier to upstream fish passage. A portion of the boulders and gravel fill that make up the weir have shifted downstream over time, thus reducing the surface water level at the intake. A picket style barrier was considered for replacing the boulder weir, but the picket barrier would need to be so large to meet NMFS criteria that it was not deemed practical. There were also concerns about providing passage around the barrier for resident fish. The barrier project is on hold for now due to permitting issues and probably will not move ahead according to FWS staff.

A fish ladder is built into the intake structure, but wild steelhead do not tend to use it. An adult trap that was built into the structure does not functional well and FWS finds it unsafe to operate. Since few fish utilize the ladder and were being caught in the trap, FWS no longer operates it.

The power at the intake structure consists of 12 volt batteries with solar cell recharging. The various slide gates to operate the fish ladder and intake are all manually operated and are in good working order, although some of the gate frames are showing a significant amount of rust. The steel trashracks are manually raked, as are the secondary screens in front of the intake gates. When icing occurs at the intake, the FWS staff pulls the trashracks and secondary screens to maintain flow.

The existing pressure transducers at the intake structure do not work very well and there have been problems with false readings. Reclamation is working to replace them. The algorithm determining total intake flow is based on water levels above and below a submerged orifice.

A significant portion of the suspended sediment in the diverted river water drops out in the irrigation ditch. The irrigation ditch needs to be dredged out about every 2 years to remove the accumulated sediment. Spring Branch Spring comingles with Foghorn Ditch water and contributes on the order of 1 cfs to flow in the ditch approximately 700 feet upstream of the hatchery screen chamber intake. The facility holds a water right authorizing use of 10 cfs from Spring Branch Spring, however initial review of DOE water right files indicates that this right was relinquished for non-use in 2005. This source is not desirable due to pathogens present and is only used in the sense that it is combined with the Foghorn Ditch upstream of the hatchery intake.

A simple intake with bar rack directs water from Foghorn Ditch into the hatchery screen chamber. A propeller meter is used to monitor the total flow from the ditch. The screen chamber contains a single rotating drum screen installed in 1995. The original spring drum screen is still in place but is not used. In very cold conditions, when the drum screen starts to ice up, it becomes buoyant and floats up in its guides to bypass flow past the screen.

2.3.4 Groundwater Supply System

The Winthrop NFH does not have any deep wells, but instead has three shallow infiltration galleries. Each infiltration gallery consists of lateral subsurface collection laterals that feed into a pump station sump. The

laterals are generally less than 12-feet deep, located in shallow sand and gravel alluvium which are in hydraulic continuity with the river. There were no reported issues with the laterals fouling or clogging and requiring maintenance.

Water from Gallery No. 1 is pumped to the valve chamber and then directed to anywhere in the hatchery. Water from Gallery No. 2 is pumped into a valve vault adjacent to the pump, then distributed to either the Spring Branch line upstream of the valve chamber, or to the adult holding ponds. Water from Gallery No. 3 is pumped into the Spring Branch line downstream of the screen chamber. There is currently no check or closure valve on the Spring Branch line upstream of the connection with Gallery No. 3. Back pressure from the Gallery No. 3 or Gallery No. 2 pumps can result in small amounts of water spilling back up in the screen chamber and flowing out the fish bypass to the back channel.

The groundwater levels in the infiltration galleries is seasonal and is closely related to river water levels. Hatchery staff indicated that operation of Infiltration Gallery 3 results in water level drawdown interference at Infiltration Gallery 1, located about 900 feet east. Hatchery staff monitor water levels in Infiltration Gallery 1 and adjust withdrawals when needed to avoid pump cavitation. This condition also has the potential to result in gas bubble disease issues in the raceways if not monitored closely. The infiltration gallery water temperatures vary seasonally from 46-52° F. The infiltration gallery pumps are all locally controlled with no remote control currently available.

Staff expressed a preference for additional groundwater supply. A water right change application has been filed with Ecology to add Galleries 1 and 2 to the surface water right for the Foghorn Ditch diversion (Gallery 3 was previously added to this right).

2.3.4.1 Infiltration Gallery No. 1

Gallery No. 1 provides 1,000 to 2,500 gpm of groundwater. The pumps are vertical turbine units with a 60 hp main pump and 25 hp back-up pump. One of the pump motors was recently replaced with a variable speed motor, and the electrical panels and pump enclosure were also recently replaced. The VFD enclosure at Gallery No. 1 is not vented and the unit will overheat if the door is left closed during high temperature weather. The discharge piping and valves are showing signs of corrosion, but are still functional. A tap off of one of the discharge lines is routed through a small inline booster to provide irrigation water for the grounds. Figure 2-9 shows the pumps and enclosure.

2.3.4.2 Infiltration Gallery No. 2

The Gallery No. 2 pump discharge tees to supply about 1,800-4,500 gpm via separate pipe runs to the spawning facility and hatchery. The pump is a vertical turbine unit with a 75 hp variable speed motor. The pump motor is controlled by a remote VFD located in the gen-set building. The pump motor, electrical panels, and pump enclosure were all recently replaced.

2.3.4.3 Infiltration Gallery No. 3

Gallery No. 3 provides about 1,200 gpm. Operation of Gallery No. 3 creates a cone of depression that affects Gallery No. 1. If the groundwater levels in Gallery No. 1 drop too far it starts to suck air and the pumps experience cavitation. This condition can also create gas bubble disease issues in the raceways, so the groundwater levels are tracked very closely to avoid this condition. Once groundwater levels in

Gallery No. 1 drop close to the critical level, the two pumps are adjusted to alleviate the situation or one may be shut down.

The pump for Infiltration Gallery No. 3 can freeze up during cold weather if it is not being used, so the staff make sure that it is kept moving. The Infiltration Gallery No. 3 pump is 75 hp, which appears to be somewhat oversized given the head and flow, and was running at about 60% during the visit. Facility staff said that at most it gets up to 80%. Back-pressure from gallery No. 3 pump will overflow to waste at the screen structure – this can be prevented by adding a valve to the supply piping. Infiltration Gallery No. 3 is not connected to the station emergency generator, so it cannot be used if power goes out, and must be manually restarted once power returns. The existing generator is a long distance from this gallery and does not appear to be large enough to handle the additional load.

2.3.5 Distribution Piping

This section covers the water supply distribution system. Schematics of the piping system are provided in Appendix A.

Surface water is supplied from the screen chamber to the valve chamber via a 36-inch welded steel buried pipe. A 36-inch gate valve inside the valve chamber controls the flow. The gate valve dates from the original construction and requires two people to operate. The exposed 36-inch pipe in the valve chamber is in poor condition and staff reported that several leak repairs have been necessary. It is likely that the buried portion of this steel pipe is also in poor condition. Most of the piping in the valve chamber appear to show significant signs of corrosion. The pipe wall thicknesses have not been measured, to determine the pipe conditions. In September 2014 a portion of pipe serving “C Bank” raceways failed and was replaced.

Groundwater from Infiltration Gallery No. 1 can be directed to either the valve box, or the valve chamber. Groundwater from Infiltration Gallery No. 2 can be directed from the valve vault to either the Spring Branch line upstream of the valve chamber, or to the adult holding facility. This piping is newer ductile iron and is in good condition. Groundwater from Infiltration Gallery No. 3 separately joins the Spring Branch pipe upstream of the valve chamber. Cross connections in the valve box and valve chamber allow groundwater to be either run separately to the hatchery building, ponds and raceways, or to be blended into the surface water. A gravity flow reuse pipe provides groundwater from the holding facility to “E” Bank raceways. Several segments of the groundwater piping system are undersized which places some operational restrictions on fish production in the outdoor rearing units. The hatchery manages around this problem by blending groundwater in to surface water supply piping which compromises the ability to manage disease and water temperatures.

The Reclamation 2011 Special Examination listed 5,235 lineal feet of buried water pipe on the site. While some of the piping has been replaced during improvement projects over the years, much of the piping is original and is likely in poor condition. The Reclamation recommended in their 2011 Special Examination report that all major lines be inspected by remotely operated camera to assess the pipe conditions and this has not been completed yet.

Valves located in the valve vault adjacent to Infiltration Gallery No. 2, the valve box adjacent to the “A” bank ponds, and in the main valve chamber, requires staff to climb down into small confined spaces in order to operate the valves. The confined spaces are labeled and ventilation is not provided. Lighting is not provided in the valve box or valve vault. A basic light is located in the valve chamber, but the bulb

was burned out on both site visits. Black widow spiders, which are common in the area, are frequently found in the three confined spaces and staff must take extra precautions.

2.3.6 Adult Holding and Spawning

A new spawning building and adult holding ponds were built in 2011. The facility spawns fish in April (steelhead), August (spring Chinook), and October/November (Coho). A pool and weir fishway directs fish from the back channel up to a transport channel where fish can be directed into either of two 12-feet wide and 68-feet long holding ponds. When the fish are ready to be spawned, they are crowded into a fish lock. A floor brail in the lock forces the fish out onto a wetted chute and into an anesthetic tank in the spawning building. The fish are then sorted and spawned or directed back into the holding pond if they are not ready for spawning. The one complaint from staff is that the floor of the spawning building is level and does not slope to the floor drain, so spilled water puddles up.

2.3.7 Hatchery Building

The hatchery building is a single story 10,000 square foot structure, with concrete walls and metal framed roof. The building houses incubation and early rearing functions along with office and storage space. It was renovated in 1992 with updates to windows and doors, insulation, plumbing, and electrical. Seismic upgrades were made to the building in 2006.

Presently, incubation is accomplished in 28 double stacks of Heath tray incubators. A water chilling system was added relatively recently, which has improved incubation and early rearing survivals. The chiller is run year round except for a two week maintenance period Early rearing is done in 36 fiberglass troughs located in the hatchery building. The troughs have a volume of 89 cubic feet each and are supplied with 20 gpm of water each.

While much of the silt drops out in the irrigation ditch, it is still somewhat of an issue down at the hatchery.

2.3.8 Raceways

There are two banks of small Foster-Lucas ponds, ‘A’ Bank and ‘B’ Bank, and one bank of large Foster-Lucas ponds, ‘C’ Bank. The other set of original large Foster-Lucas ponds were replaced in the mid-1970s with two banks of fifteen 8-foot by 80-foot raceways, ‘D’ Bank and ‘E’ Bank. All of the ponds and raceways use single pass flow except for infrequent hatch house pump back. Serial reuse of the raceway water has only had to be resorted to on three occasions in the last 35 years.

The ‘A’ Bank of ponds have a rusted out fish release and drain pipe that is not functional. The ‘B’ Bank of ponds are not in use except for a natural spawning experiment in one pond, and a beaver relocation program that uses a few ponds. The concrete for both banks of ponds is in very poor condition.

The ‘C’ Bank of large 12-foot wide Foster-Lucas ponds were modified in 1959 from circular flow to divided flow through ponds. These ponds leak and take a long time to fill due to the very poor condition of the concrete. They also have poor flow patterns that make them difficult to clean without re-suspending fish waste which can result in increased incidences of gill disease in the fish. Shading is provided by shade cloth suspended over removable frames. Sunburn can still be an issue, especially with the steelhead which are more susceptible.

The 'D' and 'E' bank of 8 x 80 ft raceways were constructed in the mid-1970s. Solid overhead roof covers were added in 1992 to both banks. Loading is 15,000 SPC per raceway. The walls are showing some roughness, but in general the raceways are working well. There is some asphalt settling around the perimeter of the raceways and roof support columns. Replacement of the asphalt in this area is planned for next year. The facility staff would prefer to have more 8 x80 ft raceways with solid roof covers. The Reclamation, in their 2011 report, recommended that all of the Foster-Lucas ponds be eventually replaced, with the order of priority being 'B' bank, then 'C' bank, and finally 'A' bank.

2.3.9 Drains, Effluent Pond, and Outfalls

The only outfall for the Winthrop NFH is the structure where the 39-inch diameter effluent pipe and the entrance to the fish ladder combine. This structure is located on the channel connecting the Foghorn Ditch with the Methow River downstream of the Coho Acclimation area.

Under normal (no-cleaning) operations, all flow from raceway banks A through E and the Hatchery building either flow through the 39-inch pipe or the adult holding pond and fish ladder. The cleaning waste is directed to the pollution abatement pond located in the northeast corner of the site. Although the pollution abatement pond is an Off Line Settling Basin (OLSB) the flow combines with the full hatchery effluent prior to discharging to the Methow River and therefore NPDES monitoring data is reported as a Full Flow Settling Basin (FFSB).

The C bank, D bank, and E bank raceways are typically cleaned using a siphon vacuum system with the discharge directed to the standpipe drain systems within the raceway. Brush cleaning to pulled standpipes is used instead of vacuuming only when the fish are very small. The cleaning waste is directed to the pollution abatement pond located in the northeast corner of the site.

The hatchery building and A Bank drains are not connected to the piping that flows to the pollution abatement pond. The small amount of incubation flow from the hatchery building is directed to the 39-inch outfall pipe via a 21-inch drain pipe on the south side of the hatchery building which turns into a 24-inch pipe as it flows below the B bank raceways. The pipe extends further upstream (east) to the A bank raceways.

The existing pollution abatement pond is approximately 200-feet long by 40-feet wide at the top. The depth and side slopes are unknown. Weirs within a control structure with establish the ponds water surface elevations in the pond. A pipe leads from the control structure and connects with the 39-inch outfall pipe.

2.3.10 Support Buildings

There is a 78-foot by 31-foot wood framed shop/garage building that also includes an insulated freezer space for feed storage that was built in 1966. A 52-foot by 31-foot CMU block addition was constructed in 1979 to add additional equipment and storage space. Staff suggested better storage for the 4-inch fish transfer hoses which are difficult to handle as presently stored. An older wooden pole building provides some additional storage space. This is an open-air structure and provides only limited protection from the elements for items stored there.

The Yakama Nation operates a newly constructed kelt re-conditioning facility on station in a separate building owned by FWS. This building is allotted 1 gpm per adult fish, but uses more. There is a

pathogen risk with this function and an effluent ultra-violet (UV) treatment system is used to address biosecurity concerns.

2.3.11 Utility Services

Domestic Water: Potable water is supplied to the hatchery and residences from a domestic well located in the valve chamber. A 5 hp pump delivers the water to a 15,000 gallon domestic water reservoir located on the hill behind the facility. Potable water is delivered to both the hatchery building and to the hatchery housing residences.

Domestic Wastewater: The domestic waste water system consists of separate septic tanks and drainfields. The five hatchery housing residences are connected to a single septic tank and drainfield located between the residences and the hatchery. Separate individual small septic tanks and drainfields are provided for the comfort station and for the host RV connection. The septic tank and drainfield for the hatchery building is located behind the building, adjacent to the storage building. This system was replaced in 2003.

Electrical Power: Incoming primary power to the site is provided through overhead lines. Service is provided from the Okanogan County Electric Coop (OCEC). Power enters the site from an aerial line located at the back of the site. The power line originates from Okanogan and comes into the Methow Valley up and over Loup Loup pass. The facility has several power outages a year, usually in the winter. There are several electrical power services to the site.

The main hatchery service in the emergency generator shed is fed from pole mounted transformers located adjacent to the generator building. The service conductors are installed in conduit and routed down the pole and over to the shed. The same utility pole mounted transformers are tapped to provide a second site service to the recently installed spawning/trap building.

A third utility power service to the area is for Infiltration Gallery No. 3. It is fed underground from OCEC pole mounted transformers to the station.

Communications: A standard phone line enters the site off of Twin Lakes Road, adjacent to the facility entrance. Phone lines are provided to each of the hatchery housing residences and to the hatchery building. In addition, there is a dedicated phone/communications service at the surface water intake structure for the telemetry control of the weir gates.

Fire Protection: There are two fire hydrants supplied by the domestic water reservoir provided on site. One hydrant is located adjacent to the hatchery housing residences, and the other hydrant is located adjacent to the hatchery building.

2.3.12 Power, Lighting, Instrumentation, and Monitoring

Power: The power service at the Generator Building feeds the majority of the site. It is rated at 480Y/277 volts, 320 amps, 60 Hz. That service feeds power to the Hatchery Building, the Equipment/Storage Building, Gallery 1 and 2, valve chamber and the screenings chamber. All feeders to the main hatchery and the out buildings have KWH energy monitoring meters.

This entire service is alternately provided with standby power from the generator. The diesel generator (as assembled by the ILI Corp) is about 30-years old and is serviced twice a year. There have been a few maintenance or operation problems with it. It supplies power to all loads at the main hatchery site except the new Spawning Building. It is rated at 205 KW, 256 KVA, 480Y/277 V, 3-phase, 60 Hz. The hatchery staff indicated that there might be some spare capacity in the generator output. This would need to be verified by a load study, however, it was determined that there is not enough spare capacity to provide power to Gallery #3 pumps. The emergency generator is housed in a 12-foot by 16-foot CMU block structure that was built in 1985 and is in good condition. A diesel storage tank is provided adjacent to the generator building.

A review of many of the miscellaneous electrical drawings for the site indicates that the power was once a 480 V, 3-phase grounded Delta service. The site trip during the summer of 2014 generally shows that the service has been converted to a 480Y/277 volt system.

The second power service onsite at the new Trap (Spawning) building is rated at 100 amps, 480Y/277 V, 3-phase. The service/disconnect and utility meter is located on the exterior N.W. corner of the building. This building has no standby power.

A third power service at Well #3 is rated at 480Y/277 volts, 200 amperes, and serves the 75 HP well pump motor. This site also has no standby power.

Lastly, the power source at the Intake Structure is solar cells tied to storage batteries providing 12 volt power for weir and telemetry operation.

After the 480 volt power is routed to a building and/or infiltration gallery, it is utilized for major loads such as motor operation and also transformed down to 120/240 volts or 208Y/120 volts for utilization at convenience outlets and other small electrical loads.

Lighting: Most of the out buildings, including the infiltration galleries, intake screenings and valve have standard fluorescent lighting. The main hatchery building also is generally illuminated by fluorescent fixtures. Site lighting generally consist of some small building mounted security lights or a wall pack type fixture. The covered pond 17-24 area is illuminated by low-bay HID (High Intensity Discharge) fixtures.

Instrumentation & Monitor/Alarm System: The facility has a relatively new SCADA monitoring system that works well. The SCADA system is approximately 2-3 years old. It is a computer/PLC-based monitor and alarm system. It monitors parameters such as flows, gallery & other low water levels, other alarms and site security. It does not seem to have historical or trending data.

The surface water intake weir level can be remotely controlled via a dedicated phone line to the site. However, during the site visit, it was noted that that the weir level position transmitters were not working. The total flow from this station is calculated by an algorithm using the position of the gates so that if the gates are not transmitting the correct position, the flow data will be false. The system does not directly control any other pump of device at the site.

The current staff expressed satisfaction with the existing monitor & alarm system. It has minimal controls and appears to be based on software that is widely used and supported.

2.3.13 Hatchery Housing

There were three on-site wood framed residences for hatchery staff that date from the original construction, three of which remain today. Minor improvements and repairs have been made over the years. Recommended improvements listed by the Reclamation in their 2011 report included adding additional insulation and making seismic upgrades. The on-site residences have either electric baseboard or wood heat.

2.3.14 Site Access and Constraints

The site is accessed from Twin Lakes Road. The original access bridge over the Foghorn Ditch was replaced in 2010 with a concrete box culvert. There are no access constraints.

2.3.15 NPDES/TMDL Compliance

The Winthrop NFH is covered under the NPDES General Permit WAG-13-000 issued to cover Federal Aquaculture Facilities and Aquaculture Facilities located in Indian Country within the boundaries of the State of Washington. This general permit was issued on August 1, 2009. The General Permit expired on July 31, 2014, however the EPA has extended the coverage under this permit until a new permit is issued. Section I.E.6 of the general permit does not allow discharges to "impaired waters" pursuant to Section 303(d) of the Clean Water Act (CWA). The wording of I.E.6 is as follows:

"The General Permit does not apply to discharges to (a) *impaired waters*, designated pursuant to Section 303(d) of the CWA, which are water-quality limited for a pollutant of concern evaluated in the development of this permit (BOD5, total suspended solids, settleable solids, nutrients, ammonia, chlorine), unless a wasteload allocation has been assigned to the discharge and is applied in this permit, or to (b) receiving waters that are one mile or less upstream from an impaired water that is designated as such pursuant to Section 303(d) of the CWA, unless a specific effluent limit based on a WLA has been applied in this permit."

It is not clear when additional studies of the Methow River might be conducted by the Washington DOE. Therefore the Winthrop NFH should be able to continue working under the General NPFES permit. It should be noted this permit is due for re-issuing and therefore additional conditions could be included in the re-issued permit. The national attention to the phosphorus issue should also be considered when developing long-term modifications to the hatchery effluent treatment system.

SECTION 3
BIOLOGICAL PROGRAMMING AND OPERATIONS SCHEDULES

3.0 Introduction

This section presents detailed fish production targets, biological criteria and hatchery operations schedules for each of the fish production programs located at the Leavenworth Hatchery Complex facilities. Critical parameters including water supply and rearing volume availability are assessed, and the potential impacts of climate change are briefly discussed.

3.1 Fish Production Targets

Fish production numbers, species, and criteria are subject to various policy agreements and hatchery reform efforts and as such, change over time. Table 3-1 provides a snapshot of the fish production numbers and size of fish in terms of fish per pound (fpp) documented in Hatchery and Genetic Management Plans (HGMP's), Future Brood Documents (FBD's), US v. Oregon mitigation agreements, and staff inputs. The colored far right columns show production targets and key biological criteria, Density Indices (DI) and Flow Indices (FI) that were used for the alternatives analysis at the direction of FWS fish health staff. In addition to these minimum criteria for water flows and rearing volumes, Complex managers would like the flexibility to provide 2 changes per hour in raceways for disease management purposes, especially when operating primarily on surface water. The supply flow required to provide 2 changes per hour is not achievable year round in all rearing units under present water rights at Leavenworth NFH or Entiat NFH.

Table 3-1. Leavenworth Fisheries Complex - Production Targets and Biological Criteria

Leavenworth NFH												
	Per HGMP		Per FBD		Per US v. Oregon		Per Staff		Target for Alt. Analysis			
Species	Number	Size (fpp)	Number	Size (fpp)	Number	Size (fpp)	Number	Size (fpp)	Number	Size (fpp)	DI	FI
Sp. Chinook	1,200,000	18	1,200,000	18	1,200,000	18	1,600,000	18	1,200,000	18	0.15	1.0
YN Coho - Incubation									1,300,000	to eye up		
YN Coho - Over winter Acclimate	751,000	19			See Entiat		300,000	16	300,000	16	0.10 to 0.17	1.0
YN Coho - Short term Acclimate			545,000	30	See Entiat		300,000	16	300,000	16	0.10 to 0.17	1.0
Entiat NFH												
	Per HGMP (2009)		Per FBD		Per US v. Oregon		Per Staff		Target for Alt. Ananlysis			
Species	Number	Size (fpp)	Number	Size (fpp)	Number	Size (fpp)	Number	Size (fpp)	Number	Size (fpp)	DI	FI
YN Coho - On Station					250,000	yrlg			Moved to LNFH			
YN Coho - Acclimation					100,000	yrlg			Moved to LNFH			
Summer Chinook	400,000	18	400,000	18	400,000	yrlg	400,000	18	400,000	18	0.11	1.0
Winthrop NFH												
	Per HGMP (2012)		Per FBD		Per US v. Oregon		Per Staff		Target for Alt. Ananlysis			
Species	Number	Size (fpp)	Number	Size (fpp)	Number	Size (fpp)	Number	Size (fpp)	Number	Size (fpp)	DI	FI
Spring Chinook	600,000	15-18	400,000	18	400,000	yrlg	420,000	18	400,000	15 to18	0.11	1.0
Spring Chinook			20,000	30	200,000	pre-smolt			200,000	eggs		
S. Steelhead	100,000		60,000	15	200,000	smolt -Age 2	200,000	4 to 5	200,000	4 to 5	0.2	1.0
S. Steelhead			50,000	7								
Steelhead - Kelt Recond.					50-100	adults			100	adults	NA	
YN Coho - Incubation									1,300,000	to eye up		
YN Coho - On Station					350,000	smolt	250,000	15	250,000	15 to 17	0.2	1.0
Coho - Back Channel Acclimation			60,000	15			100,000	15	100,000	15 to 17	0.2	1.0

3.1.1 Leavenworth NFH Fish Production

Spring Chinook production at Leavenworth NFH was reduced from 1,600,000 to 1,200,000 in 2008 as a result of US v. Oregon negotiations with the intent to produce fewer but higher quality fish as a means of improving smolt to adult return (SAR) ratios. In July 2014, FWS indicated that the US v. Oregon target was likely to remain at 1,200,000 spring Chinook and that value should be used for planning purposes. This target is consistent with production described in the most recent HGMP (FWS 2011[1]) and FBD.

The mid-Columbia coho program run by Yakama Nation (YN) incubates up to 1.3M eggs at Leavenworth NFH and ships eyed eggs to out-of-basin hatcheries for hatching and early rearing. Coho are then transported back to Leavenworth NFH for acclimation and release to Icicle Creek. The target for mid-Columbia coho releases from Leavenworth NFH is presently 300,000 yearlings, which are overwinter acclimated on site, and another 300,000 yearlings which are acclimated short term on site after rearing at Cascade or Willard hatcheries. According to US v. Oregon agreements this production was originally slated for Entiat Hatchery. It is understood that US v. Oregon will soon be revised to reflect the shift to Leavenworth NFH. The YN is hoping to be able to move incubation and adult holding to a new hatchery site in the near future and to ramp down releases into Icicle Creek, as described in the Master Plan (YN 2012[2]) and Final Environmental Impact statement (FEIS) (BPA 2012[3]). YN is also actively working to develop multiple small acclimation sites in the Wenatchee Basin, which will reduce the number of fish acclimated and released at Leavenworth as they come on line. However, project implementation has encountered difficulties, and the coho program is likely to remain at Leavenworth for an unknown time period into the future.

3.1.2 Entiat NFH Fish Production

Production at this facility was recently shifted from spring Chinook to summer Chinook with a release goal of 400,000 yearlings. Table 3-1 also shows the shift of US v. Oregon mid-Columbia coho to Leavenworth NFH. The Entiat NFH production goals are consistent with the most recent HGMP and FBD's. The rearing data portion of the HGMP shows spring Chinook data and has not been updated to reflect the different timing used for summer Chinook, or the effects of using a recently installed chilled water system during incubation on fish development.

3.1.3 Winthrop NFH Fish Production

The Winthrop NFH spring Chinook production target is being reduced from 600,000 to 400,000 yearlings, with 200,000 eggs being shipped out to the newly constructed Chief Joseph Hatchery. The HGMP, FBD and US v. Oregon goals are in the process of being adjusted accordingly. With the recent reduction in spring Chinook production, FWS has adopted an increased goal of 200,000 summer steelhead for Winthrop NFH. The summer steelhead production is being shifted from Age 1 to Age 2 smolts to achieve a larger release size of 4 fpp. These changes are described in the latest HGMP and US v. Oregon documents. Similar to Entiat, a chilled water system has recently been installed to help control

[1] United States Fish and Wildlife Service. 2011a. Hatchery and Genetic Management Plan (HGMP), Leavenworth National Fish Hatchery Spring Chinook Salmon. 79 p.
[2] Yakama Nation. 2012. Mid-Columbia Coho Restoration Program Master Plan. Prepared by Yakama Nation for the Northwest Power and Conservation Council. 201 p. plus Appendices.
[3] Bonneville Power Association. 2012. Mid-Columbia Coho Restoration Program. Final Environmental Impact Statement. March 2012. 367 p.

fish development rates without feed rationing. The growth rate descriptions in the HGMP's will need to be updated to reflect the new operating scenarios as they become formalized.

The mid-Columbia coho program run by YN incubates up to 1.3M eggs at Winthrop NFH and ships most of them as eyed eggs to out-of-basin hatcheries for hatching and early rearing. Approximately 250,000 coho are reared to smolt release size on station. YN transports 60,000 coho back to Winthrop NFH for acclimation in a back channel water way prior to release and would like to increase this number to 100,000 fish if possible. The 100,000 fish target for the back channel will be used for the alternatives analysis.

3.1.4 Mid-Columbia Coho Production Changes

The FWS has agreements in place with YN to support fish production for the mid-Columbia coho restoration effort at Leavenworth NFH and Winthrop NFH. It should be noted that the FEIS completed for the YN mid-Columbia coho program in 2012 (BPA 2012) indicates that production goals are to be ramped down significantly over the next 10 to 15 years, to approximately 400,000 in the Wenatchee River Basin and 350,000 in the Methow River Basin. Acclimation at, and releases from, Leavenworth NFH and Winthrop NFH are planned to be reduced to 35,000 and 122,500 smolts, respectively, at the end of five generations. These long term targets are shown in Table 2-6 and 2-7 of the FEIS and will be considered in the alternatives analysis.

3.2 Biological Criteria

The primary biological variables used in the preparation of the preliminary operations schedules presented below include water temperature, species specific condition factor, and standard FWS density and flow indices. The basis of the variable values used in the development of the operations schedules are explained below.

3.2.1 Water Temperature

Water temperature is a primary determining factor in the development and growth rate of fish. A combination of relatively constant temperature groundwater and seasonally variable temperature river water is used at each facility. In general, pathogen free groundwater is used for incubation and early rearing. During juvenile rearing, fish are gradually transitioned to surface water, and in most cases are on 100% river water for several months of acclimation prior to release.

The groundwater temperatures at all three hatcheries are surface water influenced and are typically in the 44 to 53° F range. As noted above, Entiat NFH and Winthrop NFH have recently incorporated mechanical chilling of groundwater to as low as 39° F during the incubation and early rearing stages to slow the rate of fish development to more closely mimic natural fish development cycles. According to hatchery managers, this thermal manipulation is working better than a previous strategy using feed rationing to control growth rates. Groundwater is used for adult holding at Winthrop NFH and is blended with surface water for adult holding at the other two facilities to maintain temperatures of 55° F or lower.

River water temperatures vary seasonally, from near freezing in the winter, to the high 50's and 60's in late summer at Leavenworth NFH and into the 70's at Entiat NFH and Winthrop NFH. This results in the need to temper surface water with groundwater during late summer and fall with a maximum target temperature of 55° F.

3.2.2 Fish Weight and Length

End of month fish weights and lengths are shown on the operating schedules for early and final rearing for each program. In general, the fish weights are taken from historical fish culture records, however in the case of newer programs (Winthrop Age 2 steelhead), historical records were not available, and approximations were based on known start dates, end dates and release size targets.

3.2.3 Density Indices (DI)

Density indices are expressed in terms of fish weight per cubic foot of rearing volume, per inch of fish length (Piper 1982). FWS and YN fish culturists have experimented with various fish densities for many years. They have found that lower densities result in higher quality fish with fewer disease problems and better survival rates. The density index targets for the purposes of this planning effort were provided by FWS and YN staff and range from 0.11 to 0.15 for spring and summer Chinook to 0.17 to 0.2 for coho and summer steelhead.

The minimum "end of month" rearing volume required for each program is shown in a row below the fish weight and length information. Fish are normally only split out or handled a couple times during the rearing process, so rearing volumes actually used are typically more than the minimum values shown unless there is a shortage of rearing space available.

3.2.4 Flow Indices (FI) and Water Exchange Rates

Flow indices (Piper 1982) take in to account site elevation, water temperature, and the dissolved oxygen carrying capacity of the water supply. The theoretical flow required in gallons per minute (gpm), is determined by dividing fish weight by the flow index times fish length. The flow index target for all programs has been set at 1.0 per FWS fish health staff. The calculated minimum "end of month" water supply flow required for each program is shown in a row below the density index. Actual flow rate recommendations consider the rearing vessel loading schedules and flows required for raceway hydraulics (solids removal) for each program.

FWS staff requested that a flow criterion of 2 water exchanges per hour be incorporated for disease management purposes such as flushing Ich protozoa at Leavenworth NFH. In general, this criterion would result in significantly higher supply flows than are presently available if it were applied to all rearing units at the same time. It is feasible to provide periodic 2 exchanges per hour flushing flows to individual banks of raceways for disease management. For best results the flushing would utilize groundwater or disinfected surface water.

3.3 Operating Schedules

Two year operating schedules have been prepared for each of the six Complex production programs as shown below. These preliminary operations schedules cover a two year period in order to illustrate any potentially overlapping water supply demand and infrastructure needed to support multiple brood years of fish on station at once. Understanding the operation schedules is critical since it drives the water requirements by month and determines space requirements for improvements to adult holding, incubation, early rearing, and juvenile rearing facilities for each fish production program. The operations schedules were developed based on detailed information provided by FWS management, fish health, and hatchery personnel.

The information presented represents a general operations plan particularly in regards to water use; however this is not typical water use. The quality and quantity of water resources available is impacted by environmental condition (flooding, freezing, mudslides, precipitation, etc.) or infrastructure which needs to be repaired, replaced or rehabilitated. Changes in water management occur regularly to provide the best rearing conditions for the fish on station given the available water resources.

The colored bars across the top section of each operations schedule shows the timing of adult holding, incubation, early (indoor) rearing, and juvenile (outdoor) rearing. Blue bars indicate the use of groundwater and green bars indicate the use of surface water, or blended surface water and groundwater. A light red bar is used to indicate the use of serial reuse water which occurs primarily at Leavenworth NFH and Entiat NFH. An overall summary of calculated groundwater and surface water flows along with rearing volume recommendations, extracted from the operation schedules, is provided below for all six production programs. This summary is particularly useful for understanding operations at Leavenworth NFH and Winthrop NFH where multiple production programs may create over-lapping flow demands.

3.3.1 Leavenworth NFH Fish Rearing Cycles

Tables 3-2 and 3-3 provide two-year operating schedules for the Leavenworth NFH spring Chinook and coho programs, with explanatory text below.

Adult Holding: The adult trap and holding ponds are operated for spring Chinook from May through September each year, with either first pass or second pass groundwater as the primary source. A flow rate of 2,000 gpm is the target flow rate for this facility. Five hundred pairs of selected adult fish are used for broodstock, and surplus fish (up to 10,000 per year) are harvested at the trap and distributed to tribes. The adult holding ponds are also used for the mid-Columbia coho program from September through November. To ensure fish health, Leavenworth NFH staff prefer to route first pass groundwater to the adult holding ponds when available. The water supply demand increases from 1000 gpm in April to 2000 gpm in June through August, then ramps down to 1200 gpm in September and 450 gpm in November as the coho spawning season concludes.

Incubation: Spring Chinook incubation begins as broodstock are spawned in August and September and runs through the end of December. A minimum of 25 double stacks of vertical tray incubators are used to accommodate the egg take target of 1.3M green eggs. 124 gpm of well water from the coldest wells is used with an average flow of 5 gpm per stack at an average temperature of 8 °C (46 °F). Coho incubation of up to 1.3M green eggs begins in October in 14 double stacks of vertical incubators. With an average flow of 4 gpm per stack, a total flow of 56 gpm is required. In mid-December, eyed eggs are shipped to Cascade and Willard hatcheries for hatching and rearing.

Early Rearing: Spring Chinook early rearing begins in December when fry are transferred from the vertical tray incubators into 89 cubic foot fiberglass troughs. The 122 existing troughs are loaded at 10,330 fry per trough (progeny from 3 females), where they are fed and held through February or early March to an approximate size of 200 fish per pound (fpp). The operations schedule indicates a calculated peak groundwater demand of 2,545 gpm at a flow index of 1.0. It also indicates that in February, the density index target of 0.15 would require 191 early rearing troughs vs the 122 troughs that are available. The calculated density index at the end of February is 0.23 lb/cf/in. vs. the 0.15 lb/cf/in target. In order to compensate for the high densities and rearing volume shortage, the hatchery is maximizing groundwater flows to the indoor rearing vessels to over 3,000 gpm during this period. Beginning in February, 10% surface water is blended in with the groundwater supply to acclimate fish to the outdoor rearing environment, which mostly utilizes surface water.

Coho early rearing occurs off-station at Willard and Cascade hatcheries.

Table 3-2; PRELIMINARY BIOPROGRAM AND APPROXIMATE HATCHERY OPERATION SCHEDULE
Leavenworth NFH Spring Chinook Supplementation Program - 1.2 M Smolts to 18 fpp

SURFACE WATER OR BLENDED
GROUND WATER

		Exceedances	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
SPRING CHINOOK PRODUCTION	1,200,000	at 18 fpp																										
Broodstock Holding																												
Egg Take: August 15 - September 30																												
Incubation: August 15 - Late December, Hatch at 1650-1750 TU's																												
Early Rearing in Troughs: Late December - Early March																												
Brood Year A - Juvenile Rearing in Ponds: March - Following April																												
Brood Year B - Juvenile Rearing in Ponds: March - Following April																												
BROODSTOCK HOLDING																												
Max Number of Fish	*1000*	*(500 pairs)*																										
Flow - Per HGMP	*2000*	*gpm (Not including 10k surplus fish)*	1200	1200								1000	2000	2000	2000	1200								1000	2000	2000	2000	1200
Holding Volume - Per HGMP	*8*	*Cu. Ft./Fish*	8000	8000								8000	8000	8000	8000	8000								8000	8000	8000	8000	8000
INCUBATION																												
Groundwater - Incubation and Early Rearing Water Temps- Degrees C			8	8	8	8	8								8	8	8	8	8									
Temp Units for Incubation			14.4	14.4	14.4	14.4	14.4								14.4	14.4	14.4	14.4	14.4								14.4	14.4
Cumulative TU's for Egg Development			216	648	1080	1512	1800								216	648	1080	1512	1800								216	648
# of eggs	1,323,000	*at 97% green egg to hatch*																										
Eggs per tray	3550	*Ave. from HGMP*																										
# of trays	373																											
# of stacks at	15	*trays/stack*	25	25	25	25	25								25	25	25	25	25								25	25
Total Flow (gpm)	5	*gpm/stack*	124	124	124	124	124								124	124	124	124	124								124	124
EARLY REARING - INDOORS	1260000	at 200 fpp																										
Fish Length (Inches) per HGMP		Inches - End of Month					1.30	2.10	2.4										1.30	2.10	2.4							
Fish Weight- per HGMP		Grams - End of Month					0.4	1.3	2.2										0.4	1.3	2.2							
Total Fish Weight		lbs.					1110	3608	6106										1110	3608	6106							
Start Tank Volume	89	cf. - 16' L x 3.25 W' x 2.75' d																										
Start Tank Loading - per staff	10,330	Fry (3 Females/Tank)					Year A												Year B									
Fish Weight per Start Tank		lbs					9	30	50										9	30	50							
Volume Req'd at Density Index	0.15	lb./cu.ft. x in.					5,693	11,454	16,960										5,693	11,454	16,960							
Density Index per Loading Schedule		lb./cu.ft./in.					0.08	0.16	0.23										0.08	0.16	0.23							
GPM of Flow Req'd at FI=	1.0	lb/(gpm*L)					854	1718	2545										854	1718	2545							
Start Tanks required at	89	*Cu. Ft./Tank*					64	129	191										64	129	191							
JUVENILE REARING - OUTDOORS	1,200,000	at 18 fpp																										
Size at transfer in	0.23	*gr*																										
Size at transfer out	25.30	*gr.*								Year A		Mark Fish @ 100 fpp												Year B	Mark Fish @ 100 fpp			
Fish Length (Inches) per HGMP		Inches - End of Month								2.8	2.9	3.04	3.63	4.2	4.5	4.7	4.8	4.83	4.83	4.87	4.9	5.01	5.19	3.04	3.63	4.2	4.5	4.7
Fish Weight- per HGMP (grams)		Grams - End of Month								3.6	4.3	5.1	8.7	13.3	16.0	18.8	19.9	20.4	20.5	20.8	21.2	22.6	25.3	5.1	8.7	13.3	16.0	18.8
Total Fish Weight		lbs.								9515.42	11,366	13,480	22,996	35,154	42,291	49,692	52,599	53,921	54,185	54,978	56,035	59,736	66,872	13,480	22,996	35,154	42,291	49,692
Volume Req'd at Density Index	0.15	lb./cu.ft./in.								23067.7	26,128	29,562	42,232	55,800	63,215	70,335	73,054	74,425	74,790	75,261	76,238	79,489	85,899	29,562	42,232	55,800	63,215	70,335
GPM of Flow Req'd at FI=	1.0	lb/(gpm*L)								3460	3,919	4,434	6,335	8,370	9,482	10,550	10,958	11,164	11,218	11,289	11,436	11,923	12,885	4,434	6,335	8,370	9,482	10,550
Flow Req'd at 30 min Turnover		gpm								5752	6,515	7,371	10,530	13,913	15,762	17,537	18,215	18,557	18,648	18,765	19,009	19,819	21,417	7,371	10,530	13,913	15,762	17,537
Overlapping Volume from Broodyear B		cf																				23,068	26,128					
Overlapping Flow From Broodyear B		*gpm*																				3460	3,919					
Groundwater Flow for Tempering and De-icing		*gpm*											1000	2000	2000	2000	2000	2000	2000	2000	3000			1000	2000	2000	2000	2000
Early Rearing Ground Water Ratio	per HGMP		1	1	1	1	1	1	0.9	0.9	0.4	0.4			1	1	1	1	1	1	0.9	0.9	0.4	0.4				
Early Rearing Surface Water Ratio	per HGMP								0.1	0.1	0.6	0.6	1	1							0.1	0.1	0.6	0.6				
TOTAL FLOW - Ground Water - (gpm)			124	124	124	124	978	1718	2290	3114	1568	2774	3000	4000	4124	3324	2124	2124	2978	3718	5290	3114	1568	2774	3000	4000	4124	3324
TOTAL FLOW - Surface Water - Ambient(gpm)			1200	1200					254	346	2352	2661	6335	8370	9482	11750	10958	11164	11218	11289	11436	13999	16804	2661	6335	8370	9482	11750
TOTAL FLOW - (gpm)			1324	1324	124	124	978	1718	2545	3460	3919	5434	9335	12370	13606	15074	13082	13288	14197	15008	16726	17114	18372	5434	9335	12370	13606	15074
TOTAL FLOW - Ground Water - (cfs)			0.3	0.3	0.3	0.3	2.2	3.8	5.1	6.9	3.5	6.2	6.7	8.9	9.2	7.4	4.7	4.7	6.6	8.3	11.8	6.9	3.5	6.2	6.7	8.9	9.2	7.4
TOTAL FLOW - Surface Water - Ambient(cfs)			2.7	2.7	0.0	0.0	0.0	0.0	0.6	0.8	5.2	5.9	14.1	18.6	21.1	26.2	24.4	24.9	25.0	25.1	25.5	31.2	37.4	5.9	14.1	18.6	21.1	26.2
TOTAL FLOW -(cfs) - Spring Chinook			2.9	2.9	0.3	0.3	2.2	3.8	5.7	7.7	8.7	12.1	20.8	27.6	30.3	33.6	29.1	29.6	31.6	33.4	37.3	38.1	40.9	12.1	20.8	27.6	30.3	33.6

Table 3-3; PRELIMINARY BIOPROGRAM AND APPROXIMATE HATCHERY OPERATION SCHEDULE
Leavenworth NFH - Yakama Nation Mid Columbia Coho Program - 600,000 Fish at 16 fpp

	SURFACE WATER
	GROUND WATER
	OFF STATION REARING
	REUSE

			AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
COHO ACCLIMATION	300,000	at 16 fpp																										
COHO PRODUCTION	300,000	at 16 fpp																										
Broodstock Holding																												
Egg Take: Oct. 15 - Nov. 30																												
Incubation: Oct. 15 - Jan. 15																												
Juvenile Overwintering Acclimation - December-April																												
Juvenile Short Term Acclimation in Ponds: Start Feb. -Out plant by End of April																												
ADULT HOLDING																												
Max Number of Fish	440	*(220 pairs)*																										
Flow - Per Staff	450	*gpm at 1 gpm/fish*		450	450	450										450	450	450										450
Holding Volume - Per HGMP	8	*Cu. Ft./Fish*		3520	3520	3520										3520	3520	3520										
INCUBATION																												
Blended Water - Rearing Average Temps- Degrees C per HGMP				11.1	7.1	3.3	1.7	1.2	1.7	6.9	7.2	7.2	9.2	13.3		11.1	7.1	3.3	1.7	1.2	1.7	3.4	5.3	10	10	10		10
Incubation Chilling Required	Tons																											
# of eggs	1,300,000	*at 97% green egg to hatch*																										
Eggs per tray	6300	*Ave. from HGMP*																										
# of trays	206				Year A												Year B											
# of stacks at	15	*trays/stack*			14	14	14										14	14	14									
Total Flow (gpm)	4	*gpm/stack*			55	55	55										55	55	55									
JUVENILE REARING - OUTDOORS	300,000	at 16 fpp																										
Size at transfer in	2.2	*gr*																										
Size at transfer out	25.30	*gr.*							Year A - Off station Rearing										Year A - Overwinter Acclimation									
Year A Fish Length (Inches) per HGMP		Inches - End of Month							1.33	1.6	2.2	2.65	2.9	3.5	4.0	4.4	4.7	4.9	5.2	5.3	5.38	5.45	5.61					
Fish Weight- per HGMP (grams)		Grams - End of Month							0.38	0.68	1.75	2.9	4.3	6.8	10.4	13.5	16.8	19.7	22.6	23.7	24.7	26	28.3					
Total Fish Weight		lbs.							251.101	449.339	1,156	1,916	2,841	4,493	6,872	8,921	11,101	13,018	14,934	15,661	16,322	17,181	18,700					
Volume Req'd at Density Index	0.17	lb./cu.ft./in.							1110.58	1651.98	3,092	4,254	5,764	7,552	10,106	11,926	13,894	15,627	16,894	17,382	17,846	18,544	19,608					
GPM of Flow Req'd at FI=	1.0	lb/(gpm*L)							188.798	280.837	526	723	980	1,284	1,718	2,027	2,362	2,657	2,872	2,955	3,034	3,152	3,333					
GPM Actual	TBD																											
			Year B		Year B - Overwinter Acclimation																Year B - Offstation Rearing							
Year B Fish Length (Inches) per HGMP		Inches - End of Month	4	4.4	4.7	4.9	5.2	5.3	5.38	5.45	5.61										1.33	1.6	2	2.65	2.9	3.5	4.0	4.4
Fish Weight- per HGMP (grams)		Grams - End of Month	10.4	13.5	16.8	19.7	22.6	23.7	24.7	26	28.3										0.38	0.68	2	2.9	4.3	6.8	$10	13.5
Total Fish Weight		lbs.	6,872	8,921	11,101	13,018	14,934	15,661	16,322	17,181	18,700										251	449	1,156	1,916	2,841	4,493	6,872	8,921
Volume Req'd at Density Index	0.17	lb./cu.ft./in.	10,106	11,926	13,894	15,627	16,894	17,382	17,846	18,544	19,608										1,111	1,652	3,092	4,254	5,764	7,552	10,106	11,926
GPM of Flow Req'd at FI=	1.0	lb/(FI*L)	1,718	2,027	2,362	2,657	2,872	2,955	3,034	3,152	3,333										189	281	526	723	980	1,284	1,718	2,027
GPM Actual	TBD																											
JUVENILE ACCLIMATION - OUTDOORS	300,000	at 16 fpp																										
Size at transfer in	24	*gr*																										
Size at transfer out	28.3	*gr.*							Year A - Short Term Acclimation												Year B - Short Term Acclimation							
Fish Length (Inches) per HGMP		Inches - End of Month							5.38	5.45	5.61										5.38	5.45	5.61					
Fish Weight- per HGMP (grams)		Grams - End of Month							24.7	26	28.3										24.7	26	28.3					
Total Fish Weight		lbs.							16,322	17,181	18,700										16321.6	17180.617	18,700					
Volume Req'd at Density Index	0.17	lb./cu.ft./in.							17,846	18,544	19,608										17845.6	18543.569	19,608					
GPM of Flow Req'd at FI=	1.0	lb/(gpm*L)							3,034	3,152	3,333										3034	3152	3,333					
GPM Actual	TBD																											
TOTAL FLOW - First Pass Ground Water - (gpm)			0	450	505	505	55	0	0	0	0	0	0	0	0	450	505	505	55	0	0	0	0	0	0	0	0	450
TOTAL FLOW - Second or Third Pass water(gpm)			1718	2027	2362	2657	2872	2955	6068	6305	6667	0	0	0	0	0	0	0	2872	2955	6068	6305	6667	0	0	0	0	0
TOTAL FLOW - First Pass Ground Water - (cfs)			0	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1
TOTAL FLOW - Second or Third Pass water(cfs)			3.8	4.5	5.3	5.9	6.4	6.6	13.5	14.0	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	6.6	13.5	14.0	14.8	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW -(cfs)			3.8	4.5	5.3	5.9	6.4	6.6	13.5	14.0	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	6.6	13.5	14.0	14.8	0.0	0.0	0.0	0.0	0.0

Juvenile Rearing: Spring Chinook are moved to outdoor rearing ponds when temperatures allow in late February or early March. These fish are initially loaded into 30 of the 8 x 80 ft raceways (upper two banks). At this time, juveniles from the previous brood year are moved into the 10 x 100 ft raceways, lower bank of 8 x 80 ft raceways, and the adult holding ponds. In May, after the previous brood year is released in April, the fish are marked (at 100 fpp) and are distributed between all 10 x 100s and the lower two banks of 8 x 80s. Fish in the middle bank of 8 x 80s are moved to the adult ponds sometime after late November. All fish from that brood year are released in late April. Based on this raceway loading schedule, water demand for each brood year begins at approximately 8 cfs and increases to 29 cfs at release. The concurrent demand from the subsequent brood year results in a total recommended flow of 41 cfs, using water from both groundwater and surface water sources.

Juvenile coho are transferred back to Leavenworth NFH in two groups of 300,000 fish for final rearing/acclimation. One group, the overwinter acclimated fish, are transferred back in December. A second group, short term acclimated fish are brought back in February. Two large Foster Lucas ponds are loaded at 100,000 fish per pond and supplied with 225 to 300 gpm per pond of reuse water from the submersible pump at the end of the 10 x 100 raceways. The remainder of the fish are loaded into 12 of the small Foster Lucas ponds at 35,000 fish per pond and supplied with 90 to 110 gpm of reuse water fed from the adult pond pumpstation. Flow indices presently range from 3.7 to 4.3 (G. Wolfe pers. comm.), which is far above the target of 1.0 lb/cf/in.

3.3.2 Leavenworth NFH Operating Summary

Table 3-4 provides a water supply and rearing volume summary for the Leavenworth NFH spring Chinook and mid-Columbia coho programs. It illustrates the amount of first pass flow and rearing volumes that would be recommended for production that meet the flow and density index criteria described in Section 3.2 above. Figure 3-1 further illustrates water rights, demand and usage.

Groundwater Supply: Calculated groundwater demand (based on flow index) at Leavenworth NFH varies from less than 1 cfs in October-November to the 6 to 7 cfs range in April and June. Groundwater in addition to the calculated amounts is needed for fish health and operational flexibility to provide:

- Increased supply to indoor juvenile rearing troughs when the target density index is exceeded.
- Flow to outdoor raceways in the winter for de-icing and to allow higher growth/feed rates during the unrestricted discharge period.
- Flexibility to route higher flow rates to rearing units to provide better flushing of pathogens during disease outbreaks.
- Flexibility to provide first pass water to the mid-Columbia coho program
- Pathogen free supply to rearing vessels when there are adult fish spawning above the intake.
- Redundant flow capacity if a well is off-line for maintenance.

The Leavenworth NFH would use the full available water right of 14.9 cfs to operate the hatchery at times if the wellfield could produce it. Production records for 2010-2012 indicate the existing wells provide highly variable flows from 0.75 to 7 cfs of groundwater which is significantly less than calculated demands and the available water right.

Surface Water Supply: Calculated surface water demands at Leavenworth NFH range from 6 cfs in May to 52 cfs in April just prior to smolt releases. The available surface water right of 42 cfs is adequate except for the late March-early April period, when there is a deficit of 3 to 14 cfs. This deficit is presently

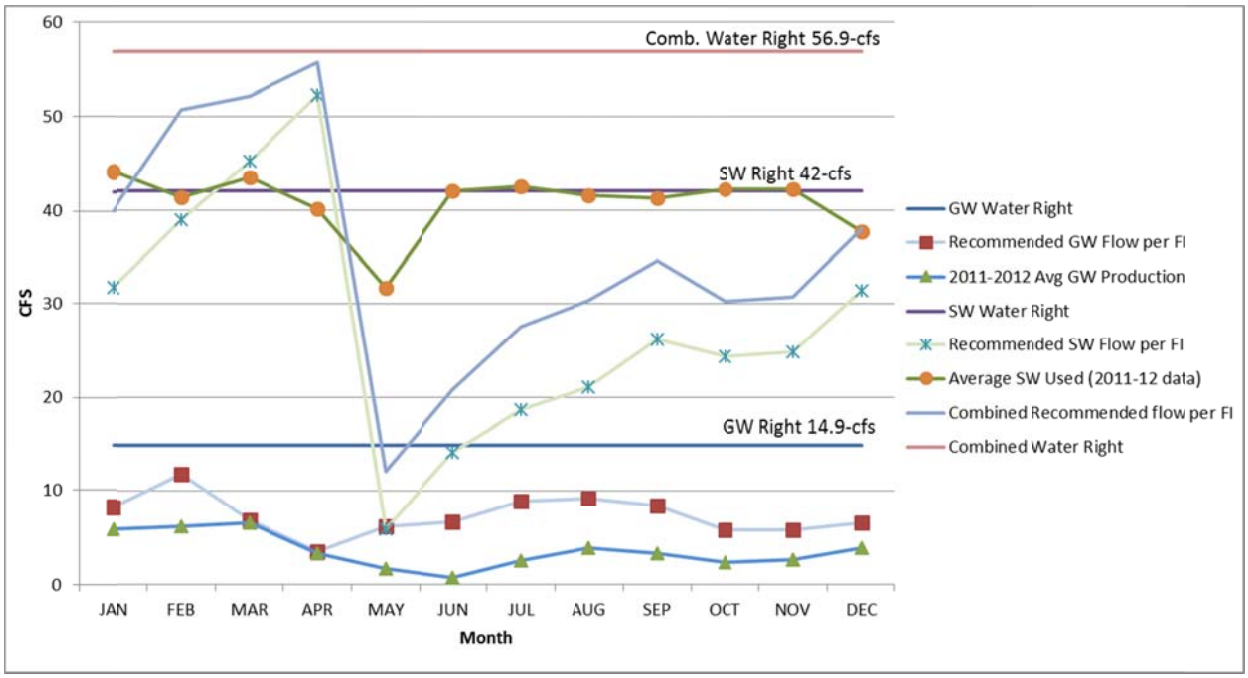
overcome by routing second or third pass water from Chinook rearing to the coho rearing units and blending in groundwater when available. If the YN coho program is reduced to 35,000 smolts (per YN Master Plan), from the present 600,000 smolt target, the calculated surface water deficit is eliminated. The reuse of untreated surface water causes disease problems particularly in the later summer when there are spawing or dead adult fish above the intake.

Early Rearing Volume: The calculated early rearing volume requirement for spring Chinook is nearly 17,000 cf in February. This results in a deficit of over 6,000 cf which would require an additional 69 indoor rearing troughs. As noted above, this deficit is presently addressed by going to a higher density index and lower flow index for a short period of time before the fish are transferred outdoors. There is no early rearing of coho at Leavenworth NFH. All coho early rearing occurs off-station at Willard and Cascade hatcheries.

Table 3-4. Leavenworth NFH Water Supply and Rearing Volume Summary

End of Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
GW Flow Summary (cfs)												
Water Right	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9
FI + Tempering for Sp. Chinook	8.28	11.78	6.94	3.49	6.18	6.68	8.91	9.19	7.40	4.73	4.73	6.63
FI + Tempering for Coho	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.12	1.12	0.00
Total GW Flow for FI + Temp.	8.28	11.78	6.94	3.49	6.18	6.68	8.91	9.19	8.41	5.86	5.86	6.63
2011-2012 Ave. GW Production	5.9	6.2	6.6	3.3	1.7	0.75	2.6	3.9	3.3	2.4	2.7	3.9
SW Flow Summary (cfs)												
Water Right	42	42	42	42	42	42	42	42	42	42	42	42
FI for Sp. Chinook	25.14	25.47	31.18	37.43	5.93	14.11	18.64	21.12	26.17	24.41	24.86	24.99
FI for Coho	6.58	13.51	14.04	14.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.40
Total SW Flow Per FI	31.72	38.98	45.22	52.27	5.93	14.11	18.64	21.12	26.17	24.41	24.86	31.38
2011-2012 Ave. SW Production	33.4	36.7	37.3	38	20.3	28.9	35.4	35.5	29.8	38.8	38	38.9
Early Rearing Volume (cf)												
Min. Recommended per DI	11,454	16,960	0	0	0	0	0	0	0	0	0	5,693
Available	10860	10860	10860	10860	10860	10860	10860	10860	10860	10860	10860	10860
Difference	(594)	(6,100)	10,860	10,860	10,860	10,860	10,860	10,860	10,860	10,860	10,860	5,167
Juvenile Rearing Volume (cf)												
For Sp. Chinook DI	75,261	76,238	102,556	112,027	29,562	42,232	55,800	63,215	70,335	73,054	74,425	74,790
For Coho DI	17,382	35,691	37,087	39,217	0	0	0	0	0	0	0	16,894
Total Volume Recommended per DI	92,642	111,930	139,643	151,243	29,562	42,232	55,800	63,215	70,335	73,054	74,425	91,683
Available	122600	122600	122600	122600	122600	122600	122600	122600	122600	122600	122600	122600
Difference	29,958	10,670	(17,043)	(28,643)	93,038	80,368	66,800	59,385	52,265	49,546	48,175	30,917

Figure 3-1. Leavenworth NFH Water Summary



Juvenile Rearing Volume: Based on the volumes of the (45) 8 x 80 ft raceways and (14) 10 x 100 ft raceways, Leavenworth NFH has 122,600 cf of rearing volume available. The deteriorated Foster-Lucas ponds presently used for coho rearing are not counted towards the total since they are obsolete and have no effective service life remaining. The calculated rearing volume required for the two programs peaks in March and April with deficits of 17,000 and 28,600 cf respectively. These deficits are presently mitigated by using the adult holding ponds temporarily for spring Chinook rearing and the aforementioned Foster-Lucas ponds for coho. The remainder of the year, there is adequate rearing volume. The existing raceways have supply channels that do not allow for control of water source or temperature in individual raceways. Any new rearing units should have separate groundwater and surface water supply valves to each unit in order to provide greater efficiency and flexible operations.

3.3.3 Entiat NFH Fish Rearing Cycles

Table 3-5 provides a two year operating schedule for the summer Chinook program at Entiat NFH.

Adult Holding: The adult holding ponds and fish ladder are operated for summer Chinook from July through October each year, with a broodstock collection goal of 350 fish. Adult holding pond #2 is supplied with 2nd pass water from A-bank from 1 July to 20 July (fish are counted, weighed and tagged and spread to all banks), and supplied with 4th pass water that has cycled through A-, B-, and C-banks from 20 July to 30 October. This water combines with the surface water from holding pond #1 and descends the fish ladder as well. 150 pairs of selected fish are used for broodstock.

Incubation: Summer Chinook incubation begins as broodstock are spawned in October and runs through the following May. A minimum of 10 double stacks of vertical tray incubators are required (18 double

stacks are available), to accommodate the egg take target of 630,000 green eggs. Well water is chilled by 7 to 9° F to 41° F with an average flow of 5 gpm per stack.

Table 3-5; PRELIMINARY BIOPROGRAM AND APPROXIMATE HATCHERY OPERATION SCHEDULE
Entiat NFH Summer Chinook Mitigation Program - 400,000 Smolts

SURFACE WATER and BLENDED
GROUND WATER
REUSE

			AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
SUMMER CHINOOK PRODUCTION	400,000	at 18 fpp																										
Broodstock Holding																												
Egg Take: October																												
Incubation: October - Pond at 1800 TU's																												
Early Rearing in Six Raceways: May - Late July																												
Juvenile Rearing in Ponds: Start Late July -Out plant by Mid- April																												
BROODSTOCK HOLDING																												
Max Number of Fish	350	*(150 pairs)*																										
Trap/Ladder Flow - Per Staff	3200	*gpm per Staff*	3200	3200	3200										3200	3200	3200										3200	3200
Broodstock Holding Flow - GW (Reuse)	1200	*gpm - per Staff*	1200	1200	1200										1200	1200	1200										1200	1200
Holding Volume - Per HGMP	8	*Cu. Ft./Fish*	2800	2800	2800										2800	2800	2800										2800	2800
INCUBATION																												
# of eggs	630,000	*per HGMP*																										
Eggs per tray	3800	*Ave. per Staff*																										
# of trays	166																											
# of stacks at	15	*trays/stack*			11	11	11	11	11	11	11	11					11	11	11	11	11	11	11	11				
Total Flow (gpm)	5	*gpm/stack*			55	55	55	55	55	55	55	55					55	55	55	55	55	55	55	55				
EARLY REARING - OUTDOORS in Six Raceways	433,000	at 140 fpp																										
Fish Length (Inches) per 2013 Records		Inches - End of Month										1.56	2.16	2.77										1.56	2.16	2.77		
Fish Weight		Grams - End of Month										0.56	1.5	3.15										0.56	1.5	3.15		
Total Fish Weight		lbs.										534	1431	3004										534	1431	3004		
Volume Req'd at Density Index	0.11	lb./cu.ft./in.										3112	6021	9860										3112	6021	9860		
GPM of Flow at FI=	1.0	lb/(gpm*L)										342	662	1085										342	662	1085		
Raceways Req'd Per DI	1480	cf ea. (8' x 74.5' x 2.5'd)										2	4	7										2	4	7		
Raceway Loading		# Raceways										6	6	6										6	6	6		
GPM Flow Per 2013-2014 Data for Hydraulics												1728	2100	2100										1728	2100	2100		
JUVENILE REARING - OUTDOORS	400,000	at 20 fpp (target is 15 fpp)																										
Size at transfer in	2.5	*gr*																										
Size at transfer out	26.30	*gr.*	Mark @ 100 fpp			Split to 30 Raceways									Mark @ 100 fpp			Split to 30 Raceways										
Fish Length (Inches) per 2011-2013 Records		Inches - End of Month	3.57	3.90	4.40	4.60	4.63	4.70	4.80	4.94	5.10				3.57	3.90	4.40	4.60	4.63	4.70	4.80	4.94	5.10				3.57	3.90
Fish Weight- per Piper (grams)		Grams - End of Month	6.8	8.1	11.5	13.3	13.5	14.1	15.1	19	22				6.8	8.1	11.5	13.3	13.5	14.1	15.1	19	22				6.8	8.1
Total Fish Weight		lbs.	5,991	7,137	10,132	11,718	11,894	12,423	13,304	16,740	19,383				5,991	7,137	10,132	11,718	11,894	12,423	13,304	16,740	19,383				5,991	7,137
Volume Req'd at Density Index	0.11	lb./cu.ft./in.	15,256	16,635	20,934	23,158	23,354	24,029	25,197	30,806	34,551				15,256	16,635	20,934	23,158	23,354	24,029	25,197	30,806	34,551				15,256	16,635
GPM of Flow at FI=	1.0	lb/(gpm*L)	1,678	1,830	2,303	2,547	2,569	2,643	2,772	3,389	3,801				1,678	1,830	2,303	2,547	2,569	2,643	2,772	3,389	3,801				1,678	1,830
Raceways Req'd Per DI	1480	cf ea. (8' x 74.5' x 2.5'd)	10	11	14	16	16	16	17	21	23				10	11	14	16	16	16	17	21	23				10	11
Raceway Loading (Per Staff)		*# Raceways*	18	18	18	30	30	30	30	30	30				18	18	18	30	30	30	30	30	30				18	18
GPM Flow for Raceway Hydraulics	45	Minute Turnover	2546	2776	3494	3865	3898	4010	4205	5141	5766				2546	2776	3494	3865	3898	4010	4205	5141	5766				2546	2776
GW Flow for Fish Health and De-icing		gpm				500	2000	2000	2000	2000	2000							500	2000	2000	2000	2000	2000					
TOTAL FLOW for DI + Tempering- Ground Water - (gpm)			*Per FI*	1,678	1,830	2,303	2200	2055	2055	2055	2055	2055	1,783	2,100	2,100	1,678	1,830	2,303	2200	2055	2055	2055	2055	2055	1783	2100	2100	1678	1830
TOTAL FLOW - Surface Water - Ambient(gpm)			*Per FI*	3200	3200	3200	2,547	2,569	2,643	2,772	3,389	3,801				3,200	3,200	3,200	2,547	2,569	2,643	2,772	3,389	3,801				3200	3200
TOTAL Make-up FLOW - Ground Water - (gpm)		1700	gpm available	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
TOTAL Make-Up FLOW - Surface Water - Ambient(gpm)			Per Hydraulics	3200	3200	3200	3865	3898	4010	4205	5141	5766	0	0	0	3200	3200	3200	3865	3898	4010	4205	5141	5766	0	0	0	3200	3200
TOTAL FLOW - Ground Water - (cfs)			Per Hydraulics	5.7	6.2	7.8	4.9	4.6	4.6	4.6	4.6	4.6	4.0	4.7	4.7	5.7	6.2	7.8	4.9	4.6	4.6	4.6	4.6	4.6	4.0	4.7	4.7	5.7	6.2
TOTAL FLOW - Surface Water - Ambient(cfs)			Per Hydraulics	7.1	7.1	7.1	8.6	8.7	8.9	9.4	11.5	12.8	0.0	0.0	0.0	7.1	7.1	7.1	8.6	8.7	8.9	9.4	11.5	12.8	0.0	0.0	0.0	7.1	7.1
TOTAL FLOW -(cfs)				12.8	13.3	14.9	13.5	13.3	13.5	13.9	16.0	17.4	4.0	4.7	4.7	12.8	13.3	14.9	13.5	13.3	13.5	13.9	16.0	17.4	4.0	4.7	4.7	12.8	13.3

Notes:
Use of Ground water presently limited to 2020 gpm max, 1700 gpm normal. A new GW collector is planned for 2015.
Use of Surface water limited by m. cerebralis April-June, NOAA restriction in Sept./Oct. and icing in winter
Increase GW to be used temporarily for de-icing intake Dec.-Feb.
Serial reuse flows not accounted for in flow totals

Early Rearing: Summer Chinook early rearing begins in May when fry are transferred from the vertical tray incubators into six of the upper bank 8 x 80 ft outdoor raceways. The six raceways are loaded at 60,000 to 68,000 fry per raceway.

Juvenile Rearing: In August, when the fish reach an average size of 100 fpp, they are marked and split out into 12 additional 8 x 80 ft raceways, (six each in the middle and lower banks). In November, the fish reach an average size of 35 fpp and are split a final time into all 30 of the 8 x 80 ft raceways. Typical supply flows to the raceways are 250 to 330 gpm per hatchery data. Smolts are released utilizing a fish pump, directly to the Entiat River the following April at a target size of 18 fpp.

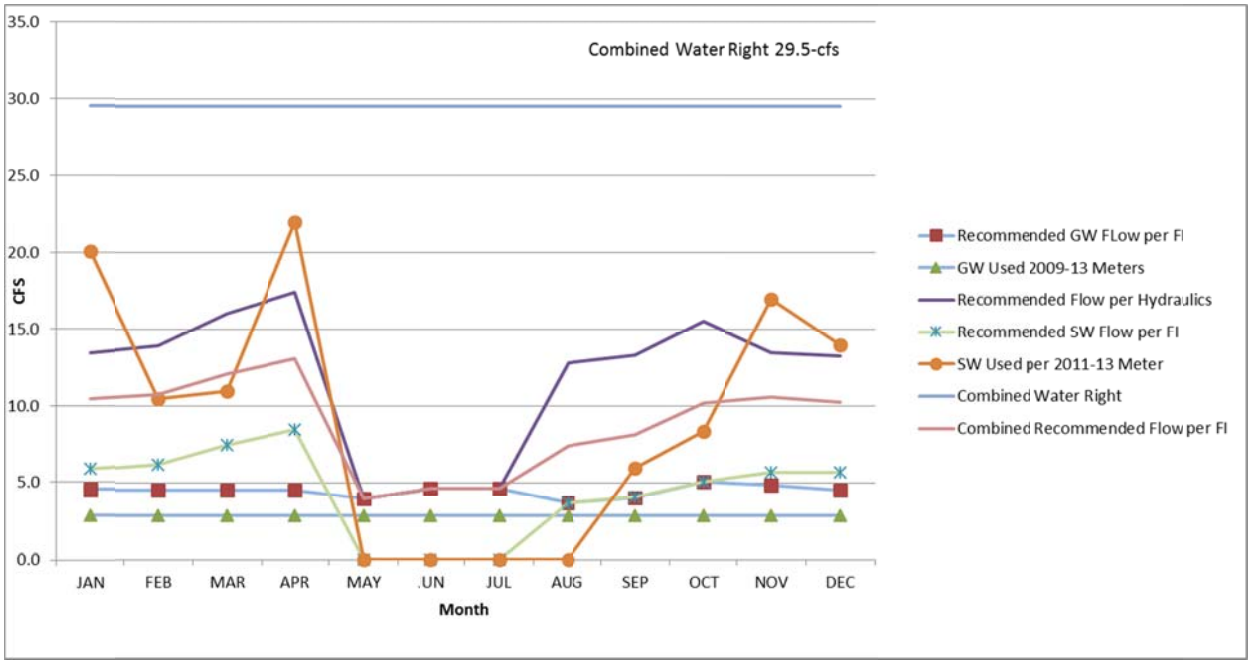
3.3.4 Entiat NFH Operating Summary

Table 3-6 provides a water supply and rearing volume summary for the Entiat NFH summer Chinook program that meet the rearing criteria described in Section 3.2 above. Figure 3-2 further illustrates water rights and usage.

Table 3-6. Entiat NFH Water Supply and Rearing Volume Summary

End of Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Combined Water Right	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
GW Flow Summary (cfs)												
FI + Tempering for Sum. Chinook	4.6	4.6	4.6	4.6	4.0	4.7	4.7	3.7	4.1	5.1	4.9	4.6
Flow For Raceway Hydraulics	4.6	4.6	4.6	4.6	4.0	4.7	4.7	5.7	6.2	7.8	4.9	4.6
Ave. GW Production 2014	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
SW Flow Summary (cfs)												
Min. SW Recommended per FI	5.9	6.2	7.5	8.5	0.0	0.0	0.0	7.1	7.1	7.1	5.7	5.7
SW + GW per FI and Tempering	10.5	10.8	12.1	13.0	4.0	4.7	4.7	10.9	11.2	12.3	10.6	10.3
ENFH Target for Raceway Hyd.	8.9	9.4	11.5	12.8	0.0	0.0	0.0	7.1	7.1	7.8	8.6	8.7
SW + GW Flow For Raceway Hydraulics	13.5	13.9	16.0	17.4	4.0	4.7	4.7	12.8	13.3	15.6	13.5	13.3
Ave. SW Used per 2011-14 Meter	20.1	10.5	11	22	0	0	0	0	6	8.4	17	14
Early Rearing Volume (cf)												
Min. Recommended per DI	0	0	0	0	3,112	6,021	9,860	0	0	0	0	0
Used per Loading Schd					8,880	8,880	8,880					
Available					44,400	44,400	44,400					
Difference	0	0	0	0	41,288	38,379	34,540	0	0	0	0	0
Junvenile Rearing Volume (cf)												
Min. Recommended per DI	24,029	25,197	30,806	34,551	0	0	0	15,256	16,635	0	0	0
Used per Loading Schd	44,400	44,400	44,400	44,400	0	0	0	26,640	26,640	26,640	44,400	44,400
Available	44,400	44,400	44,400	44,400	0	0	0	44,400	44,400	44,400	44,400	44,400
Difference	20,371	19,203	13,594	9,849	0	0	0	29,144	27,765	44,400	44,400	44,400

Figure 3-2. Entiat NFH Water Summary



Groundwater Supply: The wells at Entiat NFH produce approximately 2.9 cfs of groundwater year-round. Calculated groundwater demand (based on flow index) at Entiat NFH varies from 3.7 to 5.1 cfs during the May-October period (when surface water is not used for fish production due to the myxobolid pathogen). However, based on raceway hydraulics to provide a 30 minute turnover, the peak demand is 7.8 cfs in October of each year. Table 3-6 indicates a shortage of groundwater of 1 to 2.2 cfs based on flow index and 1.8 to 4.9 cfs based on raceway hydraulics. Significant amounts of groundwater are needed for fish growth, de-icing the intake trash rack, pipeline and screening structure during extended periods of freezing weather and to provided redundancy in case a well is offline for maintenance. All available groundwater is used November-April for outdoor rearing to provide better fish growth rates and as an emergency source when surface water is unavailable due to low flows or is unusable due to high turbidity from landslides (as occurred in 2011).

Surface Water Supply: The surface water supply from the Entiat River is not used for rearing from mid-April through October due to pathogen concerns. However, it is used for adult holding and fish ladder flows August-October. Limekiln Spring is producing only 1 to 2 cfs of its 7.5 cfs water right. Due to water quality problems FWS is trying to repurpose the spring to supply 1 to 2 cfs for the public fishing pond only. Calculated surface water demands based on raceway hydraulics (for 23 raceways), at Entiat NFH range from 7.8 cfs in November to 12.8 cfs in April just prior to smolt releases. Presently, the full combined surface water and groundwater right of 22.5 cfs is utilized when available in the winter and spring to provide better raceway hydraulics (to all 30 raceways), and to reduce the effects of known pathogens in the supply. There are shortages of surface water for outdoor rearing during low river flow periods in the winter during extended freezing periods, and in August-October for running the fish ladder.

Early Rearing Volume: There is no indoor early rearing at Entiat NFH. The fish are started in six of the 8 x 80 ft outdoor raceways and are split into additional raceways to generally comply with the density index target.

Juvenile Rearing Volume: The (30) 8 x 80 ft raceways provide a total rearing volume of 44,400 cf. The calculated minimum recommended volume per density index at peak loading in April is 34,550 cf, which equates to 23 raceways needed, or a surplus of 7 raceways. Since all 30 raceways are typically used for final rearing, the density indices are presently well below the 0.11 lb/cf/in target.

3.3.5 Winthrop NFH Fish Rearing Cycles

Tables 3-7, 3-8 and 3-9 provide two year operating schedules for spring Chinook, summer steelhead and coho production at Winthrop NFH.

Adult Holding: Adult holding ponds are operated for summer steelhead (60 pairs) from March through May, spring Chinook (190 pairs), from May through September, and mid-Columbia coho (220 pairs) from September through October each year, with first pass groundwater as the primary source for all species. Supply flows vary depending on the number and size of fish being held. At the time of the site visit in June, 1,365 gpm of groundwater from Gallery #2 was being routed to the holding ponds for spring Chinook. Later in the year, flows drop to 450 gpm for coho holding.

Incubation: Spring Chinook incubation begins as broodstock are spawned in August and September and runs through February. A minimum of 12 double stacks of vertical tray incubators are used to accommodate the egg take target of 660,000 eggs. Chilled groundwater is supplied with an average flow of 5 gpm per stack at temperatures as low as 39 ^{o}F.

Summer steelhead incubation begins in April and May and runs through August. A minimum of 3 double stacks of vertical incubators are required for the egg take target of 220,000 eggs. The same chilled groundwater is used at a flow rate of 4 gpm per stack.

Coho incubation begins in October and runs through the following April. A minimum of 22 double stack vertical incubators is required for the egg take target of 1.3M eggs. Over 1.0M of these eggs are shipped out as green eggs to other hatcheries (Willard or Cascade) for hatching and rearing.

Early Rearing: Spring Chinook early rearing begins in February when 433,000 fry are transferred from the vertical tray incubators into 36 fiberglass troughs, 89 cubic feet each. Each trough is supplied with 20 gpm of groundwater for a total demand of 720 gpm. The calculated early rearing flow requirement is 440 gpm. These fish are fed and held through April to an approximate size of 200 fpp, when they are moved outdoors into the “A Bank” of Foster-Lucas ponds. Early rearing continues until the fish reach a size of approximately 100 fpp, when they are marked and transferred into 8 x 80 ft raceways in August. The calculated “A bank” volume requirement is 12,000 cf with a peak flow of 1,700 gpm.

Table 3-7; PRELIMINARY BIOPROGRAM AND APPROXIMATE HATCHERY OPERATION SCHEDULE
Winthrop NFH Spring Chinook Mitigation Program - 400,000 Smolts, 200,000 Eggs to CJH

SURFACE WATER
GROUND WATER

			AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
	200,000	eggs to CJH																										
SPRING CHINOOK PRODUCTION	400,000	at 15 fpp																										
Broodstock Holding																												
Egg Take: August 15 - September 30																												
Incubation: August 15 - Feb, Hatch at 1650-1750 TU's																												
Early Rearing in Troughs: March/April then in Foster Lucas till July																												
Juvenile Rearing in 30 Raceways: Xfr July/Aug. -Out plant by End of April																												
BROODSTOCK HOLDING																												
Max Number of Fish	*380*	*(190 pairs)*																										
Flow - Per HGMP	*400*	*gpm*	400	400								400	400	400	400	400								400	400	400	400	400
Holding Volume - Per HGMP	*8*	*Cu. Ft./Fish*	3040	3040								3040	3040	3040	3040	3040								3040	3040	3040	3040	3040
INCUBATION																												
# of eggs	660,000	*per HGMP*																										
Eggs per tray	3550	*Ave. from HGMP*																										
# of trays	186																											
# of stacks at	15	*trays/stack*	12	12	12	12	12	12	12						12	12	12	12	12	12	12						12	12
Total Flow (gpm)	5	*gpm/stack per HGMP*	62	62	62	62	62	62	62						62	62	62	62	62	62	62						62	62
EARLY REARING - INDOORS OR FOSTER LUCAS	433,000	at 200 fpp							Year A Indoors		xfr to Foster Lucas A Bank										Year B Indoors		xfr to Foster Lucas A Bank					
Fish Length (mm) per HGMP		mm - end of month							35	44	56	68	78	89							35	44	56	68	78	89		
Fish Length (Inches) per HGMP		Inches - End of Month							1.38	1.74	2.2	2.68	3.07	3.50							1.38	1.74	2.2	2.68	3.07	3.50		
Fish Weight- per Piper		Grams - End of Month							0.4	0.8	1.5	2.6	3.9	6.2							0.4	0.8	1.5	2.6	3.9	6.2		
Total Fish Weight		lbs.							381	763	1431	2480	3720	5913							381	763	1431	2480	3720	5913		
Start Tank Volume	89	cf. - 16' L x 3.25 W' x 2.75' d																										
Start Tanks required at	*89*	*Cu. Ft./Tank*							22	35											22	35						
Volume Req'd at Density Index	0.14	lb./cu.ft./in. per HGMP							1,978	3,132	4,635	6,616	8,652	12,054							1978	3132	4,635	6,616	8,652	12,054		
GPM of Flow Req'd at FI=	1.0	lb/(gpm*L)							277	438	649	926	1211	1688							277	438	649	926	1211	1688		
JUVENILE REARING - D and E BANKS	400,000	at 15 fpp																										
Size at transfer in	2.12	*gr*																										
Size at transfer out	26.30	*gr.*	xfr to 8 x 80's								Mid April Release				xfr to 8 x 80's								Mid April Release				xfr to 8 x 80's	
Fish Length (mm) per HGMP		mm - end of month	101	114	121	123	123	126	128	135	139				101	114	121	123	123	126	128	135	139				$101	114
Fish Length (Inches) per HGMP		Inches - End of Month	3.98	4.49	4.76	4.84	4.90	4.96	5.02	5.31	5.49				3.98	4.49	4.76	4.84	4.90	4.96	5.02	5.31	5.49				4.0	4.5
Fish Weight- per HGMP (grams)		Grams - End of Month	10.1	14.5	17.2	18.2	18.7	19.2	20	24	26				10.1	14.5	17.2	18.2	18.7	19.2	20	23.8	26.3				10.1	14.5
Total Fish Weight		lbs.	8,899	12,775	15,154	16,035	16,476	16,916	17,621	20,969	23,172				8,899	12,775	15,154	16,035	16,476	16,916	17,621	20,969	23,172				8,899	12,775
Volume Req'd at Density Index	0.11	lb./cu.ft./in.	20,344	25,877	28,919	30,103	30,567	31,001	31,913	35,866	38,383				20,344	25,877	28,919	30,103	30,567	31,001	31,913	35,866	38,383				20,344	25,877
GPM of Flow Req'd at FI=	1.0	lb/(gpm*L)	2238	2846	3181	3311	3362	3410	3510	3945	4222				2,238	2,846	3,181	3,311	3,362	3,410	3,510	3,945	4,222				2,238	2,846
Raceways Req'd at	1480	cf ea (8' x 75.5' x 2.5' d)	14	17	20	20	21	21	22	24	26				14	17	20	20	21	21	22	24	26				14	17
Raceway Loading			30	30	30	30	30	30	30	30	30				30	30	30	30	30	30	30	30	30				30	30
FLOW Ratio - Ground Water per HGMP			1	1	0.6	0.5	0.5	0.4	0.3	0.2	0.2	1	1	1	1	1	0.6	0.5	0.5	0.4	0.3	0.2	0.2	1	1	1	1	1
FLOW Ratio- Surface Water per HGMP					0.4	0.5	0.5	0.6	0.7	0.8	0.8						0.4	0.5	0.5	0.6	0.7	0.8	0.8					
TOTAL FLOW - Ground Water (gpm)			2700	3308	1971	1718	1743	1426	1392	1228	1493	1326	1611	2088	2700	3308	1971	1718	1743	1426	1392	1228	1493	1326	1611	2088	2700	3308
TOTAL FLOW - Surface Water - Ambient (gpm)			0.0	0.0	1272	1656	1681	2046	2457	3156	3378	0.0	0.0	0.0	0.0	0.0	1272	1656	1681	2046	2457	3156	3378	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW -(cfs)			6.0	7.4	7.2	7.5	7.6	7.7	8.6	9.8	10.8	3.0	3.6	4.6	6.0	7.4	7.2	7.5	7.6	7.7	8.6	9.8	10.8	3.0	3.6	4.6	6.0	7.4
WATER DEMAND SUMMARY - By Flow Index			AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Sping Chinook Program																												
Ground Water (cfs)			6.0	7.4	4.4	3.8	3.9	3.2	3.1	2.7	3.3	3.0	3.6	4.6	6.0	7.4	4.4	3.8	3.9	3.2	3.1	2.7	3.3	3.0	3.6	4.6	6.0	7.4
Surface Water (cfs)			0.0	0.0	2.8	3.7	3.7	4.6	5.5	7.0	7.5	0.0	0.0	0.0	0.0	0.0	2.8	3.7	3.7	4.6	5.5	7.0	7.5	0.0	0.0	0.0	0.0	0.0
Summer Steelhead Program (Ref. Table 3-6)																												
Ground Water (cfs)			0.3	0.5	0.8	1.0	1.2	1.3	1.5	1.9	2.1	2.5	2.7	3.2	4.3	5.5	4.9	5.0	5.5	5.1	4.5	4.2	4.6	2.5	2.7	3.2	4.3	5.5
Surface Water (cfs)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	4.4	4.9	6.4	8.1	10.5	11.7	0.0	0.0	0.0	0.0	0.0
Mid Columbia Coho Program (Ref. Table 3-7)																												
Ground Water (cfs)			2.7	4.4	3.8	3.6	2.9	2.4	1.9	1.4	1.8	0.6	1.2	1.9	2.9	4.7	4.0	3.8	3.1	2.6	2.0	1.5	1.9	0.6	1.1	1.8	2.7	4.5
Surface Water (cfs)			0.0	0.0	1.8	2.5	2.7	3.3	6.2	7.0	7.4	0.0	0.0	0.0	0.0	0.0	1.9	2.7	2.9	3.6	6.5	7.4	7.8	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW - Ground Water (cfs)			9.0	12.3	9.0	8.5	8.0	6.9	6.5	6.0	7.3	6.0	7.5	9.8	13.2	17.6	13.3	12.6	12.4	10.8	9.6	8.4	9.9	6.0	7.4	9.7	13.0	17.4
TOTAL FLOW - Surface Water - Ambient(cfs)			0.0	0.0	4.6	6.2	6.4	7.8	11.7	14.1	14.9	0.0	0.0	0.0	0.0	0.0	7.8	10.8	11.5	14.6	20.1	24.9	27.0	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW -(cfs)			9.0	12.3	13.6	14.6	14.4	14.7	18.1	20.1	22.3	6.0	7.5	9.8	13.2	17.6	21.0	23.4	23.9	25.4	29.7	33.3	36.9	6.0	7.4	9.7	13.0	17.4

Table 3-8; PRELIMINARY BIOPROGRAM AND APPROXIMATE HATCHERY OPERATION SCHEDULE
Winthrop NFH -2 Year Smolt Summer Steelhead Program - 200,000 Fish at 4 fpp

SURFACE WATER
GROUND WATER
REUSE

			AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
Broodstock Holding: March -May																										
Egg Take: Late July - Sept. 15																										
Incubation: Oct. 15 - Jan. 15																										
Juvenile Rearing Indoors: Start Late August - Through Nov.																										
Juvenile Rearing Outdoor: Nov/Dec through Aprl.																										
ADULT HOLDING																										
Max Number of Fish	*120*	*(60 pairs)*																								
Flow - Per HGMP	*120*	*gpm*								120	120	120										120	120	120		
Holding Volume - Per HGMP	*8*	*Cu. Ft./Fish*								960	960	960										960	960	960		
INCUBATION																										
# of eggs	220,000	*at 97% green egg to hatch*																								
Eggs per tray	5,000	*Ave. from HGMP*																								
# of trays	44																									
# of stacks at	15	*trays/stack*	3								3	3	3	3	3								3	3	3	3
Total Flow (gpm)	4	*gpm/stack per HGMP*	12								12	12	12	12	12								12	12	12	12
JUVENILE REARING - INDOORS	220,000	fish																								
Size at transfer in	0.25	*gr*																								
Size at transfer out	2.30	*gr.*	Year A			XFR Outdoors in Nov/Dec.									Year B			XFR Outdoors in Nov/Dec.								
Fish Length (Inches)		Inches - End of Month	1.17	1.6	2.1	2.45									1.17	1.6	2.1	2.45								
Fish Weight		Grams - End of Month	0.25	0.7	1.5	2.3									0.3	0.7	1.5	2.3								
Total Fish Weight		lbs.	121	339	727	1,115									110	308	661	1,013								
Volume Req'd at Density Index	0.20	lb./cu.ft./in.	518	1,060	1,731	2,275									471	964	1,573	2,068								
GPM of Flow Req'd at FI=	1.0	lb/(gpm*L)	104	212	346	455									104	212	346	455								
GPM of Flow Req'd at R=2			129	264	432	567									117	240	392	516								
Start Tanks required at	*89*	*Cu. Ft./Tank*	6	12	19	26									5	11	18	23								
JUVENILE REARING - OUTDOORS	200,000	at 4 fpp																								
Year A *Size at transfer in*	2.30	*gr*																								
Size at volitional release	113.00	*gr.*					Year A																			
Fish Length (Inches) per HGMP		Inches - End of Month					2.8	2.9	3	3.2	3.45	3.7	4.1	4.6	5.10	5.8	6.6	7.1	7.5	7.7	8	8.4	8.9			
Fish Weight- per HGMP (2008 brood)		Grams - End of Month					3.5	3.9	4.5	5.4	6.5	8	11	15	21	30	46	57	65	74	82	96.00	113.00			
Total Fish Weight		lbs.					1,542	1,718	1,982	2,379	2,863	3,612	4,978	6,608	9,251	13,216	20,264	25,110	28,634	32,599	36,123	42,291	49,780			
Volume Req'd at Density Index	0.20	lb./cu.ft./in.					2,753	2,962	3,304	3,717	4,150	4,882	6,071	7,183	9,070	11,393	15,352	17,683	19,090	21,168	22,577	25173	27966			
GPM of Flow Req'd at FI=	1.0	lb/(gpm*L)					551	592	661	743	830	976	1,214	1,437	1,814	2,279	3,070	3,537	3,818	4,234	4,515	5,035	5,593			
GPM of Flow Req'd at R=2							686	739	824	927	1,035	1217	1514	1790.84	2,261	2,841	3,828	4,409	4,760	5,278	5,629	6276	6973			
Year B *Size at transfer in*	0.17	*gr*																								
Size at volitional release	113.00	*gr.*																	Year B							
Fish Length (Inches) per HGMP		Inches - End of Month																	2.8	2.9	3	3.2	3.5	3.7	4.1	4.6
Fish Weight- per HGMP (2008 brood)		Grams - End of Month																	3.5	3.9	4.5	5.4	6.5	8.2	11.3	15
Total Fish Weight		lbs.																	1542	1718	1982	2379	2863	3612	4978	6608
Volume Req'd at Density Index	0.20	lb./cu.ft./in.																	2753	2962	3304	3717	4150	4882	6071	7183
GPM of Flow Req'd at FI=	1.0	lb/(gpm*L)																	551	592	661	743	830	976	1214	1437
GPM of Flow Req'd at R=2																			686	739	824	927	1035	1217	1514	1791
Total Outdoor Rearing		cf									4,150	4,882	6,071	7,183	9,070	11,393	15,352	17,683	21,843	24,130	25,881	28,890	32,116			
FLOW Ratio - Ground Water			1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.6	0.5	0.5	0.4	0.3	0.2	0.2	1	1	1
FLOW Ratio- Surface Water																	0.4	0.5	0.5	0.6	0.7	0.8	0.8			
TOTAL FLOW - Ground Water (gpm)			115	212	346	455	551	592	661	863	962	1,108	1,226	1,448	1,929	2,491	2,188	2,223	2,460	2,286	2,015	1,870	2,080	1,108	1,226	1,448
TOTAL FLOW - Surface Water - Ambient(gpm)																	1228	1768	1909	2540	3161	4028	4475			
TOTAL FLOW - Ground Water (cfs)			0.3	0.5	0.8	1.0	1.2	1.3	1.5	1.9	2.1	2.5	2.7	3.2	4.3	5.5	4.9	5.0	5.5	5.1	4.5	4.2	4.6	2.5	2.7	3.2
TOTAL FLOW - Surface Water - Ambient(cfs)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	4.4	4.9	6.4	8.1	10.5	11.7	0.0	0.0	0.0
TOTAL FLOW -(cfs)			0.3	0.5	0.8	1.0	1.2	1.3	1.5	1.9	2.1	2.5	2.7	3.2	4.3	5.5	7.6	8.9	9.7	10.7	11.5	13.1	14.6	2.5	2.7	3.2

Table 3-9; PRELIMINARY BIOPROGRAM AND APPROXIMATE HATCHERY OPERATION SCHEDULE
Winthrop NFH - Yakama Nation Mid-Columbia Coho Program - 1.3 M eggs, 250,000 Fish at 16 fpp

SURFACE WATER
GROUND WATER
REUSE

			AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
COHO ACCLIMATION	**100,000**	**at 16 fpp**																										
COHO PRODUCTION	**250,000**	**at 16 fpp**																										
	Broodstock Holding																											
	Egg Take: Oct. 15 - Nov. 30																											
	Incubation: Oct. 15 - Jan. 15																											
Year A -	***Juvenile Rearing in Ponds: Start mid April - Out plant by End of April***																											
	Juvenile Acclimation in Ponds: Start Feb. -Out plant by End of April																											
Year B -	***Juvenile Rearing in Ponds: Start Mid April -Out plant by End of April***																											
ADULT HOLDING																												
	Max Number of Fish	***440***	***(220 pairs)***																									
	Flow - Per Staff	***450***	***gpm at 1 gpm/fish***		**440**	**440**	**440**									**440**	**440**	**440**										**400**
	Holding Volume - Per HGMP	***8***	***Cu. Ft./Fish***		**3520**	**3520**	**3520**									**3520**	**3520**	**3520**										**1760**
INCUBATION																												
	# of eggs	**1,300,000**	***at 97% green egg to hatch***																									
	Eggs per tray	**4000**	***Ave. from HGMP***																									
	# of trays	**325**				**Year A**											**Year B**											
	# of stacks at	**15**	***trays/stack***			**22**	**22**	**22**	**22**	**22**	**22**	**22**					**22**	**22**	**22**	**22**	**22**	**22**	**22**					**22**
	Total Flow (gpm)	**4**	***gpm/stack***			**87**	**87**	**87**	**87**	**87**	**87**	**87**					**87**	**87**	**87**	**87**	**87**	**87**	**87**					**87**
JUVENILE REARING - INDOORS	**270,000**	fry																										
Year A	***Size at transfer in***	**1.33**	***gr***																									
	Size at transfer out	**1.70**	***gr.***								**Year A**												**Year B**					
	Fish Length (Inches) per HGMP		**Inches - End of Month**								**1.4**	**1.7**											**1.4**	**1.7**				
	Fish Weight- per HGMP (grams)		**Grams - End of Month**								**0.43**	**0.78**											**0.43**	**0.78**				
	Total Fish Weight		**lbs.**								**256**	**464**											**237**	**430**				
	Volume Req'd at Density Index	**0.20**	**lb./cu.ft./in.**								**913**	**1,364**											**846**	**1,263**				
	GPM of Flow Req'd at FI=	**1.0**	**lb/(FI*L)**								**183**	**273**											**169**	**253**				
	Start Tanks required at	***89***	***Cu. Ft./Tank***								**10**	**15**																
JUVENILE REARING - OUTDOORS	**250,000**	at 16 fpp																										
Year A	***Size at transfer in***	**1.7**	***gr***																									
	Size at transfer out	**25.30**	***gr.***										**Year A**															
	Fish Length (Inches) per HGMP		**Inches - End of Month**										**2.4**	**3.0**	**3.7**	**4.2**	**4.7**	**4.9**	**5.2**	**5.3**	**5.4**	**5.5**	**5.6**					
	Fish Weight- per HGMP (grams)		**Grams - End of Month**										**2.2**	**4.4**	**8.1**	**11.8**	**16.8**	**19.7**	**22.6**	**23.7**	**24.7**	**26.0**	**28.3**					
	Total Fish Weight		**lbs.**										**1,308**	**2,617**	**4,817**	**7,018**	**9,991**	**11,716**	**13,441**	**14,095**	**14,689**	**15,463**	**16,830**					
	Volume Req'd at Density Index	**0.20**	**lb./cu.ft./in.**										**2,726**	**4,361**	**6,510**	**8,354**	**10,629**	**11,955**	**12,924**	**13,297**	**13,652**	**14,186**	**15,000**					
	GPM of Flow Req'd at FI=	**1.0**	**lb/(gpm*L)**										**545**	**872**	**1,302**	**1,671**	**2,126**	**2,391**	**2,585**	**2,659**	**2,730**	**2,837**	**3,000**					
	Raceway Loading		**12 x 100's**										**2**	**2**	**2**	**2**	**5**	**5**	**5**	**5**	**5**	**5**	**5**					
	GPM of Flow Req'd for RW Hydraulics	**360**	**gpm ea**										**720**	**720**	**720**	**720**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**					
				Year B																					**Year B**			
Year B -	**Fish Length (Inches) per HGMP**		**Inches - End of Month**	**3.7**	**4.2**	**4.7**	**4.9**	**5.2**	**5.3**	**5.38**	**5.45**	**5.61**													**2.4**	**3**	**3.7**	**4.2**
	Fish Weight- per HGMP (grams)		**Grams - End of Month**	**8.1**	**11.8**	**16.8**	**19.7**	**22.6**	**23.7**	**24.7**	**26**	**28.3**													**2.2**	**4.4**	**$8**	**11.8**
	Total Fish Weight		**lbs.**	**4,460**	**6,498**	**9,251**	**10,848**	**12,445**	**13,051**	**13,601**	**14,317**	**15,584**													**1,211**	**2,423**	**4,460**	**6,498**
	Volume Req'd at Density Index	**0.20**	**lb./cu.ft./in.**	**6,028**	**7,735**	**9,842**	**11,069**	**11,966**	**12,312**	**12,641**	**13,135**	**13,889**													**2,524**	**4,038**	**6,028**	**7,735**
	GPM of Flow Req'd at FI=	**1.0**	**lb/(gpm*L)**	**1,206**	**1,547**	**1,968**	**2,214**	**2,393**	**2,462**	**2,528**	**2,627**	**2,778**													**505**	**808**	**1,206**	**1,547**
	Raceway Loading		**12 x 100's**	**2**	**2**	**5**	**5**	**5**	**5**	**5**	**5**	**5**													**2**	**2**	**2**	**2**
	GPM of Flow Req'd for RW Hydraulics	**360**	**gpm ea**	**720**	**720**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**													**720**	**720**	**720**	**720**
JUVENILE ACCLIMATION - BACK CHANNEL	**100,000**	**at 16 fpp**																										
	Size at transfer in	**24**	***gr***																									
	Size at transfer out	**28.3**	***gr.***							**Year A**											**Year B**							
	Fish Length (Inches) per HGMP		**Inches - End of Month**							**5.38**	**5.45**	**5.61**									**5.38**	**5.45**	**5.61**					
	Fish Weight- per HGMP (grams)		**Grams - End of Month**							**24.7**	**26**	**28.3**									**24.7**	**26**	**28.3**					
	Total Fish Weight		**lbs.**							**5,441**	**5,727**	**6,233**									**5440.53**	**5726.87**	**6,233**					
	Volume Req'd at Density Index	**0.20**	**lb./cu.ft./in.**							**5,056**	**5,254**	**5,556**									**5056.25**	**5254.01**	**5,556**					
	GPM of Flow Req'd at FI=	**1.0**	**lb/(gpm*L)**							**1,011**	**1,051**	**1,111**									**1,011**	**1,051**	**1,111**					
FLOW Ratio - Ground Water			**1.0**	**1.0**	**0.6**	**0.5**	**0.5**	**0.4**	**0.3**	**0.2**	**0.2**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**0.6**	**0.5**	**0.5**	**0.4**	**0.3**	**0.2**	**0.2**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
FLOW Ratio- Surface Water					**0.4**	**0.5**	**0.5**	**0.6**	**0.7**	**0.8**	**0.8**						**0.4**	**0.5**	**0.5**	**0.6**	**0.7**	**0.8**	**0.8**					
TOTAL FLOW - Ground Water (gpm)			**1206**	**1987.1**	**1708**	**1634**	**1283**	**1072**	**845**	**612**	**825**	**273**	**545**	**872**	**1302**	**2111**	**1802**	**1722**	**1379**	**1150**	**906**	**654**	**856**	**253**	**505**	**808**	**1206**	**2034**
TOTAL FLOW - Surface Water - Ambient (gpm)			**0**	**0**	**787**	**1107**	**1197**	**1477**	**2781**	**3152**	**3333**	**0**	**0**	**0**	**0**	**0**	**850**	**1195**	**1292**	**1596**	**2923**	**3321**	**3511**	**0**	**0**	**0**	**0**	**0**
TOTAL FLOW - Ground Water (cfs)			**2.7**	**4.4**	**3.8**	**3.6**	**2.9**	**2.4**	**1.9**	**1.4**	**1.8**	**0.6**	**1.2**	**1.9**	**2.9**	**4.7**	**4.0**	**3.8**	**3.1**	**2.6**	**2.0**	**1.5**	**1.9**	**0.6**	**1.1**	**1.8**	**2.7**	**4.5**
TOTAL FLOW - Surface Water - Ambient (cfs)			**0.0**	**0.0**	**1.8**	**2.5**	**2.7**	**3.3**	**6.2**	**7.0**	**7.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.9**	**2.7**	**2.9**	**3.6**	**6.5**	**7.4**	**7.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
TOTAL FLOW -(cfs)			**2.7**	**4.4**	**5.6**	**6.1**	**5.5**	**5.7**	**8.1**	**8.4**	**9.3**	**0.6**	**1.2**	**1.9**	**2.9**	**4.7**	**5.9**	**6.5**	**5.9**	**6.1**	**8.5**	**8.9**	**9.7**	**0.6**	**1.1**	**1.8**	**2.7**	**4.5**

Summer steelhead early rearing begins in August and runs through November, using the same 89 cf fiberglass troughs. The calculated volume required for 220,000 fish is equivalent to 23 troughs with a calculated groundwater flow of 455 gpm. The fish are transferred outdoors in late November or December at a size of 200 fpp.

Coho early rearing occurs in April and May for the 270,000 fish that remain on-station. They are placed into the 89 cf indoor rearing troughs in April shortly after the spring Chinook are transferred outside. The calculated volume required for 270,000 fish is equivalent to 15 indoor troughs with a calculated groundwater supply flow of 273 gpm at the end of May when they are transferred to outdoor raceways.

Juvenile Rearing: Spring Chinook juvenile rearing begins in August and runs through the following April when fish are released at a target size of 18 fpp. In August and September the fish are held on cold groundwater, with a calculated peak demand of 1,900 gpm at the end of September. Beginning in October, surface water is blended into the juvenile rearing supply and groundwater demand gradually drops. The calculated rearing volume required for 400,000 smolts at the end of juvenile rearing in April is 38,400 cf, with a supply flow of 2,815 gpm (mostly surface water).

Summer steelhead juvenile rearing begins in late November or early December. With the new 2-year smolt program, fish are held outdoors for 17 months, and are released in April of the second year. The primary supply is groundwater through the summer months, transitioning to surface water for the final winter and spring period prior to release. The calculated rearing volume requirement for 200,000 smolts at 4 fpp is 28,000 cf with a peak flow of 2,300 gpm of groundwater and 5,600 gpm of surface water.

Mid-Columbia coho juvenile rearing begins in June and runs through the following April. The fish are held on groundwater through September, transitioning to surface water for the final winter and spring period prior to release. The calculated rearing volume requirement for 250,000 smolts at 16 fpp is 15,000 cf with a peak flow of 1,670 gpm of groundwater and 3,000 gpm of surface water. Approximately 50,000 to 60,000 of the coho reared out of basin are shipped back to Winthrop NFH in February for short term acclimation in an earthen channel (known as the back-channel). The back channel is supplied with surface water from screening structures on Foghorn Ditch. The YN would like to increase back channel acclimation to 100,000 fish if possible. The calculated rearing volume for acclimating 100,000 coho is 5,600 cf, with a supply flow of 1,100 gpm of surface water.

3.3.6 Winthrop NFH Operating Summary

Table 3-10 provides a water supply and rearing volume summary for the Winthrop NFH fish production programs. Figure 3-2 further illustrates water rights, demand and usage.

Groundwater Supply: Calculated groundwater demand (based on Flow Index), at Winthrop NFH varies from 6 to 17.4 cfs for fish production. Table 3-10 indicates groundwater production is 1 to 2 cfs below target for four months, from September through December each year with no redundant capacity. There is excess surface water capacity available during the groundwater deficit period. The remainder of the year there is some capacity for redundant groundwater supply in case a pump goes off-line.

Surface Water Supply: Calculated surface water demands at Winthrop NFH range from 7.8 cfs in May to 27 cfs in April just prior to smolt releases. The available combined water right of 63.3 cfs exceeds demand. Flow meter records from 2012-2013 indicate metered surface water flow does not exceed 17.4 cfs. Biological criteria indicate that no surface water is required from May through September, however

flow meter data shows no flows only for the mid-May through July period. There appear to be shortages of surface water during late summer low flow periods and the hatchery is not using the surface water right during this period. Water rights data indicates that 6 cfs of bypass flow from screening chambers is piped back to the river via the backchannel which would exceed the flow needed to support the coho acclimation program.

Early Rearing Volume: There is adequate early rearing volume at Winthrop NFH provided by the 36 indoor troughs (used at different times by all species), except for the obsolete "A Bank" Foster-Lucas ponds that are used for the latter portion of spring Chinook early rearing. Calculated density index targets are met only by using these obsolete units.

Table 3-10. Winthrop NFH Water Supply and Rearing Volume Summary

End of Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Comb. SW /GW Water Right(cfs)	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3
GW Flow Summary (cfs)												
FI for Sp. Chinook	3.2	3.1	2.7	3.3	3.0	3.6	4.6	6.0	7.4	4.4	3.8	3.9
FI for Sum.Sthd	5.1	4.5	4.2	4.6	2.5	2.7	3.2	4.3	5.5	4.9	5.0	5.5
FI for Coho	2.6	2.0	1.5	1.9	0.6	1.1	1.8	2.7	4.5	4.0	3.8	3.1
Total GW Flow per FI	10.8	9.6	8.4	9.9	6.0	7.4	9.7	13.0	17.4	13.3	12.6	12.4
Ave Monthly GW Prod. - 2013	11	10.5	12	12.5	13	12	15	14.5	14	11	11	11
SW Flow Summary (cfs)												
FI + Tempering for Sp. Chinook	4.6	5.5	7.0	7.5	0.0	0.0	0.0	0.0	0.0	2.8	3.7	3.7
FI + Tempering for Sum.Sthd	6.4	8.1	10.5	11.7	0.0	0.0	0.0	0.0	0.0	3.0	4.4	4.9
FI + Tempering for Coho	3.6	6.5	7.4	7.8	0.0	0.0	0.0	0.0	0.0	1.9	2.7	2.9
Total SW Flow for FI + Temp.	14.6	20.1	24.9	27.0	0.0	0.0	0.0	0.0	0.0	7.8	10.8	11.5
Ave Monthly SW Use - 2013	16.0	16.1	13.8	12.9	3.0	0.0	7.2	7.7	6.5	13.6	16.1	10.5
Combined GW + SW Water Use	27.0	26.6	25.8	25.4	16.0	12.0	22.2	22.2	20.5	24.6	27.1	21.5
Early Rearing Volume (cf)												
Per DI for Sp. Chinook	0	1,978	3,132	4,635	6,616	8,652	12,054	0	0	0	0	0
Per DI for SST	0	0	0	0	0	0	0	471	964	1,573	2,068	0
Per DI for Coho	0	0	0	0	913	1,364	0	0	0	0	0	0
Total Volume Recommended per DI	0	1,978	3,132	4,635	7,529	10,016	12,054	471	964	1,573	2,068	0
Available	3200	3200	3200	15000	15000	15000	15000	3200	3200	3200	3200	3200
Difference	3,200	1,222	68	10,365	8,384	6,348	2,946	3,200	3,200	3,200	3,200	3,200
Juvenile Rearing Volume (cf)												
For Sp. Chinook DI	31,001	31,913	35,866	38,383	0	0	0	20,344	25,877	28,919	30,103	30,567
For SST DI	24,130	25,881	28,890	32,116	4,882	6,071	7,183	9,070	11,393	15,352	17,683	21,843
For Coho	13,297	13,652	14,186	15,000	0	0	2,726	4,361	6,510	8,354	10,629	11,955
Total Volume Recommended per DI	68,428	71,446	78,942	85,499	4,882	6,071	9,908	33,775	43,779	52,625	58,415	64,365
Available	44,000	44,000	44,000	44,400	44,400	44,400	44,400	44,400	44,400	44,400	44,400	44,400
Difference	(24,428)	(27,446)	(34,942)	(41,099)	39,518	38,329	34,492	10,625	621	(8,225)	(14,015)	(19,965)

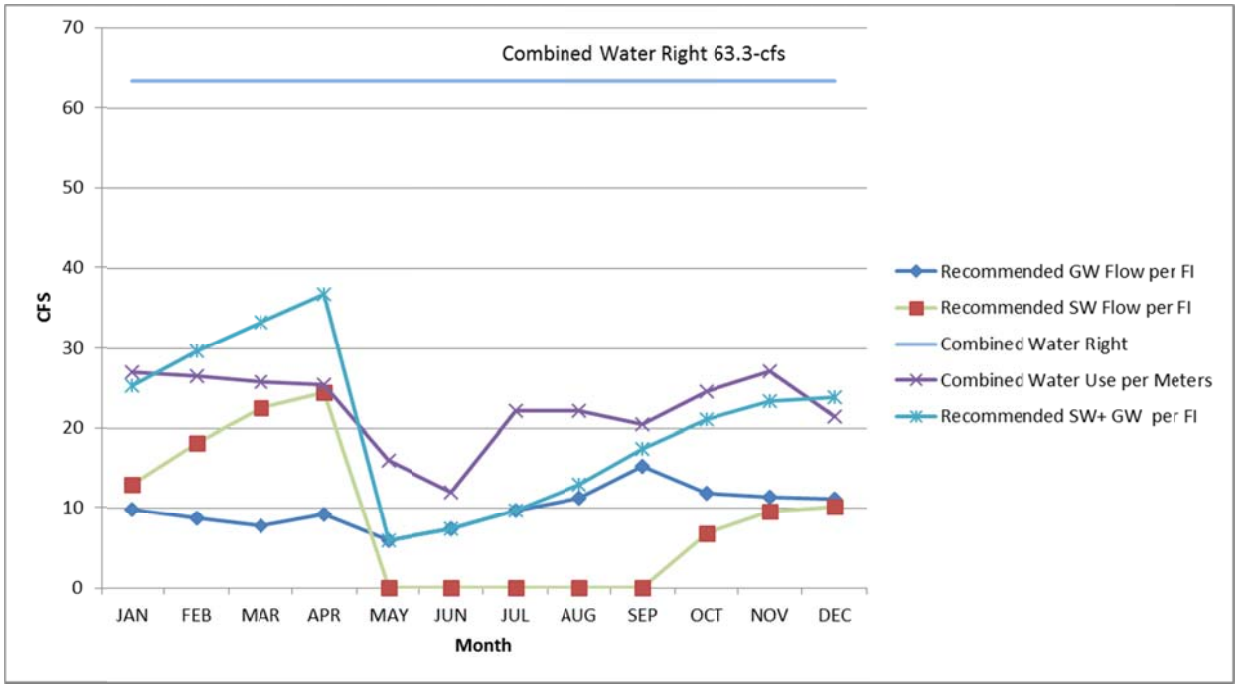


Figure 3-3. Winthrop NFH Water Summary

Juvenile Rearing Volume: The (30) 8 x 80 ft raceways provide a juvenile rearing volume of 44,400 cf. The calculated minimum required volume at peak loading in April is 85,500 cf, which indicates a 41,100 cf shortage of juvenile rearing space at Winthrop NFH. The hatchery presently utilizes obsolete (16) 12 x 100 ft "C bank" raceways and (8) Foster-Lucas "A bank" ponds to make up for this shortfall. These units are not counted towards the total volume available since they are not suitable for long term use. In summary, juvenile rearing densities at Winthrop NFH are kept below the target values by using substandard vessels that are not suitable for long term use. Table 3-10 shows only the juvenile rearing volume of the D and E Bank 8 x 80 ft raceways as available for long term planning purposes. This results in a significant juvenile rearing volume shortfall at this facility ranging from 8,225 cf to 41,100 cf, for seven months each year.

Back Channel Acclimation Volume: The earthen pond used for coho acclimation has approximate dimensions of 175 feet long, 15 feet wide and 5 feet of depth for a total volume of approximately 13,000 cf. Stop logs are placed at the lower end of the channel to control water depth. The calculated volume needed for the target of 100,000 coho is 5,600 cf, indicating that there is adequate volume available to expand from the present 50,000 fish. The water supply to this pond is piped from the Foghorn Ditch fish screens and flow availability may limit the number of fish that can supported in this system. Screen panels are placed to route fish contained in the bypass flow around the acclimation portion of the back channel.

3.4 Water Supplies and Climate Change

The effects of climate change on hatchery water supplies is an important consideration for long term planning. A 2011 memo prepared by Reclamation looked the long term effects of climate change on the Icicle Creek supply for Leavenworth NFH. The memo (See Appendix A), was based a report to Congress called the *SECURE Water Act, Section 9503(c) - Reclamation Climate Change and Water (2011).* The study documented warming trends and higher levels of rainfall vs. snowfall in the future, region wide. The following is an excerpt from the conclusion of the memo:

"In summary, areas such as Icicle Creek are projected to experience earlier snowmelt, decreased snow to rain ratios (transitioning from one dominated form of precipitation to another), increased runoff volume prior to the peak flow, and lower flows in later summer months. Diversions that use storage water as supply will likely be less impacted than those that use natural water as their supply source. Impacts to aquatic species are expected vary depending on population as water quality is projected to decrease with increasing stream temperatures, changes in flow regime, and a change in sediment transport processes. Changes in distribution of species are also projected."

In 2013, FWS released a report titled "*Winthrop National Fish Hatchery: Climate Change Vulnerability Assessment, December 2013"* – (Climate Change Assessment Team for National Fish Hatcheries, Pacific Region, U.S. Fish and Wildlife Service, Portland, Oregon). This report further documents expected reductions in late summer stream flows and significantly increased water temperatures, and that these conditions will present new challenges for hatchery programs and wild fish as well. The ability to utilize full water rights, (especially the cooler groundwater) at Complex hatcheries will help to mitigate the effects of elevated temperatures.

We conclude that it will be advantageous for FWS to be aggressive in maintaining and developing existing water rights and utilize conservative assumptions (allow for declines in aquifer productivity), in the development of any potential new water rights.

SECTION 4
GEOGRAPHICALLY SEPARATE ALTERNATIVES EVALUATION

4.0 Introduction

This section of the report describes and analyzes geographically separate site alternatives for relocating Complex fish production to locations where production costs could potentially be reduced compared to maintaining production at the three existing sites. The relocation of any of the six Complex fish production programs to geographically separate locations would require extensive consultation with NOAA and re-negotiations of US v. Oregon harvest targets with tribes and other concerned entities. In addition, relocating the programs would entail substantial costs for planning, design, environmental compliance, and construction of the new facilities. There are several challenges confronting ongoing operations at the Complex that are driving the effort to consider fish production relocation. These factors include but are not limited to:

- Potential that future NPDES/TMDL discharge limits for phosphorous cannot be met at Leavenworth NFH (could be an issue in the future at Entiat NFH or Winthrop NFH).
- Declining groundwater production from the existing wells. (At Leavenworth NFH this is related to changes in how the hatchery channel and historical channel flows are managed).
- Litigation regarding impacts of hatchery fish on ESA fish by wild fish advocacy groups.
- The difficulty and cost of replacing the 75-year old infrastructure and modernizing the facility while meeting fish production, mitigation and tribal trust obligations in a cost effective manner.

4.0.1 Range of Magnitude Cost Evaluation

In order to determine the most likely scenarios for relocation of fish production, the approximate cost of recently bid or constructed new salmon hatchery projects in the Columbia Basin were compared to potential Complex modernization costs. The recently bid or constructed Columbia Basin salmon hatchery projects located on new, bare sites are shown in Table 4-1.

Table 4-1. Recent Hatchery Construction Costs

Facility(Date)	Production Target	Approx. Cost	Comments
IDFG – Springfield (2013)	1,000,000 Sockeye Smolts,100,000 lbs	$13.5M	Abundant GW Supply, no SW supply. Higher density index used. No adult collection, holding, or spawning facilities are included
Shoshone Bannock Crystal Springs (2013 bid)	1,000,000 Sp. Chinook,100,000 lbs	$18.0M	Abundant GW Supply, higher density index and flow indexes used. Cost includes 2 remote weirs and adult collection Sites
CCT - Chief Joseph (2013)	2.9M Chinook	$50M	Abundant GW and SW Supplies. Limited indoor rearing, Large fish ladder and adult return facility

These known costs help to establish a range of magnitude for capital costs to relocate Complex facilities. These recent projects show a cost range of $17 to $18M per million smolts at sites that have abundant water supplies, use higher density indices than the Complex, and require adult return/spawning facilities.

Based on the current fish production targets (Table 3-1), correlated to the above construction costs plus a 20% contingency, the rough replacement construction costs for Complex facilities, including administration functions, in 2014 dollars are approximately $8.6M for Entiat NFH production, $17M for Winthrop NFH production, and $26M for Leavenworth NFH production (not including YN coho program facilities). These figures do not include land acquisition, planning, design, or environmental compliance costs which typically add 30% to 40% to project costs. There would also be relocation and demolition costs associated with closing existing facilities that are difficult to quantify and could add at least 5% to total costs. Factoring in 40% for these soft costs, the total project costs would be $12M for Entiat NFH, and $24M for Winthrop NFH and $36M for Leavenworth NFH.

Analyzing these rough project costs compared to the costs of modernizing the existing Complex hatcheries, only Leavenworth NFH has a high enough modernization cost to warrant consideration of replacement at a geographically separate location. Entiat NFH and Winthrop NFH have some significant issues with aging infrastructure and water supply challenges, but at this time, do not have the NPDES discharge or legal issues that face Leavenworth NFH. After review of this draft analysis, the project team reached a consensus that it was not advisable to incur the costs and policy (US v. Oregon negotiation) efforts that would be required to attempt to obtain water rights and develop supplies new site(s), and move current fish production out of Entiat NFH or Winthrop NFH instead of modernizing critical infrastructure on a more flexible schedule.

The present fish production programs at Leavenworth NFH, are the FWS spring Chinook program and the YN mid-Columbia coho program as described in detail in Section 3 above. Relocation of the YN mid-Columbia coho program is not included in the relocation analysis for the following reasons:

- YN is working separately to relocate most of the coho program, including incubation, adult holding and acclimation functions to different sites in the Wenatchee River watershed.
- YN has an approved mid-Columbia coho Master Plan and FEIS, which indicate the that Leavenworth NFH component and coho releases to Icicle Creek will be drastically scaled back over the next five to ten years, to only 35,000 fish per year.

Therefore, the alternatives analysis that evaluates moving fish production to a geographically separate location will focus solely on relocation strategies for the 1.2 million smolt Leavenworth NFH spring Chinook program. Five alternative production strategies to relocate all or part of the Leavenworth NFH spring Chinook program have been identified for consideration:

Alternative GS1: Move Leavenworth NFH Spring Chinook Production to a New Hatchery in the Wenatchee River Basin Upstream of the Icicle Creek Confluence.

Alternative GS2: Move Leavenworth NFH Spring Chinook Production to a New Hatchery in the Wenatchee River Basin Downstream of the Icicle Creek Confluence

Alternative GS3: Move present Leavenworth NFH Spring Chinook Production to a Facility on the Mainstem Columbia River

Alternative GS4: Move present Leavenworth NFH Spring Chinook Production to a Facility on the Entiat, Methow or Okanogan River

Alternative GS5: Maintain Spring Chinook Incubation and Over-winter Acclimation at Leavenworth NFH, Move Juvenile Rearing to a Geographically Separate Site

4.0.2 Essential Components of a Geographically Separate Leavenworth NFH Facility

The Leavenworth NFH functions as the administrative center for the Leavenworth Fisheries Complex. Complex management has indicated that many management functions would likely be transferred out of Leavenworth NFH to the new production location if the spring Chinook program were relocated. However, FWS has a "Freeze the Footprint" policy in place under which no new office/warehouse square footage (fish production functions are exempt) will be constructed unless there is demolition of an equal amount of existing office or warehouse space. This would apply to the existing shop and freezer/feed storage buildings at Leavenworth NFH. Because several Leavenworth NFH buildings are on the historical register they cannot be demolished which would make it difficult to replace them elsewhere under the "Freeze the Footprint" policy. With this in mind, essential components of the relocated facility would include the following major elements:

1. A 27,000 sf hatchery/administration building to house incubation, early rearing and administrative functions. (Administrative functions could be in a separate building or location).
2. Approximately 112,000 cubic feet of outdoor rearing vessel capacity.
3. 7,000 sf shop, dry storage and feed storage building (may not be allowed under Freeze the Footprint policy).
4. Adult fish ladder with long term holding and spawning facilities similar to the new facility at Winthrop NFH.
5. A surface water supply system capable of delivering up to 52 cfs of flow, which is cold enough, or can be adequately chilled in the summer, to support healthy spring Chinook rearing. Alternate rearing strategies (water reuse) could be used to address water availability issues associated with moving production to a different location.
6. A NOAA compliant intake fish screen system and sediment management provisions would need to be included.
7. A groundwater supply system capable of delivering at least 8.5 cfs of flow for early rearing, which is cold enough to minimize mechanical water chilling requirements. Alternate rearing strategies (water reuse) could be used to address water availability issues associated with moving production to a different location.
8. An overall water supply system that provides well oxygenated water with maximum temperatures that do not exceed 55° F. This will likely entail blending cooler groundwater with warmer surface water during summer and fall months at most potential sites.
9. A cleaning waste and hatchery effluent management system capable of meeting NPDES permit requirements.
10. At least four on-site housing units (3 bed, 2 bath, 2,000 sf) for hatchery staff who are required to live on station.
11. Improvements may be required to provide for tribal harvest in the vicinity of the adult return fish ladder.
12. An overall land area of 15 to 20 acres will be required to accommodate the required hatchery building, surface water intake and screening, groundwater well field, headboxes, hatchery

building, outdoor rearing vessels, adult holding ponds, effluent treatment system, parking and site circulation.

For the purposes of this analysis, relocation of the FWS Fisheries Resource Office (FRO) is considered separate from essential fish production functions and is not included in the relocation strategy.

4.1 Initial Screening Criteria

Due to budget and schedule limitations, the scope of the initial geographically separate alternatives analysis is high level, and is mostly based on available data and reports. For the purposes of this analysis, it is assumed that the spring Chinook production target will be to rear 1.2 million smolts to a release size of 18 fish per pound as directed by FWS in July of 2014. A potential future production target of 1.6 million smolts has been identified which would increase water supply, rearing space requirements and capital costs by a factor of 1.33. A more detailed analysis of selected alternatives with potentially different production targets, may be authorized in the future at the discretion of FWS.

A range of selection factors have been considered for an initial screening of each of the five alternatives in order to provide a comprehensive and objective basis for evaluation. These factors include land issues, water supply quality and quantity, effects on harvest (US v. Oregon) and mitigation (Grand Coulee mitigation) obligations, policy/legal, biological risks and benefits, and disease risks.

The Complex facilities were originally constructed to mitigate for fish losses above Grand Coulee Dam. Per *Mitigation Objectives for the Leavenworth National Fish Hatchery Complex* (Cates 2006), no potential geographically separate sites that would release fish below Rock Island Dam were considered to be viable (See Section 4.7.1 below). While Prosser Hatchery on the Yakima River (operated by Yakama Nation), was suggested by some reviewers, that facility was not considered for this analysis since the Yakima River confluence is well below Rock Island Dam, and that hatchery has significant limitations in terms of water quality and quantity, and does not have adequate land area for expansion of production facilities.

4.1.1 Land Issues

For the geographically separate alternatives, at least 15 acres of land area will be required to accommodate the infrastructure needed for a new hatchery production and support facilities. Ideally, land for the new facilities would have relatively flat topography, be adjacent to a major stream, and have low bank stream frontage to simplify the construction of water intakes, hatchery discharges, and any needed adult collection improvements. The parcel would need to be large enough to provide adequate separation for multiple groundwater wells and the rest of the major facility components described in Section 2 above. A gravity flow surface water supply system would most likely require more land area or easements in order to obtain adequate elevation differences between intake and outfalls.

4.1.2 Water Quality and Quantity

A combination of groundwater and surface water is used for the Complex fish production programs. The quality of both groundwater and surface water in the region is generally suitable for fish culture as demonstrated by the operating hatcheries and acclimation facilities on each of the watersheds under consideration. Surface water temperature is the most prevalent limiting qualitative factor on the mid-Columbia region. Under the Clean Water Act section 303(d) assessments, many reaches of the

Wenatchee, Entiat, Methow, Okanogan and mainstem Columbia Rivers are listed as impaired due to high temperatures and/or pH levels.

Groundwater is generally cold and pathogen free, which is especially important for successful adult holding, incubation, and early rearing life stages. Groundwater sources maintain relatively constant temperatures year-round, typically in the 46 ^{o} to 55 ^{o} F range in the mid-Columbia region. These temperatures are useful for accelerated fish growth and de-icing purposes in the winter, and for blending with surface water to keep hatchery salmon healthy during summer and fall periods when surface water sources typically become too warm.

Surface water is used to acclimate and imprint fish to minimize straying and meet peak flow demands in a cost effective manner. According to the U.S. Geological Survey (USGS) and hatchery intake data, surface water temperatures vary at the cold end of the spectrum between 32° F (freezing) in tributaries and 38 ^{o} F in the mainstem Columbia River. During winter freezes, tributary stream flows drop and the existing hatchery intakes experience icing problems and reduced surface water supply flows. During warm weather, surface water temperatures reach the low 70's on the Entiat, Wenatchee, Methow, and Columbia Rivers, and over 80° F on the Okanogan River. The presence of spawning adult fish above any potential surface water intakes may affect water quality and biological risk factors for Complex hatcheries.

4.1.2.1 Leavenworth NFH Water Supply Criteria

The Leavenworth NFH spring Chinook program presently utilizes peak flows of 7.5 to 8.5 cfs of high quality, cold groundwater pumped from a shallow aquifer along Icicle Creek, and 42 cfs of surface water flow for a maximum combined flow of approximately 50 cfs. The biological criteria and operating schedule presented in Section 3 above indicate that 11.8 cfs of groundwater and surface water flow of 52 cfs are the minimum flows to be provided in order to provide tempering and meet the FWS flow index target of 1.0 lb./gpm*inch for spring Chinook at Leavenworth NFH. The flows used for incubation and early rearing need to be below 45° F, which is colder than most groundwater supplies in the region. These flow rates in particular could be reduced by 50 to 75% by incorporating water disinfection and reuse technology that may entail an increased disease risk.

4.1.2.2 Obtaining New Water Rights

Permits for the quantity of water required for potential new sites not on the mainstem Columbia River would be subject to minimum in-stream flow rules and would be difficult to obtain. Under the Wenatchee River in-stream Flow Rule (Chapter 173-545 WAC) any new consumptive uses are interruptible whenever in-stream flows drop below certain seasonal targets. Although hatchery uses are typically thought of as non-consumptive, the rule has a provision (WAC 173-545-060(10)) that considers any bypass reach to be consumptive with respect to the bypassed portion of the stream and therefore subject to interruption based on flows. This is similar to DOE's definition of consumptive use in their Policy 1020 (Appendix B), which defines a non-consumptive use as "*when water is diverted and returned immediately to the source at the point of diversion following its use in the same quantity as diverted and meets water quality standards for the source, the water use is classified as non-consumptive.*" Water returned to the same pool (defined as less than a 0.05 foot water surface elevation difference between diversion and outfall) would also be considered non-consumptive per the policy; this minimal elevation difference may rule out gravity fed supply and discharge of effluent. Groundwater withdrawals, where the timing or location of the effects of those withdrawals was different than the timing of location effluent return flows, could also be considered consumptive.

There is an option under the Wenatchee rule to complete site specific studies to set a new in-stream flow target for the bypassed reach, but we are not aware of this being successfully applied. The other option is for DOE to make an overriding consideration of public interest (OCPI) determination (i.e., that the public interest in fish propagation benefits outweigh minor impacts to the bypassed reach); benefits from reduced use of Icicle Creek (assuming that is the case) could also support an OCPI determination. About two years ago a permitted supply was developed for a Grant PUD hatchery on Nason Creek near Lake Wenatchee using this approach. Although this is only a 230 foot long bypass reach, it is considered consumptive by DOE. Note also that OCPI has been receiving more scrutiny and resistance from some environmental groups, not because they disagree with a project but because they consider OCPI to undermine the purpose of the flow rules. An effluent pump-back system may be needed to overcome in-stream flow/consumptive use issues.

Water rights for Alternative GS3 (Mainstem Columbia) would require consultation with state and federal agencies (e.g., WDFW, NOAA, Reclamation) and tribes, and appear feasible to obtain.

4.1.3 Biological Analysis

The Leavenworth NFH spring Chinook salmon program is operated as a segregated harvest program with the primary purpose of providing fish for harvest (FWS 2011)[4]. A hatchery program is classified as a segregated type if the intent is for the hatchery population to represent a distinct population that is reproductively isolated from naturally spawning populations in the basin (HSRG et al. 2004)[5]. Segregation from the natural population is maintained through broodstock management wherein only hatchery origin fish (HOR) are used as broodstock and HOR fish are prevented from spawning naturally.

The Hatchery Scientific Review Group (HSRG) determined that the contribution of HOR fish spawning naturally (pHOS), to the overall population is dependent on the biological significance of the natural population. For primary populations, such as Wenatchee River spring Chinook, the HSRG recommends that pHOS not exceed five percent. The FWS Columbia Basin Hatchery Review Team (HRT) estimated that although the program only had an adult stray rate of 2.6 percent (proportion of hatchery fish not returning to the hatchery), Leavenworth NFH fish constituted 34.6 percent (i.e., pHOS) of all carcasses recovered on the spawning grounds (HRT 2007)[6]. According to the HRT,

> *Adult spring Chinook from the Leavenworth NFH composed a combined average of 9% of the natural spawners (i.e. carcass recoveries) in the Chiwawa River, Chickamin Creek and Rock Creek, 53% of the natural spawners in the Little Wenatchee River, 18% of the natural spawners in Nason Creek , 3% of the natural spawners in the White River, Napeequa Creek and Panther Creek, and 89% of the natural spawners in the upper Wenatchee River mainstem.*

In 2014 the FWS updated the Leavenworth NFH stray analysis through return year 2012. The analysis showed that Leavenworth NFH adult stray rates to areas above Tumwater Dam (upper Wenatchee River) averaged 0.8 percent and ranged from 0 to 3.2 percent (FWS 2014)[7]. Leavenworth NFH adult strays were found only in Nason Creek and the Wenatchee River mainstem. The decrease in the stray rate was at least

[4] United States Fish and Wildlife Service. 2011. Hatchery and Genetic Management Plan (HGMP)
[5] Hatchery Scientific Review Group, Washington Department of Fish and Wildlife and Northwest Indian Fish Commission. 2004. HSRG/WDFW/NWIFC Technical Discussion Paper #2: Segregated Hatchery Programs.
[6] FWS. 2007. Columbia River Basin, Columbia Cascade Province, Wenatchee, Entiat and Methow River Watersheds.
[7] FWS 2014. Leavenworth NFH spring Chinook Upper Wenatchee River Impact Analysis.

partially the result of Leavenworth NFH origin adults being removed at Tumwater Dam. As a result of this action, no Leavenworth NFH origin fish were found on the spawning grounds in 2011 and 2012. Thus, the genetic impacts Leavenworth NFH may pose to ESA-listed Upper Wenatchee spring Chinook have been substantially reduced[8].

Leavenworth NFH adults also spawn in Icicle Creek which is defined as a minor spawning area for Wenatchee River spring Chinook. The 2011 HGMP indicates that 7.9% of all Leavenworth NFH coded-wire tag recoveries were obtained from carcasses in Icicle Creek. From 1996-2006 the average number of Leavenworth NFH spring Chinook spawning naturally in Icicle Creek was 565 fish (FWS 2011). Data collected in 2004 through 2006 showed that the natural spawning population consisted of more than 95 percent hatchery fish from Leavenworth NFH (Murdoch et al. 2007)[9]. Hatchery fish spawning naturally in Icicle Creek likely have low reproductive success considering that very few NOR fish return to spawn in this stream.

Leavenworth NFH adults are known to spawn in the Entiat River. Entiat River spring Chinook are listed as Endangered under the ESA. Based on an analysis of spawning data collected in the Entiat River from 2000-2011 the FWS estimated that Leavenworth NFH origin adults composed 2 percent (range 0-10 percent) of the total natural spawning population in this river system (FWS 2012a)[10]. The 2 percent value is considered by the Interior Columbia Basin Recovery Team (ICTRT) to pose little risk to Entiat spring Chinook if not exceeded over three generations (ICTRT 2007)[11,12].

According to the Leavenworth NFH HGMP (FWS 2011), hatchery juvenile releases (1.2 million) pose little predation, competition or disease risks to ESA-listed species in the basin. This is due to multiple factors including:

1. Release Location- Hatchery fish are released into Icicle Creek, a stream that lacks an ESA-listed spring Chinook population. The major spawning areas for ESA-listed spring populations are located at least 20 miles upstream of Icicle Creek.
2. Juvenile Physiology- Hatchery fish are released at a time, size and condition that encourages rapid migration out of the system.
3. Habitat Utilization- Migrating hatchery juveniles are expected to use different habitat than the smaller juvenile steelhead and Chinook fry and fingerlings thereby minimizing the possibility for predation or competition effects to materialize.

A description of how program related biological effects may differ by alternative is provided below.

[8] Errors in marking hatchery fish may result in a small number of these fish being released above Tumwater Dam. This occurs because natural fish abundance is so low that even a few hatchery fish spawning naturally make up a large portion of the total spawning population.
[9] Murdoch A.R., T. Pearsons, T. Maitland, C. Deason, M. Ford and K. Williamson. Monitoring the reproductive success of naturally spawning hatchery and natural spring Chinook salmon in the Wenatchee River.
[10] FWS 2012a. Review of Entiat Basin spring Chinook spawning population, 2001-2011.
[11] ICTRT 2007. Viability Criteria for Application to Interior Columbia Basin Salmonid ESU's.
[12] The ICTRT 2 percent criterion is calculated based on the total number of adult strays from all hatchery populations combined. Based on the FWS analysis, at one time or another fish from nine different hatchery programs have spawned in the Entiat River. From 2000-2011 hatchery fish composed 46 percent of the total natural spawning population.

4.1.4 Policy and Legal

The key policy and legal issues that may be affected by each alternative are as follows:

- Grand Coulee Mitigation
- US v Oregon
- Tribal Usual and Accustomed Fishing Area
- NPDES Compliance

These factors are discussed for each geographically separate alternative below. Following initial screening to three or fewer alternatives, additional factors including NEPA, socioeconomic, capital and operational cost issues may be considered.

4.2 Alternative GS1 - Move Leavenworth NFH Spring Chinook Production to a New Hatchery in the Wenatchee River Basin Upstream of the Icicle Creek Confluence

This alternative would maintain spring Chinook production in the Wenatchee River Basin, with fish production, fish release and broodstock collection sites moved upstream of present locations. This would affect harvest opportunities and impact ESA-listed species in the stream reaches upstream of Tumwater Dam. Nutrient loading issues in the Wenatchee River would remain a significant challenge. No specific sites have been located for this alternative, except that broodstock collection would likely occur at existing Tumwater Dam facilities. Collection of broodstock at Tumwater Dam would require that Leavenworth NFH fish be uniquely marked or that the program be converted to an integrated program that shares local broodstock with other hatchery programs in the basin.

4.2.1 Alternative GS1 – Land Issues

The most likely area for locating a new hatchery on the Wenatchee River upstream of the Icicle Creek confluence, would be above Tumwater Canyon, and downstream of the Lake Wenatchee outlet, (Fig 4-1)

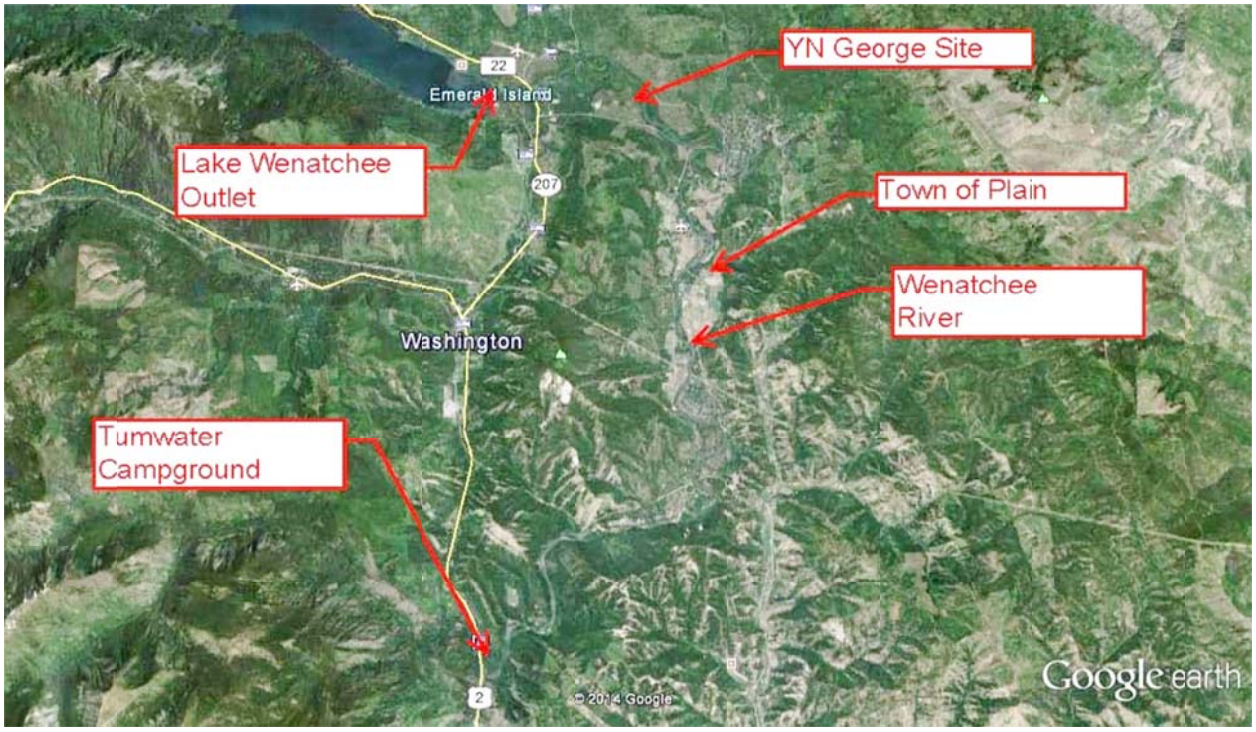


Figure 4-1. Upper Wenatchee River Vicinity

in the vicinity of the town of Plain, Washington (elevation 1,850 feet). There are several miles of low bank property along both sides of the river in this area. Most properties are residential or recreational, with little agricultural development. A review of real estate listings in this area shows that few large parcels of private land are available. Land prices average around $150,000 to $300,000 per acre for smaller 1 to 4 acre developed or developable parcels to $50,000 per acre for larger parcels over 10 acres in size.

The U.S. Forest Service (USFS) manages large parcels of river front land between Plain and Tumwater Canyon. The availability of low bank developable land along the river is limited on the USFS holdings and is generally riparian habitat. A special use permit and rigorous environmental compliance would be required to construct a new hatchery on USFS land.

After a prolonged planning effort, the YN procured a 150 acre parcel of land for a new hatchery site on the Wenatchee River to support the mid-Columbia coho program. This is known as the George site and it is located approximately 2 miles downstream of the Lake Wenatchee outlet. Development of the site has been slowed due to high phosphorous levels in the groundwater supply wells which exacerbates the same effluent discharge issues that are affecting Leavenworth NFH.

A site evaluation study would be needed to determine the feasibility of obtaining a suitable parcel for the large scale hatchery facility proposed for spring Chinook on the Wenatchee River upstream of Icicle Creek.

4.2.2 Alternative GS1 – Water Quantity and Quality

New water rights, for both surface water and groundwater, would need to be applied for and obtained from DOE for any new hatchery development in this area. These are likely to be difficult to obtain.

Groundwater: Water rights and well log information on the DOE website indicate that groundwater development in the upper Wenatchee River basin consists primarily of small wells drilled into shallow aquifers for small community water systems, domestic use for individual residences, and for irrigation of small parcels. The YN recently drilled a well at the George site which is capable of producing 1,100 gpm, (2.5 cfs). Water from this well has higher phosphorous levels than the background levels in the river which may prevent YN from releasing effluent from the proposed hatchery into the river. The prospects for obtaining the groundwater needed to support the spring Chinook program would be determined after detailed hydrogeological studies and test drilling and test pumping activities at a selected site.

Surface Water: It is assumed that adequate quantities of high quality surface water would be available via direct withdrawals from the Wenatchee River. The feasibility of constructing a gravity flow intake vs. a pumped supply would be a site specific determination. It is most likely that surface water pumping would be required at a high cost for both construction and operations. Hatchery sites upstream of the Chiwawa River confluence would tend to have fewer problems with bed load, since Lake Wenatchee would function as a settling basin for the contributing flows from White River and Little Wenatchee Rivers. Late summer surface water temperatures in the Wenatchee River above Icicle Creek exceed 65° F for extended periods, which is well above recommended thresholds for spring Chinook rearing. There would be adult spawning salmon above the intake of a hatchery located on the upper Wenatchee.

Effluent Discharge: It may be possible to transfer the waste load allocation from Leavenworth NFH to a new upstream site. See Section 4.7.4 for additional discussion of NPDES issues.

4.2.3 Alternative GS1- Biological Analysis

In Alternative GS1 the hatchery would be located upstream of Tumwater Dam and below Lake Wenatchee. The predation, competition and disease risks hatchery fish pose to ESA-listed spring Chinook populations would increase as a result of fish being released within or closer to the primary spawning and rearing areas of this species.

Under this alternative, all Leavenworth NFH adult fish arriving at Tumwater Dam would be removed from the system. A portion of the collected fish would be taken as broodstock and the remainder used to meet tribal subsistence needs or other purposes. The removal of all Leavenworth NFH spring Chinook at Tumwater Dam would eliminate deleterious genetic impacts hatchery fish spawning naturally pose to ESA-listed populations upstream of Tumwater Dam[13]. Thus, impacts to natural populations for this alternative would be similar to existing conditions, so long as adults can be effectively removed at the dam.

[13] Hatchery origin adults with no or poor clips may be misidentified and released upstream of Tumwater Dam. However, because clip rates and quality are generally greater than 98 percent the number of misidentified fish is expected to be quite low.

However, removing all Leavenworth NFH origin adults at Tumwater Dam would either require that Leavenworth NFH production be uniquely marked or that the hatchery program be converted to an integrated or stepping-stone program that uses the ESA-listed stock for broodstock.

The operation of Tumwater Dam to collect broodstock for the program may complicate the marking program for other hatcheries, result in increased handling, possible migration delay of other ESA-listed species, and may require expansion or rebuilding of existing trapping and sorting facilities. The long-term existence of and need for Tumwater Dam is being questioned, so a new trap facility at the potential GS1 site may be needed.

Small numbers of Leavenworth NFH fish may stray and continue to spawn in Icicle Creek. Although the number of Leavenworth NFH spring Chinook that would exhibit this behavior is unknown, it is likely to be less than under current conditions as adult fish would not have imprinted to the stream as juveniles. The vast majority of the returning adults should migrate past Icicle Creek to Tumwater Dam. Program operation and facility impacts to fish populations in Icicle Creek would be mostly eliminated[14].

Impacts of the hatchery program to other ESA-listed species at the hatchery site would be minor. Water intake structures would be screened to prevent juvenile fish from entering the hatchery. Adult collection facilities would be designed such that handling mortality would be less than 1 percent.

4.3 Alternative GS2 - Move Leavenworth NFH Spring Chinook Production to a New Hatchery in the Wenatchee River Basin Downstream of the Icicle Creek Confluence

This alternative would maintain spring Chinook production in the Wenatchee River Basin, with fish production, fish release and broodstock collection sites moved downstream of present locations. This would affect harvest opportunities and potentially alter impacts on other fish species in the stream reaches between the new release site and Icicle Creek. Nutrient loading issues in the Wenatchee River would remain a significant challenge. Potential sites include a 24 acre parcel owned by WDFW on the right bank of the Wenatchee River at Dryden Dam, or a presently available 157 acre parcel of private property located on Peshastin Creek just upstream of the Peshastin Irrigation Diversion. Broodstock collection would occur at the existing Dryden Dam trap.

4.3.1 Alternative GS2– Land Issues

Two potential sites have been identified for a new hatchery on the Wenatchee River downstream of Icicle Creek. One site is a 24 acre parcel on the right bank of the river at Dryden Dam (Fig. 4-2), which is owned by WDFW according to the Chelan County assessor's records. Peshastin Creek forms the north boundary of this site as it flows into the Wenatchee River. The other site is a 156 acre parcel of private property located on Peshastin Creek approximately 2 miles upstream of its confluence with the Wenatchee (Fig 4-3).

The Dryden parcel was evaluated by the YN for the mid-Columbia coho program and was identified as the recommended site for a new coho hatchery in the 2012 FEIS prepared by the Bonneville Power

[14] Facility impacts to Icicle Creek fish populations would continue if the Yakama Coho Program was transferred to this location.

Administration (BPA). The site has since been abandoned by the YN due to site remediation issues (lead contamination from a firing range), phosphorous discharge limits, and other development issues raised by Chelan County (Wolfe pers comm. 2014). The site was deemed feasible for hatchery development under the YN planning effort. Land information extracted from the FEIS indicates that the property flood hazard is X500 (between 100 and 500 year flood levels), that it is used for storage of highway sand by Washington Department of Transportation (WSDOT), presently provides access to Dryden Dam, and provides portage for rafters, and angler access to the Wenatchee River. The site has all weather access via plowed roads, and has three-phase power readily available. Discussions with the State of Washington and Chelan County would be needed to obtain current information on property availability and potential development restrictions.

Figure 4-2. Dryden Dam Parcel

The 156 acre Peshastin Creek site has over 3,000 feet of creek frontage along the right bank of Peshastin Creek at elevation 1,200 feet. The downstream end of the site includes an irrigation diversion and fish screening structure operated by Peshastin Irrigation District, with a water right of 50 cfs. The property is presently owned by Elizabeth Keizer and has been listed for sale since April 2014 at an asking price of $1,565,000. The site has access to Highway 97 via a bridge over Peshastin Creek. Three-phase power is available along the highway. Approximately 10 acres of the site are low bank, level pasture along the creek frontage and would be suitable for fish facilities. There are orchards and timber on higher elevation portions of the site. Flood studies would need to be conducted for the low lying portions of the site. It may be feasible to locate fish production facilities on the low lying lands along the creek frontage, with support facilities, such as an office, shop and residences on nearby higher ground. There is a privately owned (Smithson) parcel immediately to the north of the Keizer parcel which has a smaller amount of low bank creek frontage, and is downstream of the irrigation diversion. Though not presently listed for sale, this parcel may offer access to a gravity flow water supply from the downstream side of the irrigation diversion fish screens.

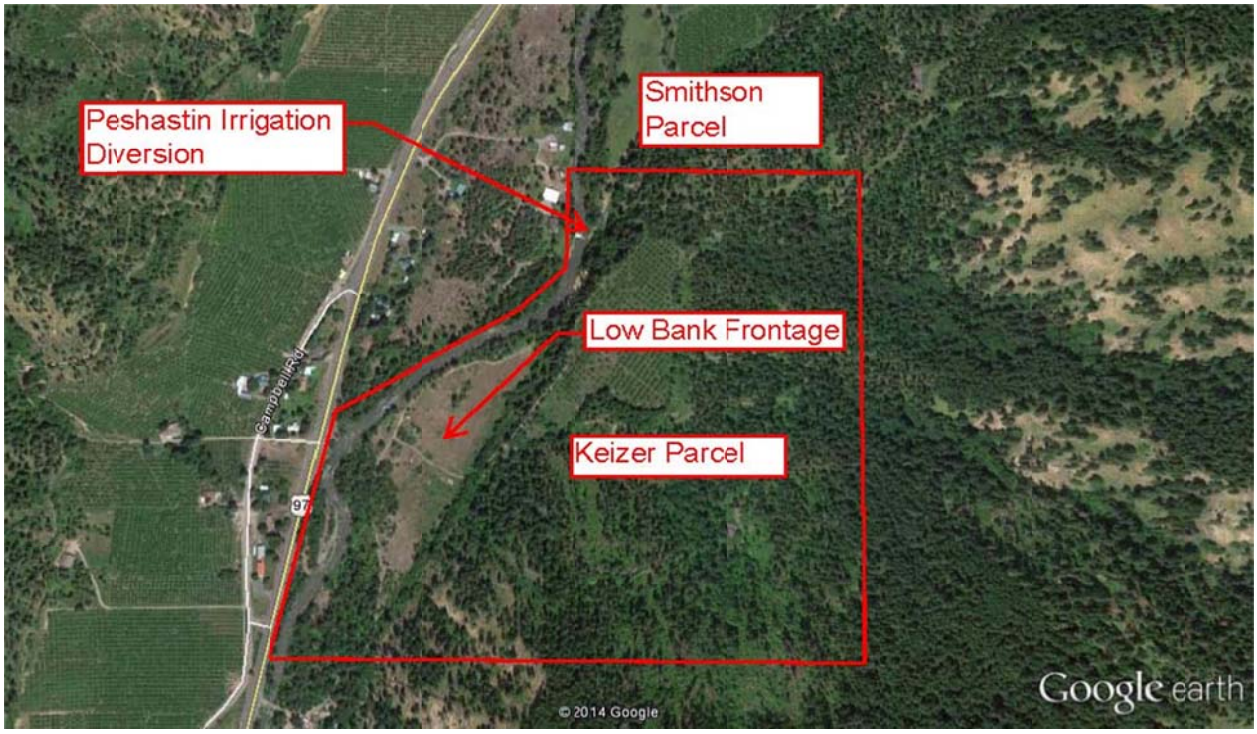


Figure 4-3. Peshastin Creek Parcel

4.3.2 Alternative GS2 – Water Quantity and Quality

Groundwater: The well logs for residential and commercial water supplies in the vicinity of the Dryden Dam site suggest productive aquifer conditions. Water bearing sands and gravels are noted at shallow depths, with well yields in the 20 to 60 gpm range for several 6 to 8-inch wells. There are good prospects for obtaining higher yields from large wells or infiltration galleries. Significant investment in test drilling and pumping would be required to determine if adequate supplies of groundwater would be available at this site.

Well logs for residences in the vicinity of the Peshastin Creek site indicate variable subsurface conditions with thinner water bearing strata and lower yields in the 3 to 20 gpm range. The prospects of developing a high capacity wellfield at this site are not promising due to the more confined canyon morphology which limits the area available for water bearing sand and gravel deposits.

Surface Water: The mid-Columbia coho FEIS indicates that the 4.7 cfs surface water supply for the proposed YN coho hatchery would be Wenatchee River water, pumped from the Dryden Dam fishway. Further study would be required to determine if it is feasible to withdraw the flow required for the spring Chinook program. Late summer surface water temperatures in the Wenatchee River at Dryden exceed 70° F for extended periods, which is well above recommended thresholds for Spring Chinook rearing.

At the downstream (north) end of the Peshastin Creek site, there is an existing irrigation diversion on the right bank that routes surface water through a modern fish screen array and into a canal operated by the Peshastin Irrigation District. The district has a 50 cfs water right for this diversion point according to the DOE website. Utilizing the existing diversion would require a pump back system to move the water back upstream to the Keizer site. Gravity flow may be possible at the Smithson site. It is possible that the existing surface water right could be modified for year-round non-consumptive use by the hatchery if the

irrigation district and DOE were receptive. Late summer surface water temperatures in Peshastin Creek have 10° F diurnal variations, between 60 and 70° F, for extended periods which are well above recommended thresholds for spring Chinook rearing. Late fall and winter flows in Peshastin Creek, particularly during freezing conditions, are not adequate to support the proposed program using single pass rearing. More investigation would be required to determine if water is sufficient for rearing using a reuse system.

Effluent Discharge: It may be possible to transfer the waste load allocation from Leavenworth NFH to a new downstream site. See Section 4.7.4 for additional discussion of NPDES issues.

4.3.3 Alternative GS2 – Biological Analysis

Spring Chinook production would be moved to a site at or near Peshastin Creek under Alternative GS2. Peshastin Creek enters the Wenatchee River at approximately river mile (RM 16.2). This stream is located approximately 9 miles downstream of Icicle Creek. Peshastin Creek is not considered critical habitat for ESA-listed spring Chinook, but is classified as such for steelhead.

The predation, competition and disease risks hatchery fish pose to ESA-listed spring Chinook populations would likely decrease as a result of fish being released further downstream of the primary spawning and rearing areas of this species. Few spring Chinook spawn in Peshastin Creek, and those that have in the past may be the offspring of hatchery releases from Leavenworth NFH.

The existing trap at Dryden Dam does not function well during high water. FWS staff indicate that it is likely not suitable for collection of spring Chinook broodstock and that a new Dryden Trap or a new adult collection facility located in Peshastin Creek would be needed for this alternative. As Peshastin Creek does not have a sustainable run of ESA-listed spring Chinook, hatchery fish that spawned naturally in this stream would pose few genetic risks to this species. Because adult hatchery fish that strayed to Tumwater Dam would be removed from the system, the program would also have little impact to ESA-listed spring Chinook populations in the Upper Wenatchee River.

Impacts of the hatchery program to other ESA-listed species would be minor. Water intake structures would be screened to prevent juvenile fish from entering the hatchery. Adult collection facilities would be designed such that handling mortality would be less than 1 percent.

Program operation and facility impacts to fish populations in Icicle Creek would be eliminated.

4.4 Alternative GS3 - Move present Leavenworth NFH Spring Chinook Production to a Facility on Mainstem Columbia River

This alternative would relocate all Leavenworth NFH spring Chinook production to new facilities on the mainstem of the Columbia River. Adult collection and smolt releases would occur at mainstem facilities which would significantly alter harvest opportunities and socioeconomic benefits. Impacts to ESA fish in the Wenatchee River would be reduced, and nutrient loadings to Icicle Creek and the Wenatchee River associated with spring Chinook production would be eliminated. Three existing hatchery sites have been identified that may have adequate land and water supplies to support the expanded production needed to accommodate the relocated program. These sites include Chief Joseph, Wells, and Colville Resident fish hatcheries.

4.4.1 Alternative GS3 – Land Issues

Informal discussions have been held with the Confederated Colville Tribe (CCT), and the hatchery manager for Chief Joseph Hatchery (CJH), regarding expansion at the CJH or the CCT Resident Fish Hatchery to accommodate the Leavenworth NFH spring Chinook production.

The CJH was recently constructed on US Army Corps of Engineers (COE) land on the right bank of the Columbia River near Bridgeport Washington. There are approximately 7 acres of flat developable land at elevation 860 feet, to the west of the hatchery site and adjacent to an existing COE day use area, (Fig 4-4) which may be available for the relocation. This is about half of the 15 acres needed for the major facility elements. The existing CJH does not currently have any unused rearing capacity. Discussions with COE would be needed to determine whether this site is available and can be used to develop at least a portion of the needed facilities.

Figure 4-4. Chief Joseph Hatchery Vicinity

The CCT resident fish (trout) hatchery was recently evaluated by McMillen under a separate study. This facility is located on the right bank of the Columbia River, four miles downstream from Chief Joseph Dam. The CCT owns a vacant 15 acres parcel immediately west (downstream) of the developed hatchery area (Fig 4-5). This parcel is slightly sloping, low bank pasture with 800 feet of Columbia River frontage at elevation of 830 feet. There is a dirt access road along the south edge of the parcel that is dedicated for tribal access to fishing sites along the river frontage. This parcel has enough land area to support the major project elements identified above. Paved road access and three phase power are available to the site. Formal discussions with the CCT would be needed to determine if the land could be made available to the FWS for spring Chinook production.

Figure 4-5. CCT Resident Fish Hatchery

The Douglas County Public Utility District (DCPUD), Wells Hatchery has been identified as another potential site on the mainstem Columbia River. This facility is located immediately downstream of Wells Dam. DCPUD is presently conducting a modernization plan for this hatchery. The amount of spare land and water that may be available for the spring Chinook program relocation is unknown and does not look promising based on satellite imagery of the developed site in relation to the approximate property boundary shown in Figure 4-6. Discussions with DCPUD would be needed to become familiar with their renovation plans and determine if there are opportunities to utilize a portion of the site.

Figure 4-6. Wells Hatchery Vicinity

4.4.2 Alternative GS3 – Water Quantity and Quality

Groundwater: The CJH has a several high capacity groundwater wells drilled into an aquifer on the right bank of the reservoir upstream of the hatchery site. It is fully utilizing both its surface water and groundwater supply systems for existing spring and summer Chinook programs. The design of the hatchery included development of a 23 cfs groundwater supply that is collected via existing infiltration piping under the right abutment of the dam and discharged to tailwater through a 4-foot diameter conduit. This element was left out of the construction contract due to funding limitations and has an estimated cost of $10 to $15M for the pump station and piping. The pump station design consisted of a 16-foot diameter 80-foot deep secant pile shaft with three 250 hp pumps to lift the groundwater from the relief tunnel, through a 24-inch transmission pipe to the hatchery headbox. Construction of the relief tunnel pump station would likely require a lengthy approval process through COE.

The CCT Resident Fish Hatchery utilizes a pumped groundwater supply for all fish (trout) production. The groundwater is produced from a series of 6 wells drilled 120 to 200 feet apart, along the Columbia River frontage, with a total production of 9 cfs. This well water is surface water influenced with seasonal temperature variations of 10° F (a range of 47 to 57° F), four months out of phase with river water temperatures. The wells have 40 hp submersible pumps with well heads and discharge valves located in buried concrete vaults. The dissolved oxygen content of this groundwater is very low at 4 mg/l. Simple aeration and Low Head Oxygen (LHO) supplementation technology are used to increase the carrying capacity of the water supply. The vacant parcel downstream of the hatchery could accommodate several new wells and prospects are good for obtaining a robust groundwater supply. The relatively warm temperatures of the groundwater at this site in the winter time are not ideal for spring Chinook production and mechanical chilling of incubation and early rearing water may be required.

At Wells Hatchery, groundwater is supplied from a total of 15 wells that produce 1 to 2 cfs each at a temperature averaging 50° F, according to the HGMP. The HGMP also notes that juvenile rearing at this hatchery is constrained by lack of cold water in the late summer months. Detailed discussions would need to be held with DCPUD to determine if adequate water supplies at acceptable temperatures could be developed at this site to meet the needs of the target program in addition to existing hatchery needs.

Surface Water: The CCT Chief Joseph Hatchery utilizes gravity flow surface water from an intake on the upstream side of Chief Joseph Dam. This supply utilized a block-out for an irrigation conduit that was included in the original dam construction. The development of a new gravity flow surface water supply via a second conduit through the dam may also be feasible (though costly), depending on approvals from COE.

At the CCT Resident Hatchery there is no existing surface water supply. A new pumped surface water intake could be constructed on the right bank of the Columbia River upstream of the resident hatchery outfall. The capacity of the pumpstation would range between 19 to 38 cfs depending on whether single pass or water reuse technology were incorporated.

Wells Hatchery utilizes gravity flow surface water from a screened intake on the upstream side of Wells Dam. The total discharge of the hatchery to the Columbia River is 83 cfs according to the 2005 summer Chinook HGMP. The HGMP also notes that juvenile rearing at this hatchery is constrained by lack of cold water in the late summer months. Detailed discussions would need to be held with DCPUD to determine if adequate water supplies at acceptable temperatures could be developed at this site to meet the needs of the target program.

Due to the warm temperatures of the Columbia River surface water in the late summer and fall, additional groundwater supplies above the 4 cfs (with reuse) to 8.5 cfs (single pass) design criteria used at Leavenworth NFH would need to be developed for any of the GS3 alternatives.

Effluent Discharge: This alternative eliminates phosphorous discharge to Icicle Creek except for the any concentrations associated with the YN coho program. An NPDES permit would be required at the new discharge to the Columbia River. See Section 4.7.4 for additional discussion of NPDES issues.

4.4.3 Alternative GS3 – Biological Analysis

In Alternative GS3, all hatchery production would occur at one of three mainstem Columbia River sites:

1. Chief Joseph Hatchery
2. Wells Hatchery
3. Colville Resident Fish Hatchery

Moving hatchery production out of the Wenatchee River basin eliminates virtually all biological program effects to ESA-listed species in the Wenatchee River[15].

[15] Harvest effects are discussed in a separate section of the report.

Hatchery program adult fish may still stray and spawn with natural populations in the Wenatchee River, Methow River and Entiat River[16]. The effect on ESA-listed spring Chinook populations would depend on the number of hatchery spring Chinook that strayed to each basin and the abundance of natural origin fish. Adults from the hatchery program that strayed into the Wenatchee River could still be removed at Dryden and Tumwater dams. This action would ensure that genetic effects to spring Chinook populations in stream reaches above the dams are, for the most part, eliminated.

Program fish straying and spawning in the Entiat River and Methow River would have deleterious genetic effects on ESA-listed spring Chinook populations in these basins. Again, the level of genetic effect would be dependent on the number of hatchery strays and natural origin fish abundance in each basin.

Hatchery fish spawning naturally in the Okanogan River would be of little concern as this species has been extirpated from this basin. However, this assumption may change once the CCT begin reintroducing this species to the Okanogan River in the next few years. The reintroduction program will release 200,000 Methow Composite spring Chinook directly to the Okanogan River.

It should also be noted that the CCT are in the process of implementing a 700,000 spring Chinook segregated hatchery program at Chief Joseph Hatchery. Broodstock for this program will come from Leavenworth NFH. If Leavenworth NFH production is transferred to Chief Joseph Hatchery, then the total number of hatchery spring Chinook released would increase to 1.9 million. This increase in hatchery production may result in more non-target spring Chinook adults spawning in the Okanogan River or Methow River than anticipated by the CCT. The likelihood that the CCT reintroduction program is successful decreases as the proportion of non-Methow Composite stock hatchery fish spawning naturally in the Okanogan River exceeds 5 percent.

Impacts of the hatchery program to other ESA-listed species (summer steelhead) would be minor. Water intake structures would be screened to prevent juvenile fish from entering the hatchery. Adult collection facilities would be designed such that handling mortality would be less than 1 percent.

4.5 Alternative GS4 - Move present Leavenworth NFH Spring Chinook Production to a Facility on the Entiat, Methow, or Okanogan River

This alternative would relocate Leavenworth NFH spring Chinook production to new facilities on one of the other major mid-Columbia River tributaries identified in the Grand Coulee Dam mitigation planning (Cates 2006). Adult collection and smolt releases would occur on the selected tributary, which would significantly alter harvest opportunities and socioeconomic benefits. Impacts to ESA-listed fish in the Wenatchee River would be reduced and redistributed to the selected tributary. Nutrient loadings to Icicle Creek and the Wenatchee River associated with spring Chinook production would be eliminated. Expansion of the existing Entiat NFH and Winthrop NFH sites and several Okanogan River sites that were recently studied for a new steelhead hatchery under a separate contract have been considered as potential sites.

[16] The Okanogan River does not currently support a natural spring Chinook population. Efforts are being initiated to reintroduce spring Chinook to this basin.

4.5.1 Alternative GS4 – Land Issues

Potential sites on the major Columbia River tributaries include the existing Entiat NFH and Winthrop NFH on the Entiat and Methow Rivers respectively, private parcels that have not been explored, and several potential Okanogan River sites that were recently studied for a potential steelhead hatchery.

The undeveloped land at Entiat NFH (Fig. 4-7), consists mostly of relatively flat riparian zones along the river frontage, and a large wetlands area in the central part of the site. It appears that there is not adequate space for construction of the target spring Chinook production facilities at this site, and that any major development would have significant impacts on sensitive areas which would result in high environmental compliance and mitigation costs. Upstream of the hatchery site, the valley widens and there are quite a few agricultural parcels with low bank frontage along the river.

There is a 100 acre parcel of private land with low bank river frontage listed for sale on the Entiat River upstream of the hatchery site for $600,000. A site evaluation study would be needed to determine if there are suitable locations for a large new fish production facility in the Entiat Basin.

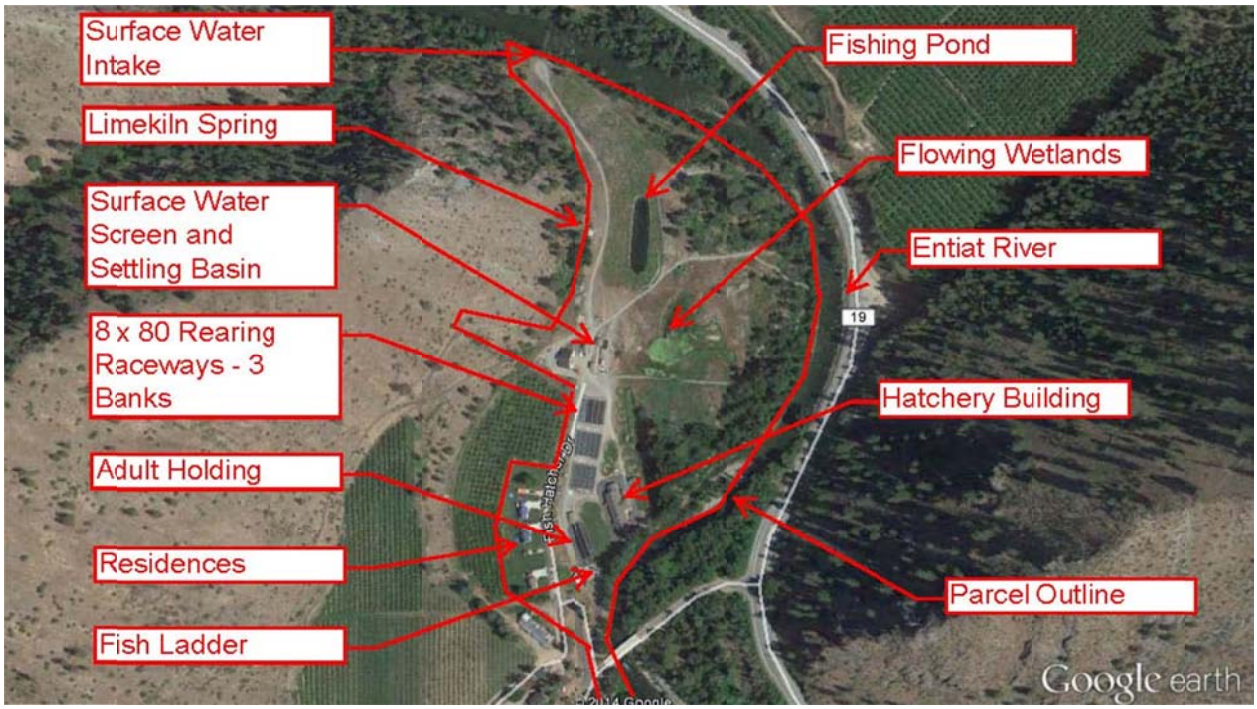


Figure 4-7. Entiat NFH

Similar to Entiat NFH, much of the undeveloped land at Winthrop NFH consists of riparian areas along the Methow River, which would be subject to sensitive areas development conditions. There are 3 to 4 acres of vacant uplands to the west of the kelt reconditioning facility that could accommodate significant rearing facility improvements if an adequate water supply were available. Expansion of the hatchery building to accommodate the required early rearing troughs may be possible if "A" bank or the mostly unused "B" bank Foster-Lucas ponds were demolished and filled in. Overall, it would be difficult to fit the target spring Chinook production within the available land area at Winthrop NFH.

A 48-acre private parcel with low bank Methow River frontage is presently listed for sale at $850,000. Other smaller parcels near the river are listed at $20,000 to $40,000 per acre. A site evaluation study would be needed to determine if there are suitable locations for a large new fish production facility in the Methow Basin.

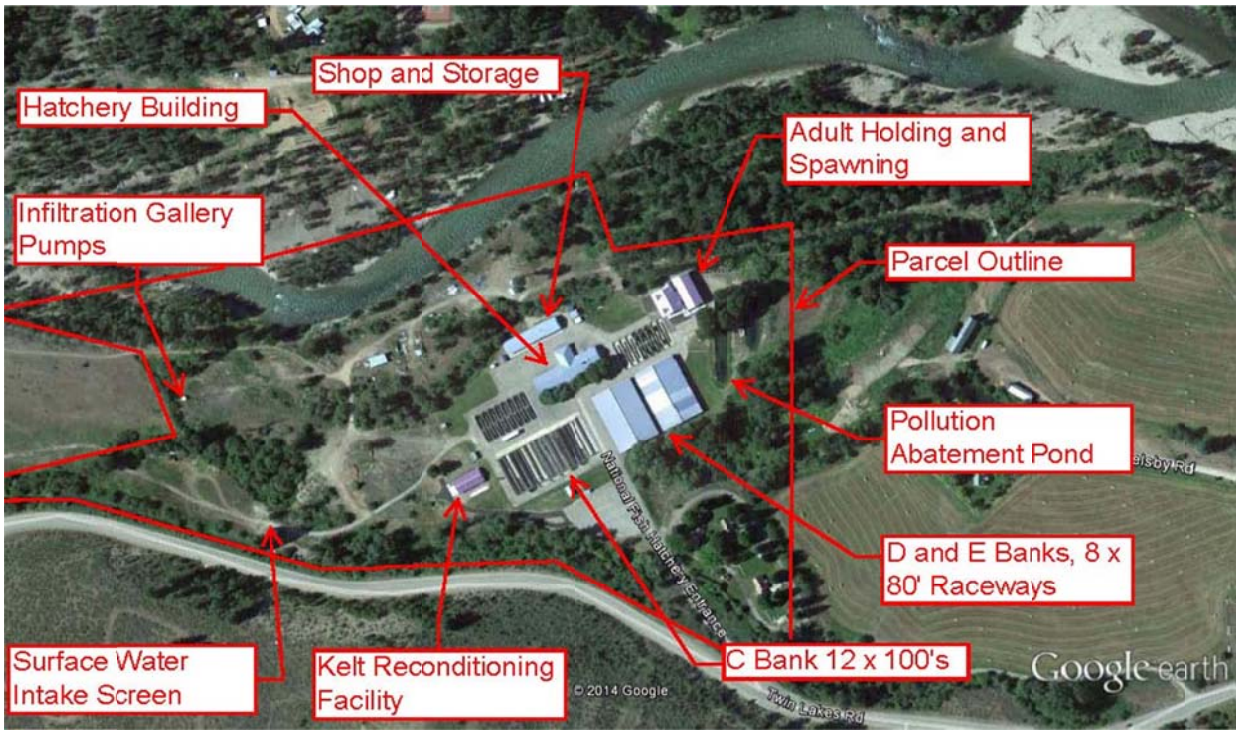


Figure 4-8. Winthrop NFH

Regarding a possible spring Chinook hatchery in the Okanogan watershed, it should be noted that the CCT has been working on re-introducing spring Chinook in the Okanogan for many years. Due to a lack of adequate cold water supplies in the basin during the summer and fall months, the CCT chose to locate its Okanogan spring Chinook artificial propagation facilities for up to 900,000 smolts at the new Chief Joseph Hatchery on the Columbia River.

The CCT also recently completed a draft Master Plan that reviewed potential locations for a new steelhead hatchery on the Okanogan. The proposed steelhead hatchery has a production goal of 100,000 smolts, and would utilize 75% water reuse technology in order to make it feasible to operate that hatchery on a limited cold groundwater supply. Several sites identified in the draft Master Plan could be considered for a Leavenworth NFH alternative:

- 22 Brooks Tract Road, a 4.6 acre site on Omak Creek near the Okanogan confluence. This site is not large enough for the spring Chinook hatchery.
- Sheila Crowder Site, an 88 acre site on the Okanogan River just south of the town of Omak. The low bank portion of this site is in the 100 year floodplain. There is adequate land area on an upland terrace 30 to 50 feet above the floodplain to locate the new spring Chinook hatchery.
- Evelyn Crowder Site, a 15.4 acre parcel on the Okanogan River just south of the town of Okanogan. Approximately 1/3 of this site is in the 100 year floodplain. The land area above the floodplain is not adequate to locate the new spring Chinook hatchery. This was also the

recommended site for the CCT steelhead hatchery, so the CCT is not likely to cooperate with a different program at this site.

- CCT Cassimer Bar Hatchery, a 4 acre site near the confluence of the Okanogan River and the Columbia River. This hatchery was most recently used as a steelhead hatchery and has been mothballed since 2012. This site is too small for the spring Chinook hatchery, however there are adjacent parcels of flat land that may be available.

From a land availability standpoint the Sheila Crowder and Cassimer Bar sites would be most feasible. There are other challenges with these sites however as discussed below.

4.5.2 Alternative GS4 – Water Quantity and Quality

Groundwater: The FWS has been successful at developing groundwater supplies in the Entiat and Methow basins for the Entiat NFH and Winthrop NFH hatcheries as described in Section 2 above. The well water is high quality and has favorable temperatures for fish propagation purposes at the existing facilities. Well yields have decreased by up to 50% over time at Entiat NFH. FWS has invested in well redevelopment to keep production from dropping more than it has. Winthrop NFH generally has adequate well water supplies to meet present production targets, with little surplus. It should also be noted that the water rights for both these facilities date back to 1943 and much development has occurred since then. Any new high capacity wells would need to be located to avoid interferences with existing wells. Water bearing strata is likely to be available at other sites along both of these rivers. Exploratory test drilling and test pumping would need to be conducted at selected sites to verify the availability of adequate well water supplies.

A groundwater feasibility study (AES 2012), conducted by the CCT for the Okanogan steelhead hatchery Master Plan found that water bearing strata along the Okanogan River are limited, with relatively low production potential. The Cassimer Bar Hatchery site at the downstream end of the watershed, has three existing wells with a combined capacity 2.5 cfs and water temperatures in the low 50's F. A review of well logs at sites higher in the basin indicated flows of 100 to 500 gpm per well might be obtainable.

Surface Water: A new surface water right is likely to be difficult to obtain at these sites. A new surface water supply would typically be configured for non-consumptive use with a return to the river a short distance downstream of the withdrawal point. The Entiat River has the highest gradient and would offer the best opportunity for developing a gravity flow water supply within a compact footprint. However, the Entiat River has issues with a neural myxobolid parasite and adult fish above the intake that limit the time periods surface water can be used to November through April. The Methow has a flatter gradient which would make a gravity flow supply more difficult to develop. On the Okanogan River, due to the low gradient of the river and extreme differences between low water and flood stage events, it is unlikely that a gravity flow surface water supply could be developed. The existing acclimation ponds on the Okanogan all use pumped surface water supplies, some with small wells that are used to de-ice intake screens and pond surfaces. The Omak, and Sheila and Evelyn Crowder sites are all in close proximity to potential Okanogan River intake and pumpstation locations. The Cassimer Bar Hatchery site is over 7,000 feet from the Okanogan River and would require a remote pump station with a long transmission pipe to obtain surface water. As noted above, the water temperatures in the Okanogan exceed 80° F in late summer and surface water can only be used in winter and spring, or in limited quantities, and must be blended with groundwater to keep temperatures in the required range for spring Chinook rearing.

Effluent Discharge: An NPDES permit would be required for a new hatchery discharge into the Okanogan River. See Section 4.7.4 for additional discussion of NPDES issues.

4.5.3 Alternative GS4 – Biological Analysis

This alternative would relocate Leavenworth NFH spring Chinook production to new facilities located in the Entiat River, Methow River or Okanogan River. In short, with the implementation of this alternative, hatchery predation, competition, disease, genetic and facility effects of hatchery operations are simply transferred from the Wenatchee River to other basins.

The Entiat River spring Chinook program was evaluated by the HRT, which conducted a benefit/risk analysis of operating a small segregated hatchery program in the basin. The HRT concluded that the biological risks significantly outweighed program benefits. They recommended that the existing 400,000 release segregated program be terminated (HRT 2007). Based on the HRT findings, the risks to naturally produced spring Chinook associated with releasing three times as many spring Chinook (1.2 million) to the Entiat River would be substantially greater and likely not acceptable for implementation by the co-managers.

For the Methow (Winthrop Hatchery) spring Chinook program, the HRT (2007) recommended that to reduce impacts to the natural population hatchery releases should be reduced from 600,000 to 400,000 fish. The HSRG (2009) in their review of the same program concluded that production from the segregated hatchery program could be maintained at 600,000, but would require a method to collect 80 percent of the un-harvested adults. Both groups were concerned about the genetic effects large numbers of hatchery fish spawning naturally would have on listed Methow River spring Chinook fitness and overall survival. Releasing an additional 1.2 million segregated (non-Methow origin) hatchery fish to the basin would dramatically increase genetic risks to the listed population to unacceptable levels. As noted by the HSRG (2009), risks could be reduced if a highly effective weir or other capture techniques could be employed to remove hatchery fish from the system.

Because spring Chinook have been extirpated from the Okanogan River, the release of 1.2 million segregated hatchery fish to this system has little risk associated with it under current conditions. In the future, if the CCT spring Chinook reintroduction integrated program is successful, adult strays from the segregated program spawning naturally would pose a genetic risk to the reintroduced spring Chinook. This could result in the failure of the reintroduction program; however this conclusion is speculative at this point.

The number of hatchery strays from the program could be reduced by:

1. Releasing juvenile fish in the Similkameen River (largest Okanogan tributary) where high summer temperatures would result in near 100 percent pre-spawn mortality for returning adults.
2. Releasing juvenile fish upstream of Zosel Dam and then capturing returning hatchery adults at the dam.

Impacts of the hatchery program to other ESA-listed species (e.g. summer steelhead) would be minor. Water intake structures would be screened to prevent juvenile fish from entering the hatchery. Adult collection facilities would be designed such that handling mortality would be less than 1 percent.

4.6 Alternative GS5 - Maintain Spring Chinook Incubation and Over-winter Acclimation at Leavenworth NFH, Move Juvenile Rearing to a Geographically Separate Site

This alternative would maintain spring Chinook releases in the Wenatchee River Basin, with juvenile rearing moved to a different location either in or out of the Wenatchee River Basin. The smolt release and broodstock collection sites would remain in the present locations. This alternative would maintain usual and customary harvest opportunities. Less surface water would be diverted from Icicle Creek from May through October (after smolt release), which would make more water available to the historical channel. Well water use and nutrient discharges would be reduced for the six month period the fish are held off-site. Potential sites for a juvenile rearing facility would most likely be one of the mainstem locations identified under Alternative GS3 or GS4 in order to minimize nutrient loading issues and impacts on ESA-listed fish. These remote mainstem sites include expansion at existing Chief Joseph, Wells, or Colville Resident fish hatcheries, or utilizing net pens in Lake Rufus Woods.

4.6.1 Alternative GS5 – Land Issues

Under this alternative, a smaller geographically separate site would be needed since many of the critical hatchery functions, including early rearing facilities and offices, would remain at Leavenworth NFH. The major components needed at the new juvenile rearing site would be 75,000 cubic feet of outdoor juvenile rearing volume (twenty 10 x 100 ft raceways), and large water supply systems to provide 40 cfs of surface water and 8 cfs of groundwater. Approximately 5 acres of land would be needed for the juvenile fish production facilities, plus what land is needed to obtain a surface water supply and well field productivity for the new groundwater supply system. Feasible sites considered under the other four general alternatives could be considered for the geographically separate juvenile production.

4.6.2 Alternative GS5 – Water Quantity and Quality

Groundwater: Under this alternative, groundwater demand at the Leavenworth NFH would remain similar to the present demand of 8.5 cfs through February. This demand would then drop off in March as fingerling fish are transferred off station to remote juvenile rearing facilities. The Leavenworth NFH presently transitions the fingerlings from groundwater to surface water by blending the supplies over a 4 month period (February through May) as shown on the operations schedules. This results in high groundwater demands through May at Leavenworth NFH. Groundwater demand for a flow through hatchery at a many of the potential remote juvenile rearing sites would be in the range of 12 to 15 cfs since the surface water would be too warm to use as a sole source from June through at least October. Alternate rearing strategies could be used to address water availability issues.

Surface Water: The peak surface water demand for this alternative is 38 cfs which would occur at Leavenworth NFH just prior to smolt releases in April of each year. Less water surface water would be needed from May to October, after one broodyear is released. The peak surface water demand for the remote juvenile rearing facility would be approximately 25 cfs in October of each year, and would need to be tempered with a cold surface water supply at most sites since surface water is too warm.

Effluent Discharge: There would be reduced effluent discharge to Icicle Creek under this alternative and meeting permit conditions for phosphorous limits would still be difficult during the final two months of rearing (March-April), during the restricted period. A second NPDES permit would be required at the new remote juvenile rearing facility. See Section 4.7.4 for additional discussion of NPDES issues.

4.6.3 Alternative GS5 – Biological Analysis

The major difference between this alternative and the current program is that fish would be reared for six months at an out-of-basin facility before being returned to Leavenworth NFH in November for overwinter acclimation. Out-of-basin rearing would be used to increase flows in the historical channel during low flow periods and reduce the phosphorous load to the Wenatchee River resulting from hatchery operations. Possible sites for the six month out-of-basin rearing period include Chief Joseph Hatchery, Wells Hatchery, Colville Resident Fish Hatchery and/or utilizing net-pens in Lake Rufus Woods.

Because juvenile fish would be released from Leavenworth NFH, predation, competition, disease and hatchery facility effects to natural populations would be similar to current operations. Stream flow conditions in the lower portions of Icicle Creek during the out-of-basin rearing period would improve as water currently used for rearing fish would not be diverted from the stream. During the same period of time, hatchery effluent would not be discharged to the stream which should result in slightly improved water quality.

The major biological concern for this alternative is adult straying. Hatchery fish would be reared on a water source located outside of the basin where adult fish are expected to return. This action could result in program fish straying at increased rates both within the Wenatchee River and to other basins (e.g. Entiat River).

An assumption that fish reared on multiple water sources have relatively high stray rates is supported by data collected on the Chiwawa River spring Chinook program. Fish from this program are reared at Eastbank Hatchery and then transported back to the Wenatchee basin where they are acclimated (over-winter) and then released. From 1992-2012, Chiwawa Hatchery spring Chinook have composed from 9 percent to 63.3 percent of the fish spawning naturally in the Wenatchee River basin. In addition, Chiwawa Hatchery spring Chinook composed 0.4 percent and 5 percent of the total number of spawners in the Methow River and Entiat River, respectively (Hillman et al. 2014)[17]. In contrast, FWS (2012a) estimated that hatchery fish from the Chiwawa program composed 12 percent of the Entiat River natural spawning population from 2000-2011 (FWS 2012a).

Potential program stray rates under this alternative to other basins are speculative and may depend on the facility used for the six month rearing period. The water signature at each facility would be unique and therefore stray rates may be higher or lower than those observed for the Chiwawa program.

According to the HSRG, hatchery fish from programs not integrated with the receiving population should make up less than 5 percent of the total natural spawning population. It should be noted that the <5 percent HSRG stray rate criterion is calculated based on the total number of hatchery fish spawning naturally in the basin. For example, any hatchery strays from the Leavenworth NFH that spawn in the Entiat River would be added to the Chiwawa number to calculate the impact to natural fish. The combined number of strays would therefore exceed the 5 percent criterion unless the stray rate for the Leavenworth NFH program is zero, or the Chiwawa stray rate could be reduced proportionate to the Leavenworth NFH stray rate.

[17] Hillman Tracy, L. Keller, C. Willard, C. Moran, M. Tonseth, M. Hughes, A. Murdoch, B. Ishida, C. Kamphaus, T. Pearsons and P. Graf. 2014. Monitoring and Evaluation of the Chelan and Grant County PUDs Hatchery programs. 2013 Annual Report.

The genetic risks program fish under this alternative pose to natural populations in the Wenatchee River are expected to be similar to current conditions. All program adults would be removed at Tumwater Dam to prevent them from spawning with Upper Wenatchee River natural spring Chinook populations; genetic risks to ESA-listed spring Chinook are therefore negligible.

4.7 Geographically Separate Sites - Policy and Legal

The key policy and legal issues that may be affected by each alternative are as follows:

1. Grand Coulee Mitigation
2. US v Oregon
3. Tribal Usual and Accustomed Fishing Areas
4. NPDES Compliance

Brief descriptions of these four policy and legal issues are presented below.

4.7.1 Grand Coulee Mitigation

The Leavenworth National Fish Hatchery Complex was constructed to perpetuate the anadromous fish runs that were blocked by the construction of Grand Coulee Dam (Cates 2006[18]). According to Cates (2006) the mitigation objectives of the hatchery programs were:

1) "to bring by stream rehabilitation and supplemental planting the fish populations in the 677 miles of tributary streams below Grand Coulee and Rock Island Dam up to figures commensurate with the earlier undisturbed conditions and with the natural food supply in these streams."

2) "to produce in addition, by combination of artificial spawning, hatching, feeding, rearing and planting in these streams, a supplemental downstream migration equivalent to that normally produced by the 1,140 miles of streams and tributaries above Grand Coulee Dam."

Based on documents reviewed by Cates (2006), it appears that the mitigation activities would be focused on the major tributaries above Rock Island Dam and below Grand Coulee Dam. These tributaries consist of the Entiat, Methow, Wenatchee and Okanogan Rivers. Cates (2006) concluded that the adult Chinook mitigation objective for the Leavenworth NFH Complex was 48,600 fish.

For this alternatives analysis, it is assumed that any alternative that releases hatchery fish into the Columbia River above Rock Island Dam or its tributaries above Rock Island Dam, including the Entiat River, Methow River, Wenatchee River or Okanogan River, is in compliance with Grand Coulee Mitigation objectives.

4.7.2 US v. Oregon

According to NOAA Fisheries[19]:

[18] Cates, B. 2006. Mitigation objectives for the Leavenworth National Fish Hatchery Complex. January 2006, FWS, Leavenworth, WA. 8 p.

"United States v. Oregon (302 F. Supp. 899) is the on-going federal court proceeding in the United States District Court of Oregon that enforces and implements the Columbia River Treaty tribes' reserved fishing rights. In his 1969 decision, Judge Robert C. Belloni ruled that the Nez Perce, Umatilla, Warm Springs and Yakama tribes, in 1855 treaties signed with the United States government, reserved to the tribes exclusive rights to fish in waters running through their reservations and at "all usual and accustomed places, in common with the citizens of the United States [or citizens of the territory]." The "in common with" language of the treaties was ultimately interpreted by federal courts to mean that these tribes were collectively entitled to harvest up to 50% of the harvestable surplus of the fish runs destined to the tribes' usual and accustomed fishing areas in the Columbia River basin.

After a decade of litigation involving the states of Oregon, Washington, and Idaho and the treaty tribes named above, along with the United States, the parties to the case shifted to implementing the decisions of the Court through negotiated fishery Management Agreements. These Management Agreements are entered as Orders of the District Court of Oregon and are binding on all parties. Tribal and non-tribal fisheries are managed consistent with the US v Oregon Management Agreement (US v Oregon 2008)20. Significant for this analysis is that under the current Management Agreement, federal, state and tribal production programs were negotiated and agreed upon at a detailed level. This agreement spells out harvest and production goals for the Columbia River, and describes legally binding hatchery production numbers and release locations for the Leavenworth NFH Complex. The agreement currently expires in 2017 at which time a new agreement will be negotiated.

Release numbers will remain at 1.2 million smolts under all alternatives, and this aspect of the program will remain consistent with US v Oregon requirements as set forth in Table B1 (Spring Chinook Production for Brood Years 2008-2017). However, Table B1 of the Management Agreement clearly provides that the release site is "on station." Therefore, for this analysis, a change in release location is considered inconsistent with the Agreement and would require consultation with the participating parties to implement. Because the "on station" release site is an element of the Court Order, the U.S. v. Oregon parties would need to agree to a change in that element, and modify the Court Order for a different release location strategy.

It is also worth noting that the current Leavenworth program described in Table B1 has a detailed footnote associated with it, indicating that the US v. Oregon parties anticipate a dynamic discussion about the Leavenworth program leading up to and as part of the new Agreement discussions. Production levels, among other issues, are addressed in the footnote, which reads as follows:

> *The Leavenworth NFH Complex is currently undergoing hatchery review. It is anticipated that there may be changes to the program during the period of this Agreement including program levels, release location, development of locally adapted broodstocks, and marking protocols to meet specific objectives. The Parties will collaboratively develop implementation guidelines per Part III.H. of this Agreement. The Yakama Nation agrees to the reduction in spring Chinook production from 1.625 Million (2005-2008) to 1.2 Million as an interim action to achieve the current objectives with respect to UFWS concerns over water quality, fish health, hatchery infrastructure issues, and ESA straying risks. Restoration back to the 1.625 Million 2005-2007 Interim Agreement program level is the goal of the parties in the future with resolution of these issues.*

---

[19] (http://www.westcoast.fisheries.noaa.gov/fisheries/salmon_steelhead/united_states_v_oregon.html
[20] US v Oregon. 2008. 2008-2017 United States v. Oregon Management Agreement (May 2008).

4.7.3 Tribal Usual and Accustomed Fishing Areas

After substantial legal proceedings, the Colville Tribe and Yakama Nation non-exclusive fishing rights at Wenatshapam were affirmed by the courts. The center of the Wenatshapam fishery is located near the confluence of Icicle Creek and the Wenatchee River. The 1.2 million smolts released from Leavenworth NFH in Icicle Creek produce the adults that comprise the vast majority of the spring Chinook caught by tribal fishers in the Wenatshapam fishery. Icicle Creek provides a terminal fishing area where harvest can occur at high rates with little impact to ESA-listed spring Chinook.

In this analysis, alternatives that might reduce the number of adults returning to Icicle Creek are considered in conflict with tribal fishing rights and would require consultation with US v Oregon parties to implement.

More generally, the Warm Springs, Umatilla, Nez Perce and Yakama tribes have usual and accustomed fishing areas throughout the Columbia River mainstem and its tributaries. As noted above, they have developed a Management Agreement that deals with both harvest and production to give effect to those treaty rights. Any changes in the Leavenworth program that would alter run timing, abundance, stock composition, or other expected contribution of Leavenworth NFH to treaty fisheries at any of those usual and accustomed fishing areas could be challenged as inconsistent with the current Court Order Management Agreement.

4.7.4 NPDES Compliance

Unless the hatchery size is below the thresholds outlined in Section 2 for Concentrated Aquatic Animal Production (CAAP), any geographically separate hatchery location will require coverage under the NPDES permit program. The Washington State TMDL program is administered by the Department of Ecology (DOE). Through research and conversation with DOE staff it was difficult to determine an exact schedule of future TMDL studies within the mid-Columbia Basin. However both Alternatives G1 and G2 are within the Wenatchee Basin and will therefore be under the same permit conditions as the existing Leavenworth NFH site.

Pertinent to Alternative GS4, the Winthrop NFH and Entiat NFH are covered under the NPDES General Permit WAG-13-000 issued to cover Federal Aquaculture Facilities and Aquaculture Facilities located in Indian Country within the boundaries of the State of Washington. This general permit was issued on August 1, 2009. Section I.E.6 of the general permit does not allow discharges to “impaired waters” pursuant to Section 303(d) of the Clean Water Act (CWA). This general permit is scheduled to be re-issued every 5-years. The General Permit expired on July 31, 2014, however the EPA has extended the coverage under this permit until a new permit is issued. The general permit places effluent limits for Total Suspended Solids (TSS), settleable solids and chlorine. The permit also includes effluent monitoring requirements and requirements on specific operations.

The Leavenworth NFH (GS5), is in the Wenatchee River Basin and has been assigned a waste load allocations (WLA) identified in the Wenatchee River Total Maximum Daily Load Study. Therefore the Leavenworth NFH could not be covered under a general permit and is required to obtain a permit directly with the US Environmental Protection Agency (EPA). The NPDES permit for the Leavenworth NFH has not been updated since the adoption of the Wenatchee TMDL in 2009. Evaluation of potential new permit conditions for the Leavenworth NFH were based on draft permit language developed by EPA and distributed for public comment on December 22, 2010. In October, 2011, the Leavenworth NFH

submitted a new NPDES permit application. The draft language would place difficult to achieve phosphorus effluent limits on the Leavenworth NFH.

It is difficult to predict the timeline of the TMDL studies and the NPDES program requirements that may arise out of it. It should be expected that effluent limits on the main stem of the Columbia River will be less stringent than future conditions that may apply to the tributaries that flow into the Columbia River. Therefore Alternative G3 is likely to have less restrictive future effluent limits than the other alternatives.

4.8 Initial Screening Summary

The following sub-sections summarize the above analysis of the initial screening factors used to evaluate the feasibility of geographically separate fish production alternatives. Table 4-2 provides a summary matrix. In addition to these factors, it should also be noted that modernization of an existing facility is a process that can be efficiently implemented using a phased approach, completing smaller projects over a several year period while maintaining the fish production to satisfy legal agreements. Construction of an entirely new hatchery facility at the least cost would require a more concentrated capital outlay. Using a phased approach over a number of years to construct a new hatchery would result in significantly higher construction costs for multiple mobilizations and extended overhead and administrative costs. Reclamation has stated that annual funding for Complex improvements are likely, at most, to be in the $5 to $10M range which would make it difficult to implement a single large capital project efficiently. Including land acquisition, planning, design, environmental compliance, construction and moving costs, the total cost of a geographically separate facility could be in the $30 to $40M range (2014 dollars).

4.8.1 Land Issues Summary

For geographically separate alternatives, the cost and availability of land does not appear to be a limiting factor for feasibility analysis. Alternatives GS1 and GS4 would require a discovery phase to identify actual sites that meet land area requirements followed by selection and acquisition processes. Previously studied sites that have the required 15 to 20 acres of land area include the WDFW Dryden site (GS2), on the Wenatchee, and the CCT Resident Hatchery (GS3), on the Columbia River. Alternative GS5 requires less land area which increases the number of sites that would provide adequate space including the CJH site. The Wells Hatchery site looks to be the least promising site in terms of land area available.

Table 4-2 LFC Geographically Separate Alternatives Evaluation Matrix
Updated: 3/1/15

No.	*Alternative*	*Description*	*Land issues*	*Water Quality*	*Water Quantity and Availability*	*Biological Risks/Benefits*	*Policy/Legal*	*Socio-Economic*	*Environmental Compliance Issues (NEPA, NPDES, etc,)*	*Other Benefits/ Risks*	*Other Comments and Considerations*
1	**Move LNFH spring Chinook production to a new hatchery in the Wentachee Basin, upstream of the Icicle Creek confluence. No specific site has been identified.**	The Leavenworth spring Chinook program is moved to a new site higher in the Wentachee River watershed, most likely on the mainstem of the river. Fish would be produced and released from the new facility. Broodstock collection occurs at existing Tumwater Dam trap.	A siting study would need to be conducted to identify potential locations for the 15-20 acre facility, followed by land acquisition.	Water temperatures are well above 60 F in Wentachee River in July and August. Large amounts of cooler groundwater and/or reuse technology would be needed during that time period. Need to filter and disinfect surface water.	The feasibility of acquiring high quality new water supplies for a new hatchery on the Wenatchee upstream of Icicle Creek are unknown and would be a high risk to project sucess.	Assuming that all HOR fish are removed at Tumwater Dam, this eliminates genetic risks to ESA-listed spring Chinook. Predation, competition and disease effects of the program on ESA-listed spring Chinook would increase over baseline due to fish being released above Tumwater Dam closer to spawning and rearing areas for this species.	Fish are released in the Wenatchee River basin. Sport and tribal harvest of spring Chinook is maintained in the Wenatchee River Basin. However, fishing success at the Wenatshapam fishery may be lower. Under U.S. v. Oregon, any release location changes will require the agreement of all parties and a modification to the Court Order that is in force through 2017.	Harvest and visitation benefits of the program are maintained within the Wenatchee River basin.	NEPA required. Does not reduce phosphorous load in the Wenatchee River. Waste load allocation could be transferred to new site upstream and there would be similar issues meeting phosphorous discharge limits.	FWS has obligations to maintain historically significant structures at LNFH. Public facilites and activites at this site would also be impacted by moving the hatchery.	YN has been trying to develop a much smaller hatchery facility in the Wentachee Basin to support the mid-Columbia coho program for over 20 years at a high cost with little success.
2	**Move LNFH spring Chinook production to a new site in the Wentachee Basin downstream of the Icicle Creek confluence.**	A new hatchery would be constructed near the mouth of Peshastin Creek at Dryden Dam, or a short distance upstream on Peshastin Creek. Broodstock collection would occur at Dryden Dam.	Dryden site owned by WDFW and may be available for purchase. A large site with low bank frontage on Peshastin Creek is for sale.	Surface water temperatures in the Wenatchee River and Peshatin Creek are too warm in summer/fall. Large amounts of groundwater and/or reuse technology would be needed. No known issues with ground water quality - investigation needed.	Difficult to obtain water right for the required surface water supply at Dryden Dam. The availability of groundwater for incubation and early rearing is unknown but promising.. Peshastin Creek flows are too low in winter and geology is not favorable for large scale ground water supply.	At Dryden, surface water supply would likely need to be pumped from the river and disinfected due to presence of spawning fish above the hatchery intake. Genetic risks would be similar to or less than baseline condition as adults would continue to be removed at Tumwater Dam, and fish spawning in Peshastin Creek would have less potential effect on NOR spring Chinook.	Fish are released in the Wenatchee River basin. Sport and tribal harvest of spring Chinook is maintained in the Wenatchee River Basin. However, fishing success at the Wenatshapam fishery may be lower. Under U.S. v. Oregon, any release location changes will require the agreement of all parties and a modification to the Court Order that is in force through 2017.	Harvest and visitation benefits of the program are maintained in the Wenatchee River basin.	NEPA and State Shorelines Development process required. Remediation of lead contamination from firing range may be required. Waste load allocation could be transferred to new site and there would be similar issues meeting phosphorous discharge limits.	FWS has obligations to maintain historically significant structures at LNFH. Public facilites and activites at this site would also be impacted by moving the hatchery.	YN has been trying to develop a much smaller hatchery facility in the Wentachee Basin to support the mid-Columbia coho program for over 20 years at a high cost with little success.
3	**Relocate all present LNFH Spring Chinook production to a site on the mainstem Columbia River such as Chief Joseph, CCT Resident, or Wells Hatcheries**	A new large hatchery would be built to replace LNFH. Only spring Chinook would be reared at the new facility.	Varies depending on site selected. CJH would require COE, BPA and CCT approval. Wells Hatchery would require DCPUD approval. CCT may support development at it's resident hatchery.	Surface water temperatures are too high July - October on the Columbia River. Large amounts of groundwater and perhaps reuse technology would be needed. Need to filter and disinfect surface water	Good potential to develop a water right for the required surface water supplies at these locations. The development of groundwater for adult holding, incubation and early rearing may be feasible.	Moving hatchery production out of the Wenatchee Basin eliminates most impacts on ESA-listed fish in the Wenatchee River. Possible genetic effects to ESA-listed fish in Entiat and Methow due to straying. Okanogan runs mostly extirpated so risks are lower.	Appears to meet GCFMP as fish are released in the identified mitigation area. Fish are not released to the Wenatchee River system. Substantially reduces fishing success in the Wenatshapam fishery. Under U.S. v. Oregon, any release location changes will require the agreement of all parties and a modification to the Court Order that is in force through 2017.	Harvest and visitation benefits are significantly changed. The fishery is moved to the mainstem Columbia which transfers economic benefits to lower river communities and may reduce tribal harvest.	NEPA, State Shorelines, and NPDES may be required for development at an existing site.	FWS has obligations to maintain historically significant structures at LNFH. Public facilites and activites at this site would also be impacted by moving the hatchery.	NOAA Fisheries is looking at reintroducing salmon back above Grand Coulee Dam as part of Columbia River Treaty. If this occurs, rearing fish at Chief Joseph or Cassimer Bar may be beneficial to this effort. Also, reintroduction of fish to above Grand Coulee may reduce/eliminate need for LNFH spring Chinook program.
4	**Relocate all present LNFH Spring Chinook production to a location on a major mid-Columbia River tributary, including Entiat, Methow, or Okanogan Rivers**	A new spring Chinook hatchery would be constructed on one of the major tributaries to meet the original intent of the language in the Grand Coulee Fish Mitigation Plan..	Site evaluation study required to identify 15 to 20 acres of land would be required to replace LNFH at a new site. Land Costs do not appear to be prohibitive.	Will vary depending on site selected. Surface water temperatures are generaly too warm, exceeding 70 F for prolonged periods in the summer/fall. Large amounts of groundwater and/or reuse technology would be needed.	Surface water supply will be difficult to permit. May be feasibile to develop groundwater at some sites. Further study needed.	Issues with ESA-listed fish in Entiat and Methow are similar to the Wenatchee. Okanogan runs mostly extirpated so risks are lower. Genetic risks to NOR spring Chinook in the Entiat and Methow are greater as a dam does not exist to remove hatchery strays; however a weir could be built to mitigate risk.	Appears to meet GCFMP. Fish are not released to the Wenatchee River system. Under U.S. v. Oregon, any release location changes will require the agreement of all parties and a modification to the Court Order that is in force through 2017.	Harvest and visitation benefits are relocated to other communities.	NEPA, State Shorelines and NPDES required for development at a new site.	FWS has obligations to maintain historically significant structures at LNFH. Public facilites and activites at this site would also be impacted by moving the hatchery.	
5	**Maintain LNFH Spring Chinook incubation and acclimation at LNFH. Relocate Spring Chinook juvenile rearing to a geographically separate site either in or out of basin.**	Imprint fish by incubating and acclimating spring Chinook at LNFH. Move fish to a remote site for juvenile rearing March through October to reduce phosphorous discharge during the critical periods of March-May and July-Oct. (final two months of acclimation in March and April would still be problematic for phosphorous).	Requires only 5 to 7 acres of land for new facility since many functions stay at LNFH.	Surface water temperature would be an issue at geographically separate sites. Large amounts of groundwater and/or reuse technology would be needed.	Non -consumptive surface water right may be feasible at potential sites. Large amounts of groundwater likely required and would be a high risk to project success.	Fish stress due to two truck transfer events may affect fish health. Stray rates may increase due to out-of-basin rearing, which imprints juveniles on out-of-basin water sources. Straying may increase genetic risks to the natural spring Chinook populations in the Entiat, Methow and to a lesser extent in the Okanogan River.	Fish continue to be released at present location on Icicle Creek . Meets all requirements as long as production levels do not change.	Harvest benefits likley remain unchanged so long as production level remains at 1.2 M.	NEPA, state Shorelines and NPDES likely required for development at remote site. Partially reduces phosphorous loading associated with Spring Chinook production. Phosphorous levels could be reduced further with shorter acclimation time, less production or using hatchery effluent to meet irrigation needs.	Would accommodate FWS obligation to maintain historically significant structures at LNFH.	Operational costs would be high due to fish transportation and maintenance at two sites.

No land owners have been approached during the preparation of this report. The relocation of program functions may trigger a more detailed site evaluation study depending on which sites are selected based on other factors.

4.8.2 Water Supply Quality and Quantity Summary

Minimum in-stream flow rules would make it difficult to obtain permits and water rights for any of the alternatives considered except for those on the mainstem Columbia River (GS3). There are potential avenues around this restriction (the OCPI process), however they are untested and may spur litigation.

Existing hatcheries in the region generally utilize groundwater from surface water influenced shallow aquifers. These aquifers tend to be more productive and less mineralized than deeper aquifers and have good chemistry qualities for raising fish. However the productivity of existing wells at all three existing Complex hatcheries has declined significantly over time and the trend is likely to continue region wide according to government climate change studies as noted above.

Sites with the highest potential for groundwater development will be in areas where extensive deposits of water bearing sands and gravels have occurred, that are hydraulically connected to surface flow. Sites with known productive aquifers include all of the Columbia River sites (GS3), and the existing Entiat NFH and Winthrop NFH facilities (GS4). Preliminary investigations indicate the Dryden site (GS2) has water bearing strata that might be successfully developed. Sites with lower potential for groundwater development include Peshastin Creek (GS2) and Okanogan River sites (GS4). Aquifer productivity at the existing hatcheries has a pattern of declining over time, so adequate contingencies should be planned for during the design of any new groundwater supply systems.

The major limiting water quality factors are surface water temperatures, high tubidity, and disease vectors due to the presence of spawning adult fish above surface water intakes (and *myxobolus* in the Entiat). The FWS stated criteria is a maximum rearing water temperature of 55° F. All of the sites considered under the geographically separate alternatives have warmer surface water temperatures of at least 70° F than the Icicle Creek supply (which is usually less than 60° F), presently used at Leavenworth NFH. Therefore, a new water supply system at any of the alternate locations would need to have a larger groundwater component, for blending with surface water, or would depend on costly mechanical chilling during the mid-summer through early fall rearing period. The peak rearing flow for the target program during the warm weather time period is 25 to 26 cfs in September-October. Roughly 50% to 60% of this peak flow (12 to 15 cfs) will need to be groundwater in order to meet temperature criteria. Alternatively, water reuse technology could be incorporated to reduce both the groundwater and surface water flow rates by 50% to 75% subject to approval by FWS fish health staff.

The geographically separate sites with the greatest water temperature issues are the Okanogan River sites (GS4) where surface water exceeds 80° F in the summer. Surface water at other sites generally does not exceed the low 70s, which could more feasibly be blended with 50° F groundwater to meet program criteria (if adequate amounts of groundwater are developed).

Surface water supply quantities on tributary streams often become limited during winter cold snaps, when stream flows drop and intake screens and trash racks may become occluded by ice build-up. Hatcheries are generally not allowed to withdraw more than 10% of total stream flow during these low flow periods. Intakes at lower elevations and on larger rivers are less impacted. Since the Columbia River stays above 38° F, the GS3 alternatives would be affected the least by icing and winter time flow

reductions. At the other end of the spectrum, Peshastin Creek (GS2), gaging station data indicates flows of less than 10 cfs for extended periods in the winter. All of the Complex hatcheries have icing issues, with heroic efforts required by Entiat NFH staff to keep surface water flowing most winters.

All of the geographically separate sites, except for the CJH, presently have disease vector exposure with spawning salmon above existing or potential surface water intakes. However, there are long term efforts underway to restore passage above Chief Joseph Dam as well. Entiat NFH in particular has pathogen issues with a neural myxobolid parasite in its surface water supply. Though disinfection of surface water is not presently used at Complex facilities, it will be considered as part of the long term planning effort.

Water reuse technology could be incorporated to reduce both groundwater and surface water source development costs for geographically separate alternatives. Several of these technologies are discussed in detail in Section 6 below.

In summary, the feasibility of obtaining an adequate water right and supply for a geographically separate site is most promising at a mainstem Columbia River site, and is far from certain. The development of the water supply is likely to be a high cost item that would need to incorporate gas stabilization, filtration and disinfection, mechanical chilling and/or water reuse technology in order to meet water quality and quantity objectives.

4.8.3 Biological Analysis Summary

The existing Leavenworth NFH spring Chinook hatchery program is a segregated program that provides fish for harvest. In a segregated program, the goal is to prevent HOR fish from spawning naturally (i.e., minimize pHOS). Currently, the stray rate from the program is relatively low (0.8 percent). A recent analysis showed that few Leavenworth NFH adults spawn naturally upstream of Tumwater Dam (FWS 2014).

To reduce pHOS levels, Leavenworth NFH adults are now marked such that they may be removed at Tumwater Dam. This reduces the genetic risks of the program to ESA-listed spring Chinook populations upstream of the dam. Current hatchery releases pose relative few predation, competition or disease risks to ESA-listed species in the basin due to the current release location in Icicle Creek; the timing of release just prior to outmigration; and differences in habitat use by hatchery juveniles and wild steelhead and Chinook fry.

4.8.3.1 Genetic Risks (pHOS)

Adult hatchery-origin fish arriving at Tumwater Dam would continue to be removed from the system under all alternatives. Thus, impacts to natural spring Chinook populations in the Wenatchee River basin upstream of the dam would be similar to existing conditions. However, the release of juveniles upstream of Tumwater Dam (GS1) would increase the number of adults returning to Tumwater Dam requiring changes in basin adult management and marking.

If releases occur outside the Wenatchee River basin (GS3, GS4), program fish straying and spawning in the Entiat River and Methow River may have deleterious genetic effects on ESA-listed spring Chinook populations in these basins. These effects would likely be magnified if hatchery fish are released directly into these basins (GS4). Program fish spawning naturally in the Okanogan River would be of little concern because this population has been extirpated. However, the CCT recently initiated an integrated

program to reintroduce spring Chinook to the Okanogan River, and hatchery strays could interfere with the success of this program.

Alternative GS5 likely has the highest stray risk associated with it because program fish would be reared on a water source located outside of the basin where adult fish are expected to return. Rearing hatchery fish using multiple water sources is known to increase the stray rate, but the actual stray rate may depend on the facility used for the six month rearing period. Any additional hatchery strays to the Entiat River would result in a stray rate that exceeds the 5 percent HSRG criterion unless the number of strays from other hatchery programs is reduced.

4.8.3.2 Predation, Competition, Disease

The predation, competition and disease risks hatchery fish pose to ESA-listed spring Chinook populations in the Wenatchee River basin depend on the location of hatchery releases. These risks would increase if fish are released on the Wenatchee River upstream of the current hatchery (GS1), which is closer to the primary spawning and rearing areas of this species. These types of impacts would remain unchanged if releases continue to be made at Leavenworth NFH (GS5). In contrast, these risks would likely decrease if fish are released in Peshastin Creek (GS2), which is further downstream of the primary spring Chinook spawning and rearing areas, and would be eliminated if hatchery production is moved out of the Wenatchee River basin (GS3, GS4). However, alternatives GS3 and GS4 transfer these risks to the Methow River and Entiat River spring Chinook populations, and to a lesser extent to the Okanogan River. The presence of the neural myxobolid parasite in the Entiat River, (GS4), would be a disease concern for any new hatchery production there.

4.8.3.3 Effects on Other ESA-listed Species

Under all of the alternatives, impacts of hatchery facilities to other ESA-listed species (e.g., summer steelhead, bull trout) would be minor. Water intake structures would be screened to prevent juvenile fish from entering the hatchery. Adult collection facilities would be designed such that handling mortality would be less than 1 percent. Steelhead, bull trout and spring Chinook migration past Tumwater dam may be delayed in alternative GS1 due to the increased number of fish arriving and being handled under this alternative.

4.8.4 Legal Summary

The U.S. v. Oregon Management Agreement is a binding Order of the District Court of Oregon. Reference to Table B1 and its associated Footnote 5 illustrates that release location changes will require the agreement of all parties to that proceeding, and ultimately a modification to the Court Order that is in force through 2017. Additionally, these terms make it clear that those parties have agreed that many issues associated with the Leavenworth NFH will be addressed “collaboratively” and no one party, is expected to make changes to the current program parameters unilaterally.

Alternatives need to consider impacts to the fishery at Icicle Creek and also to all other treaty reserved fishery areas in Zone 6. Even minor changes to stock, abundance, run timing, ESA risk, or alteration in composition of mixed stocks could have a negative impact on usual and accustomed fishing areas locally and throughout the Columbia River generally and be inconsistent with tribal rights.

4.8.5 Geographically Separate Feasibility Summary

After a review of the initial screening analysis presented above, there was a consensus between the FWS, Reclamation and consulting team that none of the geographically separate alternatives were viable enough to justify advanced screening. The primary factors in reaching this decision include:

- Difficulty in obtaining funding for the project cost of a new $35 to $40M hatchery facility
- Difficulty obtaining adequate new water rights and supplies that also meet water quality criteria at a reasonable cost. This is a potential fatal flaw.
- Straying risks would be a major concern to FWS and regional fisheries managers
- Even minor changes to stock, abundance, run timing, ESA risk, or alteration in composition of mixed stocks could have a negative impact on usual and accustomed fishing areas locally and throughout the Columbia River generally and may be inconsistent with tribal rights.

4.9 Advanced Screening Criteria for Geographically Separate Sites

The following paragraphs describe the methodology that would be used to conduct advanced screening if further study of geographically separate sites is determined to be warranted at some point in the future.

4.9.1 Socioeconomic Analysis

If the FWS decides that assessing the Leavenworth NFH site alternatives (GS1 through GS5) or some subset of these site alternatives is needed, an assessment of harvest and capital/operations-related effects following steps similar to those described in Section 5.0.1 below would be required. Because this assessment would focus on identifying economic effects in comparison to the effects under baseline conditions, the assessment would focus on the following elements:

- Trade-offs in tribal benefits would be described based on where Leavenworth NFH would be located under the alternatives. The assessment would assume that commercial and C&S harvest levels, and resulting benefits, described under baseline conditions would not change, but that the harvest, cultural, and socioeconomic benefits generated by the Leavenworth NFH spring Chinook program would be shifted to a different location, potentially shifting benefits to a different tribe.
- If tribal harvest levels would increase or decrease due to changes to the Leavenworth NFH spring Chinook program and/or to changes in fishing opportunities, effects on baseline socioeconomic benefits (employment and income) would be estimated based on weight, ex-vessel value, income, and employment factors used for the baseline assessment. Any changes in tribal harvest levels (commercial, ceremonial/subsistence, surplus) would need to be developed in consultation with Service staff
- Trade-offs in sport fishing benefits would be described based on where Leavenworth NFH would be located under the alternatives. The assessment would assume that sport catch levels, and resulting benefits, would not change, but that the socioeconomic benefits would be shifted to a different location, potentially shifting some of the benefits to different communities or regions.
- If sport catch levels increase or decrease due to changes to the Leavenworth NFH spring Chinook program and/or to changes in fishing opportunities, effects on baseline socioeconomic benefits attributable to sport fishing would be estimated based on catch-per-trip, spending-per-trip, income, and employment factors used for the baseline assessment. Any changes in sport catch levels would need to be developed in consultation with Service staff.
- Employment and income generated by hatchery construction and operations expenditures would be estimated based on budget and staffing data provided by the project team, including estimated

percentages of local construction and operations spending. Employment and income factors used for the baseline assessment would be used to estimate total (direct, indirect, and induced) employment and income supported by hatchery construction and operations. (Alternatively, budget expenditures and direct staffing levels may be fed through county-level IMPLAN models to estimate total income and employment effects.)

Communities near hatchery facilities that may be affected by shifting tribal harvests, sport angling, and hatchery facilities construction and operations spending to a new location would be identified based on the proximity of communities to hatcheries and fishing areas. The effects of estimated tribal and sport fishing benefits (angler spending, employment, and income) on nearby communities would be assessed. (Note that dispersed benefits and tradeoffs in communities located adjacent to more-distant fisheries, such as in tribal or sport fisheries in the mainstem Columbia River or Pacific Ocean would not be assessed, unless harvest-related information specific to these more-distant fisheries is provided.)

4.9.2 Capital Costs

A more detailed analysis of capital costs for evaluation of geographically separate alternatives would begin based on preparation of a non-site specific, generic design. The generic design would then be modified to address site specific conditions in order to improve the accuracy of the estimate. The estimate would be organized to present the costs by Construction Standards Institute (CSI) specification section. A summary sheet with costs by major division would be provided, along with back-up detail showing unit costs for individual line items within each division. A contingency of at least 30% would be applied due to the conceptual nature of the facility design and unknown site conditions.

4.9.3 Operating Costs

A more detailed analysis of estimated operating costs to be utilized for evaluation of geographically separate alternatives would, as with capital costs, be based on a non-site specific, generic design and location. These costs would then be modified to address site specific operations that could affect the estimated costs. This would involve a detailed analysis of estimated costs for each operational function to meet the program goals (broodstock collection, eggtake, incubation, rearing, marking/ tagging, transport, acclimation and release). Major issues that could impact site specific operating costs include: increased labor, water pumping, heating and/or cooling, and transport. An operational line item summary sheet would be provided along with back-up details showing all unit costs for each line item. The estimate(s) would utilize the most recent cost data provided by FWS for labor, vehicles, and program supplies (shop, office, lab and fish culture functions).

4.9.4 Environmental Compliance

An analysis of environmental compliance issues for geographically separate alternatives would be based on the site adapted generic facility design for each location. The location of a major fish production program at any of the geographically separate sites may require the following based on site conditions and the location of new hatchery components:

- National Environmental Policy Act (NEPA)
- NPDES Permit
- ESA Section 7 Consultation with the FWS and/or NOAA
- USACE Section 404 Permitting
- SHPO Section 106 Consultation

- U.S. EPA Construction General Permit
- U.S. EPA Hazardous Substance Assessment
- Ecology 401 Water Quality Certification
- WDFW Hydraulic Project Approval (HPA)
- WDFW State Environmental Policy Act (SEPA)
- Local Permitting if not located on Federally owned land

SECTION 5
EXISTING SITES ALTERNATIVE EVALUATION

5.0 Introduction

This section provides descriptions and analysis of broad factors that were considered under the alternative scenario of maintaining fish production at the three existing Complex hatchery facilities. These factors include the same initial screening categories used in Section 4 for the geographically separate alternatives; land issues, water quality and quantity, biological risks and benefits, and policy/legal considerations. Additional factors, including socioeconomics, capital, operations and maintenance costs, and environmental compliance are also discussed.

5.0.1 Socio-Economic Introduction

The hatchery fish production programs supported by Complex operations contribute to salmon and steelhead harvests in tribal, commercial, and sport fisheries in the Columbia River Basin and the Pacific Ocean, although the effects in the marine environment are not location specific. Additionally, the programs provide salmon for treaty ceremonial and subsistence harvests and surplus fish for tribal uses in the Columbia River Basin, as well as cultural benefits to these tribes. Operations of hatchery facilities provide additional economic benefits to communities through spending on goods and services in the regional economy, which in turn generate job opportunities. It is understood that FWS and YN provide significant socio-economic value in support of the mid-Columbia coho restoration program at Leavenworth NFH and Winthrop NFH, however Reclamation does not consider this to be a part of the core mission of the Complex and it is outside the scope of this analysis to quantify that value.

For the baseline conditions described in the following sections, harvest levels attributable to the hatchery fish programs are characterized based on average annual harvest levels predicted to be sustained under current program operations. Although data on historical harvests are considered in the estimates, these data are very limited in some cases and, as a result, are not considered representative of harvests currently supported by the hatchery programs. Factors that contribute to this include recent changes in the programs themselves, such as changes in the stocks being reared (e.g., the Entiat NFH program changed from spring to summer Chinook); changes in fish production levels, such as for the Leavenworth NFH and Winthrop NFH spring Chinook programs; and changes in the availability of coded wire tag and fish recovery data (Cooper pers. comm.). As a result of these changes, the harvest levels reported in Table 5-1 below represent the FWS's best predictions of future harvest levels based on relevant harvest data and current program operations.

It should be noted that the predicted harvest levels, however, do not capture or characterize the substantial variability that can occur from year to year. Additionally, the harvest predictions are based on the best available data available at this time, recognizing that new fish recovery data become available on a daily basis and that fish return data reported for recent years may change as new or revised data are reported in the future (Cooper pers. comm.).

Table 5-1. Predicted Average Annual Harvest of Salmon and Steelhead Produced by Current Complex Hatchery Production Programs

Hatchery Program/Fishery	Number Harvested	Percentage of Total
Leavenworth NFH Spring Chinook Program[1]		
Icicle Creek and freshwater vicinity		
Sport	587[2]	10.6%
Treaty ceremonial and subsistence	1,982[3]	35.8%
Hatchery surplus	1,947[4]	35.2%
Columbia River		
Tribal commercial	187[2]	3.4%
Non-tribal commercial	191[2]	3.5%
Sport	631[2]	11.4%
Non-tribal ocean commercial	8[2]	0.1%
Total	5,533	100.0%
Entiat NFH Summer Chinook Program[5]		
Entiat River		
Treaty ceremonial and subsistence	28	0.5%
Hatchery surplus	1,876[4]	29.9%
Columbia River		
Tribal commercial	656[6]	10.4%
Non-tribal commercial	185[6]	2.9%
Sport	930[6]	14.8%
Ocean		
Tribal commercial	95[6]	1.5%
Non-tribal commercial	2,045[6]	32.6%
Sport	465[6]	7.4%
Total	6,280	100.0%
Winthrop NFH Spring Chinook Program[7]		
Methow River		
Treaty ceremonial and subsistence	0[8]	0.0%
Hatchery surplus	884[4]	85.8%
Columbia River		
Tribal commercial	128	12.4%
Sport	18	1.8%
Total	1,030	100.0%
Winthrop NFH Summer Steelhead Program[9]		
Methow River		
Sport	747[10]	54.3%
Treaty ceremonial and subsistence	0[8]	0.0%
Hatchery surplus	0	0.0%
Columbia River		
Tribal commercial	157	11.4%
Sport	472	34.3%
Total	1,376	100.0%

Notes:

[1] Harvest levels were predicted based on program release targets, and on smolt-to-adult survival rates and recovery data, for brood years 2001-2007.

[2] Harvest distributions estimated based on 2001-2006 recovery data.

[3] Icicle Creek tribal harvest accounts for virtually all of this harvest, which is conducted by the Yakama Nation and Colville Confederated Tribes.

[4] Represents hatchery-origin adults surplus to hatchery broodstock needs provided directly to Columbia River tribes (Yakama Nation, Colville Confederated Tribes, Spokane Tribe, Kalispell Tribe, and possibly the Coeur d'Alene Tribe) and food banks.

[5] Because of limited recovery data for this program, which is relatively new, harvest levels were predicted based program release targets, and on smolt-to-adult survival rates and recovery data, for the Wells Hatchery and Okanogan/Similkameen summer Chinook yearling programs, brood years 2000 and 2002-2007.
[6] Because of the lack of recovery data for the Entiat NFH summer Chinook program, harvest distributions for commercial and sport catch were calculated based on a surrogate data for the Wells Hatchery yearling summer Chinook program from return years 2000-2005
[7] Harvest levels were predicted based on program release targets, and on smolt-to-adult survival rates and recovery data, for brood years 2006-2007.
[8] Recovery data indicate no ceremonial and subsistence harvests; however, harvests by the Yakama Nation and Colville Confederated Tribes could occur in the future.
[9] Harvest levels were predicted based on program release targets, and on smolt-to-adult survival rates and recovery data, for brood years 2008-2009.
[10] Includes a small number of Winthrop NFH steelhead caught in the Okanogan and Similkameen rivers.
Source: Cooper pers. comm., October 24, 2014.

Based on the estimated harvest levels attributable to each hatchery programs, current levels of ex-vessel value received by commercial harvesters were estimated based on average weights for Chinook salmon and steelhead and per-pound prices. Similarly, factors were developed for average catch per sportfishing trip and spending per trip to estimate sport angler spending attributable to Complex fish. The estimates of ex-vessel value and angler spending were then used to estimate the number of jobs and the amount of personal income (direct, indirect, and induced) generated by commercial and sport fisheries affected by Complex programs. For evaluating regional effects, economic impact factors were derived from counties comprising the Columbia River Basin.

For estimating the regional economic effects (jobs and personal income) generated by the operations of Complex facilities and by the improvement and repair of existing facilities, the operations and construction estimates presented elsewhere in this report were used as inputs to an IMPLAN input-output model for Chelan and Okanogan counties to generate effects. (IMPLAN is an input-output database and modeling routine. Originally developed by the USDA Forest Service to assist with land and resource management planning, the IMPLAN model is a widely used model employed to assess the regional economic impacts of private and public projects.) Effects were estimated by assuming that 85 percent of spending by Complex employees and 60 percent of Complex spending on goods and services occurs within the two-county area. For construction spending, effects were estimated by assuming that 50 percent of capital spending would occur within the two-county area.

5.1 Leavenworth NFH Analysis

5.1.1 Land Issues

In addition to fish production, the Leavenworth NFH site supports a variety of public outreach, education, and tribal fishing activities. With nearly 157 acres of land, there would be plenty of area that could be made available for facility modifications or expansion if needed. In general, most anticipated modernization activities would occur with the footprint of existing facilities. Improvements that may occur on presently vacant land include new wells and associated pipelines, and perhaps expanded effluent treatment facilities. There are easements for the surface water transmission pipeline which passes through private property to the south and west of the hatchery site.

5.1.2 Water Quantity and Quality

Surface water quantity is generally adequate at Leavenworth NFH, though icing in the winter causes flow reductions and impedes fish feeding. There are some pathogen concerns with surface water quality due to

passage improvements that have increased the presence of adult spawning fish above the intake, mostly July through November. Reclamation is conducting a separate study on potential intake, fish screening, and pipeline improvements. The ability to release cold water from storage in Snow and Nada Lakes in the late summer to cool Icicle Creek above the intake is a significant benefit to fish culture activities and to Icicle Creek temperatures as well. A treatment facility to disinfect at least a portion of the surface water supply should be considered.

As demonstrated in Section 3, groundwater quantity is limited and declining at Leavenworth NFH. Separate studies and investigations are underway to determine groundwater source expansion feasibility. The ground water quality is good for salmon culture. The evaluation of alternative rearing technologies address low water availability or make the best use of the available water are discussed in Section 6.

5.1.3 Biological Risks and Benefits

Based on information presented previously in section 4.3 and the HGMP, program effects on ESA listed spring Chinook and steelhead are likely minor. Genetic effects of Leavenworth NFH hatchery-origin fish spawning naturally with natural-origin spring Chinook are negligible as adult stray rates are within acceptable limits as defined by the ICTRT and HSRG. According to the Leavenworth NFH HGMP (FWS 2011a), hatchery juvenile releases (1.2 million) pose few predation, competition or disease risks to ESA-listed species in the basin. This is due to multiple factors including:

- Release Location- Hatchery fish are released into Icicle Creek, a stream that lacks an ESA-listed spring Chinook population. The major spawning areas for ESA-listed spring populations are located at least 8 miles upstream of the Icicle Creek release location.
- Juvenile Physiology- Hatchery fish are released at a time, size and condition that encourages rapid migration out of the system.
- Habitat Utilization- Migrating hatchery juveniles are expected to use different habitat than the smaller juvenile steelhead and Chinook fry and fingerlings thereby minimizing the possibility for predation or competition effects to materialize.

Fisheries targeting hatchery program spring Chinook are highly regulated to reduce the negative effects these fisheries have on naturally produced spring Chinook and steelhead

In regards to program effects on bull trout, the Biological Opinion (BiOp) for the program concluded that the program is not likely to jeopardize the continuous existence of the coterminous U.S. population of the bull trout, and is not likely to destroy or adversely modify designated critical habitat for the bull trout (FWS 2011b) . The FWS noted that program operations and facilities are likely to cause impaired upstream passage of bull trout and entrainment of bull trout into the hatchery water supply, confinement of bull trout in the hatchery holding ponds and exposure to degraded habitat conditions in the historical channel during August aquifer recharge. The analysis indicated that up to 91 bull trout may be effected by these factors but result in the loss of only 1 fish.

5.1.4 Policy/Legal

Currently the Leavenworth Program meets US v. Oregon obligations (see section 4.7.2) and GCFMP objectives.

The U.S. v. Oregon Management Agreement is a binding Order of the District Court of Oregon. Reference to Table B1 and its associated Footnote 5 illustrates that release location changes will require the agreement of all parties to that proceeding, and ultimately a modification to the Court Order that is in force through 2017. Additionally, these terms make it clear that those parties have agreed that many issues associated with the Leavenworth NFH will be addressed "collaboratively" and no one party is expected to make changes to the current program parameters unilaterally.

Alternatives need to consider impacts to the fishery at Icicle Creek and also to all other treaty reserved fishery areas in Zone 6. Even minor changes to stock, abundance, run timing, ESA risk, or alteration in composition of mixed stocks could have a negative impact on usual and accustomed fishing areas locally and throughout the Columbia River generally, and be inconsistent with tribal rights.

5.1.5 Socio-Economic (Includes Harvest)

Leavenworth NFH is located in the community of Leavenworth in Chelan County. Situated on Icicle Creek, Leavenworth NFH is about 3 miles upstream of the creek's confluence with the Wenatchee River, a tributary to the Columbia River. The hatchery is also the administrative headquarters of the Leavenworth NFH Complex. According to the U.S. Census, the community of Leavenworth had a population of 1,965 in 2010. Nearby communities downstream of the hatchery include Peshastin, Dryden, Cashmere, and Wenatchee.

The harvest goal for Leavenworth NFH is to support tribal and recreational fisheries in Icicle Creek and the mid-Columbia River (U.S. Fish and Wildlife Service 2007). Of the hatchery production programs located at the three hatcheries comprising the Complex, the Leavenworth NFH spring Chinook program provides the most significant benefits to local and regional fisheries (FWS 2007). The spring Chinook program produces adult salmon that are harvested in several fisheries throughout the Columbia River Basin, although the major part of the program's contribution is to the tribal and sport fisheries in a short section of Icicle Creek near the hatchery (FWS 2011). The Leavenworth NFH spring Chinook salmon program is operated as a segregated program and provides the only spring Chinook salmon for recreational harvest opportunities in the upper Columbia River (FWS 2011).

As summarized in Table 5-2, the Leavenworth NFH spring Chinook program provides harvest benefits to both tribal and non-tribal fisheries. In Icicle Creek, Chinook salmon produced by the program are predicted to annually sustain ceremonial and subsistence harvests of 1,982 salmon for the Yakama Nation and Colville Confederated Tribes, and sport harvests of 587 salmon. In addition, the program is anticipated to annually supply Columbia River tribes, including the Yakama Nation, Colville Confederated Tribes, Spokane Tribe, Kalispell Tribe, the Coeur d'Alene Tribe, and local food banks with an average of 1,947 surplus Chinook adults that are trapped at Leavenworth NFH and are in excess of hatchery broodstock needs.

The Icicle Creek sport fishery supported by the Leavenworth NFH spring Chinook program produces important economic benefits for the community of Leavenworth and the regional economy. Leavenworth NFH fish caught in the local sport fishery are estimated to generate an average of $274,000 in annual angler spending, to support an estimated 6 jobs, and generate about $200,000 in personal income in the local economy (Table 5-2). The Icicle Creek spring Chinook salmon fishery is particularly important to tribal members, including members of the Yakama Nation and Colville Confederated Tribes, because it is one of the few remaining places in Washington State that provides a productive fishing opportunity utilizing traditional fishing methods. Salmon caught by tribal members in the Icicle Creek ceremonial and subsistence fishery cannot be assigned a monetary value. Tribes consider salmon sacred, and salmon

plays an integral part in tribal religious and cultural practices, and well as contributing to the physical sustenance of tribal members. Similarly, harvest of surplus fish are essential to local Native American tribes for subsistence and ceremonial purposes, and the monetary value of these fish cannot be estimated. Generally, surplus salmon are provided directly to tribal members for food, but can also be used for ceremonial purposes or even processed and distributed back to tribal members (Cooper pers. comm.).

Table 5-2. Estimated Regional Economic Impacts of Leavenworth NFH Operations

Impact Category	Commercial Ex-Vessel Value	Sport Angler Spending	Jobs[1]	Personal Income
Spring Chinook Program				
Icicle Creek and freshwater vicinity				
Sport	N/A	$274,100	6.2[2]	$199,000[2]
Treaty ceremonial and subsistence	N/A	N/A	N/A	N/A
Hatchery surplus	N/A	N/A	N/A	N/A
Columbia River				
Tribal commercial	$7,600	N/A	0.3[2]	$12,200[2]
Non-tribal commercial	$12,100	N/A	0.2[2]	$9,200[2]
Sport	N/A	$294,000	6.0[2]	$213,900[2]
Non-tribal ocean commercial	$400	N/A	0.0[2]	$1,000[2]
Total	$20,100	$568,100	12.7[2]	$435,300[2]
Leavenworth NFH and Leavenworth NFHC Operations	N/A	N/A	17.0	$1,373,800
Direct Effects	N/A	N/A	13.9	$808,400
Secondary (Indirect & Induced) Effects	N/A	N/A	30.9	$2,182,200
Total				

Notes:
Values are shown in 2013 dollars.
N/A = not applicable.
[1] Includes full- and part-time jobs.
[2] Includes direct and secondary (indirect and induced) effects.
Source: Project team estimates generated using fishery harvest estimates, operations budget expenditures, impact factors, and IMPLAN input-output model software and data files for Chelan and Okanogan counties.

In the mainstem Columbia River, the Leavenworth NFH spring Chinook program is predicted to support an annual tribal commercial fishery averaging 187 spring Chinook salmon (Table 5-1), generating an estimated $7,600 in ex-vessel value for tribal fishers and supporting a small number of jobs (Table 5-2). These harvests typically benefit the Yakama Nation and the Warm Springs, Nez Perce, and Umatilla tribes (Cooper pers. comm.). Additionally, the program supports a predicted annual average sport catch of 631 salmon in the mainstem Columbia River, as well as a minor level of commercial harvest in the Columbia River and ocean. The predicted Columbia River sport catch would generate an estimated $294,000 in angler spending, six jobs, and $213,900 in personal income in the regional economy (Table 5-2).

Other regional economic benefits are generated by Complex operations and administration. Based on currently budgeted staffing levels, Leavenworth NFH operates with a staff of 9 full-time-equivalent (FTE) employees. This includes the hatchery manager, fish biologist, receptionist, purchasing agent, information and education specialists, animal caretakers, and maintenance personnel. In addition, Leavenworth Complex staff consists of the administrative and outreach functions for complex-wide management.

Including Complex staff, the total number of employees located at Leavenworth NFH is currently 17 FTE employees. Budgeted salary expenditures for hatchery and Complex staff totals nearly $1.4 million annually. The spending by employees and Complex on goods and services in the local area generates additional economic activity, supporting an estimated 14 additional jobs and $800,400 in personal income within Chelan and Okanogan counties.

Considered together, the economic benefits of the Icicle Creek sport fishery and Complex operations are important contributors to the local area, supporting an estimated 37 jobs and nearly $2.4 million in personal income to the economy. Most of the direct benefits would accrue to the community of Leavenworth, where the sport fishery and the Complex facilities are located. The secondary benefits of angler spending and the Complex operations are spread throughout the two-county region, but are likely concentrated in Wenatchee, where a greater variety of goods and services are available to regional residents and businesses.

In addition to harvest- and operations-related benefits, Leavenworth NFH provides recreational, educational, and cultural benefits to the local community and to an estimated 150,000 visitors annually through various programs and activities (FWS 2007). Permitted special uses on hatchery lands include a cross-country ski trail system, summer horseback rides, winter sleigh rides, outdoor theater, and weekly meetings and activities for the Friends of Northwest Hatcheries and the Boy Scouts. Other public uses on hatchery lands include sport fishing for spring Chinook salmon, walking on the Icicle Creek Nature Trail, and bicycling and picnicking at Hatchery Park. Requests are received throughout the year for special events produced by community organizations. Leavenworth NFH also provides the following benefits to the local area:

- Public education, cultural, and economic benefits to the community of Leavenworth from the Wenatchee River Salmon Festival, which is held annually at the Leavenworth NFH. This event attracts participants and visitors from throughout Washington State and the Northwest.
- Educational benefits provided to school groups visiting Leavenworth NFH, and benefits provided by the *Kids-in-the-Creek* and *Salmon in the Classroom* programs.
- Cultural benefits provided to Columbia River tribes (Yakama Nation, Colville Confederated Tribes, Spokane Tribe, Kalispell Tribe, Coeur d'Alene Tribe), local chapter of Trout Unlimited, and food banks from distribution of hatchery-origin adults that have entered the hatchery holding ponds and are surplus to broodstock needs. (FWS 2007)

The ongoing economic benefits of the Icicle Creek sport fishery and Leavenworth NFH and Complex operations are important contributors to the regional economy, adding an estimated 37 jobs and nearly $2.4 million in personal income to the economy. These benefits, as well as the cultural, educational, recreational and community benefits of Leavenworth NFH described in the introductory section, would continue under the Leavenworth NFH Existing Site Alternative.

In addition to these benefits, capital spending by Leavenworth NFH on hatchery maintenance and improvements over the 20-year planning period would generate local and regional economic benefits. Preliminary estimates of capital spending over the planning period include an average of $200,000 to be spent annually for small projects, and an average of $3 million to $4 million to be spent every other year on large projects (Reiser pers. comm.). (Note that funding for large project is dependent on annual Congressional appropriations. As a result, the timing and magnitude of spending on large projects is unpredictable.) Assuming that about 50 percent of capital spending occurs within the two-county region (Chelan and Okanogan counties), spending on small projects would annually support an estimated 2 jobs and $83,300 in personal income. During years when large projects occur, capital spending would support

an estimated 27 jobs and $1.4 million in personal income. Most of the direct benefits of capital spending would likely accrue to the community of Leavenworth, but secondary benefits could be spread throughout the two-county region, potentially concentrated in Wenatchee, where a greater variety of goods and services are available to regional residents and businesses. Out-of-region effects would be expected to occur mostly in the Spokane and Seattle areas.

5.1.6 Capital Costs

The Reclamation conducted an infrastructure assessment of the Complex hatcheries in 2011, titled *"2011 Special Examination – Leavenworth Fisheries Complex"*. Building on that assessment, FWS has kept a running list of completed projects and proposed upgrades to modernize the three Complex hatcheries.

The FWS has identified over $32M in capital and deferred maintenance costs to modernize the Leavenworth NFH. Nearly half of this cost ($15M), is an allowance for potential replacement of the surface water delivery system upstream of the screen chamber. A figure of $1.6M is included for replacement of the surface water pipe downstream of the screen chamber which is scheduled for 2015 construction, with a construction contract recently awarded. Other major work items include NMFS compliant fish screens, a new spawning building, electrical upgrades, extensive outdoor rearing unit rehabilitation, yard piping replacements, seismic upgrades to buildings, an effluent pump back system, and demolition of most of the obsolete Foster Lucas ponds. See Section 6 for updated list of modernization items and related costs.

5.1.7 Operating Costs

The annual operating cost data provided by the FWS for the full Complex is included as Appendix E-1 through Appendix E-3. The purpose of this section is to provide an overview of annual operating costs for the full Leavenworth Fisheries Complex (LFC). The annual funding is provided through the Bureau of Reclamation and is based on estimated annual budget for the full LFC. Actual costs on an annual basis may vary somewhat for Leavenworth NFH, Entiat NFH and Winthrop NFH. The cost estimates presented in this section are based on actual staffing at the three facilities and allocations of complex administration and management staff and unallocated direct costs based on actual production. The estimated allocations were necessary for the socioeconomic analysis in this report.

The information shows a total operating budget for Leavenworth NFH, Entiat NFH and Winthrop NFH of $3.652 million. Additional overhead of 26% added to the base operating costs brings the total operations budget to $4.605 million (Table E-1, Appendix E-1 and Appendix E-2). It should be noted that this presentation of annual operating costs does not include the Yakima Nation's kelt program at Winthrop NFH and Coho program at Leavenworth NFH. The budgets for these programs total about $30,000 for the kelt program and $250,000 for the coho program. These funds are provided from the Bonneville Power Administration to the Yakima Nation. It is expected that these funding levels would ramp down commensurate to the reduced coho production at Complex facilities proposed in the YN master plan.

Annual budget information provided for the MCFRO totals $1.30 million and for the Olympia Washington Fish Health Center (OFHC) totals $391,000. The cost information utilized for these budgets was provided as an FY 2014 budget summary from the Grand Coulee budget Fiscal Year 2014 (Appendix E-3). Annual operating costs for Complex, inclusive of the MCFRO and OFHC total $6.296 million (Table E-1, Appendix E-1).

The annual operating costs provided by FWS did not break out all costs for each site. Labor costs for employees assigned to specific sites and some site specific operating costs (site maintenance, etc.) were provided. For the purpose of estimating total annual operating costs for each site, labor and some of the direct costs (which were not allocated by site) were allocated based on the current production numbers for each site (see Table 3.1 Production Targets and Biocriteria). The following assumptions were utilized:

- Labor costs for Complex employees were allocated at 48.58% for Leavenworth NFH, 16.19% for Entiat NFH and 35.22% for Winthrop NFH (see Tables E-2, E-3, and E-4 in Appendix E-1).
- Other operating expenses provided for the full Complex that were not provided as site specific costs allocated at 48.58% for Leavenworth NFH, 16.19% for Entiat NFH and 35.22% for Winthrop NFH (see Appendix E-2).

Based on the assumptions noted above, the estimated annual operating costs for Leavenworth NFH are $1.574 million. With allocation of overhead at 26.08%, assumed annual operating costs would be $1.984 million (Table E-2, Appendix E-1).

5.2 Entiat NFH Analysis

5.2.1 Land Issues

The Entiat NFH parcel is 29.48 acres in size according to the Chelan County assessors office. There are two potential land issues at Entiat NFH. First, it is not known if the site is large enough to allow for development of adequate groundwater supplies. As noted above there appears to be some interference between wells and declining aquifer recharge rates that may be improved by adding new wells with greater spacing. At some point the land area available for well separation may become a limiting factor.

The other issue is with the agricultural use of an adjacent privately owned parcel immediately to the west of the hatchery. FWS staff have concerns with orchard spraying that occurs on this land in close proximity to the outdoor raceways and hatchery housing. The private parcel also shares an access road and a small water right with the hatchery. Tank trucks and other heavy equipment used by the orchard frequently drive through the hatchery which has recently caused some friction according to hatchery staff. The hatchery manager has suggested that FWS consider a purchase or swap with the adjoining land owner to reduce concerns with exposure of fish and hatchery staff and families to agricultural chemical and to relieve tensions over access issues. There is presently a negotiation under way related to the Roaring Creek Diversion Relocation Project that may provide a venue for resolving some of these issues.

5.2.2 Water Quantity and Quality

There are seasonal issues with surface water quantity and quality at Entiat NFH. Anadromous fish are known to access the area around and above the surface water intake and this has the potential to bring salmonid pathogens into the hatchery. This has been experienced in the past with both bacterial and viral disease events near the time of smolt release. There is also a neural myxobolid present in the surface water supply which is an added reason to consider surface water supply disinfection at Entiat NFH. The presence of the neural myxobolid in the river precludes the use of surface water from mid-April through November. Low flows during winter freeze-up are also a persistent problem that needs to be addressed.

Groundwater well production has been declining and is not adequate to meet single pass flow targets. A new infiltration gallery is to be constructed in 2015 to address this problem. Incorporating water reuse

technology could be employed to make better use of available water supplies if source development is not successful. The evaluation of alternative rearing technologies address low water availability or make the best use of the available water are discussed in Section 6.

5.2.3 Biological Risks and Benefits

Biological effects of the Entiat summer Chinook hatchery program on ESA-listed salmonid populations and their habitat are described in detail in the programs' 2013 BiOp (NMFS 2013)[21].

The NMFS BiOP for the program concluded the following:

1. The program is not likely to jeopardize the continued existence of the Upper Columbia River spring-run Chinook salmon endangered species unit (ESU), or destroy or adversely modify designated critical habitat.
2. The program is not likely to adversely affect Upper Columbia River steelhead and their designated habitat.

A finding of "not likely to adversely affect" an ESA-listed species or its designated critical habitat indicates that effects of the action (i.e. the program) are expected to be "discountable, insignificant or completely beneficial".

NMFS's findings for the program were based on a review of seven factors. These factors and NMFS findings for each with respect to effects on spring Chinook are presented in Table 5-3. The analysis indicated that the program effects on spring Chinook and steelhead were for the most part negligible or beneficial[22].

[21] NMFS 2013. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, Section 7(a)(2) Not Likely to Adversely Affect Determination, and Magnusson-Stevens Fishery Conservation and Management Act essential Fish Habitat (EFH) Consultation.

[22] The exact wording in the BiOP for steelhead is as follows: "Effects of the Proposed Action on the UCR Steelhead DPS are insignificant and/or discountable for all seven factors analyzed by NMFS, individually and cumulatively."

Table 5-3. Summary of the effects of the Entiat NFH summer Chinook program on Upper Columbia spring Chinook salmon and designated habitat (NMFS 2013)

Analysis Factor	Range in Potential Effects for this Factor	Analysis Finding
Factor 1- The hatchery program does or does not promote the conservation of genetic resources that represent the ecological and genetic diversity of a salmon ESU or steelhead DPS.	Negligible to negative effect	Negligible effect
Factor 2- Hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities	Negligible to negative effect	Negligible effect
Factor 3- Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas	Negligible to negative effect	Negligible effect
Factor 4- Hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, in the estuary, and in the ocean	Negligible to negative effect	Negligible effect
Factor 5- Research, monitoring, and evaluation that exists because of the hatchery program	Beneficial to negative effect	Beneficial effect
Factor 6- Construction, operation, and maintenance, of facilities that exist because of the hatchery program	Beneficial to negative effect	Negligible effect
Factor 7- Fisheries that exist because of the hatchery program	Beneficial to negative effect	Not Applicable

Program effects on bull trout would be similar to those described for spring Chinook and steelhead and would require ESA consultation within FWS.

5.2.4 Policy/Legal

Currently the Entiat NFH meets US v. Oregon obligations (see section 4.7.2) and Grand Coulee fisheries mitigation plan (GCFMP) objectives. There are not any known policy or legal issues presently confronting operations at Entiat NFH.

5.2.5 Socio-Economic (Includes Harvest)

Entiat NFH is located on the Entiat River in Chelan County, about seven miles west of the river's confluence with the Columbia River. The hatchery is situated six miles west of Entiat, a relatively isolated community of 1,110 persons, according to the 2010 Census. Nearby communities located downstream of Entiat include Orondo and Wenatchee on the Columbia River.

In 2007, Entiat NFH terminated its spring Chinook program and in 2011 began producing summer Chinook salmon. The summer Chinook program is intended to function as a segregated program for harvest benefits. Because this is a relatively new program, no salmon recovery data are currently available. As a result, predictions of future harvests supported by this program are based on release targets for the Entiat NFH summer Chinook program, and on smolt-to-adult survival rates and recovery data for the Wells Hatchery and Okanogan/Similkameen summer Chinook yearling programs. The Entiat NFH summer Chinook program is anticipated to perform similarly to these programs (Cooper pers. comm.).

Fisheries potentially benefitting from the Entiat NFH summer Chinook program include fisheries in the Entiat River, mainstem Columbia River, and ocean. As shown in Table 5-4, the Entiat NFH summer Chinook program is predicted to support a limited Entiat River tribal fishery, including providing a small number of salmon for ceremonial and subsistence harvests (which could increase in the future), and nearly 1,900 surplus salmon annually for tribes, potentially including the Yakama Nation, Colville Confederated Tribes, Spokane Tribe, Kalispell Tribe, and the Coeur d'Alene Tribe (Cooper pers. comm.). The religious, cultural, and sustenance benefits provided by the Entiat River ceremonial and subsistence fishery and Entiat NFH surplus fish would be similar to those described previously for Leavenworth NFH.

In the mainstem Columbia River, Entiat NFH hatchery fish are predicted to support an annual average commercial tribal harvest of 656 summer Chinook salmon, benefiting the Yakama Nation, Nez Perce Tribe, and Umatilla Tribe, and a non-tribal commercial harvest of 185 summer Chinook salmon (Table 5-1). These harvests are estimated to generate $33,100 in ex-vessel revenue for tribal fishers and $10,300 in ex-vessel revenue for non-tribal commercial fishers (Table 5-4). Commercial fisheries also support a small number of jobs in the regional economy. In addition to commercial fisheries, mainstem Columbia River sport fisheries benefit from the Entiat NFH summer Chinook program, which supports a predicted average sport catch of 930 salmon per year (Table 5-1). This catch would generate an estimated $434,200 in angler spending, $315,200 in personal income, and nine jobs (Table 5-4). The hatchery program is also predicted to support an ocean harvest that includes a tribal commercial harvest of 95 salmon, a non-tribal commercial harvest of 2,045 salmon, and a sport catch of 465 salmon, generating income and employment in regional economies along the northern Oregon and Washington coast.

Table 5-4. Estimated Regional Economic Impacts of Entiat NFH Operations

Impact Category	Commercial Ex-Vessel Value	Sport Angler Spending	Jobs[1]	Personal Income
Summer Chinook Program				
Entiat River				
Treaty ceremonial and subsistence	N/A	N/A	N/A	N/A
Hatchery surplus	N/A	N/A	N/A	N/A
Columbia River				
Tribal commercial	$33,100	N/A	1.4[2]	$51,500[2]
Non-tribal commercial	$10,300	N/A	0.3[2]	$11,900[2]

Impact Category	Commercial Ex-Vessel Value	Sport Angler Spending	Jobs[1]	Personal Income
Sport	N/A	$434,200	8.8[2]	$315,200[2]
Ocean				
Tribal commercial	$4,300	N/A	0.2[2]	$6,000[2]
Non-tribal commercial	$110,700	N/A	6.0[2]	$220,400[2]
Sport	N/A	$60,500	1.0[2]	$41,100[2]
Total	$158,400	$494,700	17.7[2]	$646,100[2]
Entiat NFH Operations				
Direct Effects	N/A	N/A	3.0	$254,000
Secondary (Indirect & Induced) Effects	N/A	N/A	6.7	$358,700
Total	N/A	N/A	9.7	$612,700

Notes:
Values are shown in 2013 dollars.
N/A = not applicable.
[1] Includes full- and part-time jobs.
[2] Includes direct and secondary (indirect and induced) effects.
Source: Project team estimates generated using fishery harvest estimates, operations budget expenditures, impact factors, and IMPLAN input-output model software and data files for Chelan and Okanogan counties.

Operation of Entiat NFH provides economic benefits to the local and regional economy, particularly to the small community of Entiat, located near the hatchery. The hatchery employs a staff of 3 FTE employees, but also supports an estimated 7 jobs elsewhere in the region through the spending of hatchery employees and hatchery operations-related spending on goods and services. Personal income directly attributable to hatchery employment currently totals about $254,000 annually, with secondary regional income from spending by employees and for hatchery operations totaling about an estimated $358,700 annually. These economic benefits would not only affect the community of Entiat, but also other nearby communities, including the larger communities of Wenatchee and Chelan, where more goods and services are available.

In addition to harvest- and operations-related economic benefits, Entiat NFH provides the following recreational, educational and cultural benefits to the local area, according to an assessment by the FWS (2007).

- Educational benefits provided to school groups from hatchery visitations.
- Educational benefits provided by cooperative outdoor education activities with Entiat High School students and salmon-in-the-classroom activities with Entiat Elementary School students and Mission View Elementary School.
- Recreational and educational benefits through partnership in hosting Kid's Fishing Days and Open House events with Entiat Service club, and cooperative outreach activities with the U.S. Forest Service, Entiat Ranger District, including fishing days and camp activities.
- Cultural and sustenance benefits provided to Colville Confederated Tribes, Spokane Tribe, Kalispell Tribe, and Coeur d'Alene Tribe from hatchery-origin adults that are surplus to broodstock needs.

The economic benefits of the Entiat NFH-supported fisheries, including the ceremonial and subsistence fishery in the Entiat River, and Entiat NFH operations are important contributors to the local and regional economy, with operations spending supporting a total of about 10 jobs and an estimated $415,400 in

personal income annually. These benefits, as well as the cultural, educational, recreational and community benefits of Entiat NFH described in the introductory section, would continue under the Entiat NFH Existing Site Alternative.

In addition to these benefits, capital spending by Entiat NFH on hatchery maintenance and improvements over the 20-year planning period would generate a small level of local and regional economic benefits. Preliminary estimates of capital spending over the planning period include an average of $50,000 to be spent annually for small projects and an average of $1 million to be spent every four years on large projects (Reiser pers. comm.). (Note that funding for large project is dependent on annual Congressional appropriations. As a result, the timing and magnitude of spending on large projects is unpredictable.) Assuming that about 50 percent of capital spending occurs within the two-county region (Chelan and Okanogan counties), spending on small projects would annually support an estimated one job and about $21,000 in personal income. During years when large projects are being constructed, capital spending would support an estimated 8 jobs and about $400,000 in personal income. These economic benefits would not only accrue to the community of Entiat, but would also occur in other nearby communities, including the larger communities of Wenatchee and Chelan, where more goods and services are available. Out-of-region effects would be expected to occur mostly in the Spokane and Seattle areas.

5.2.6 Capital Costs

In the 2011 Special Inspection, Reclamation and FWS identified capital and deferred maintenance spending of $1.8M for modernization of Entiat NFH, (not including the cost of the groundwater development project scheduled for 2015). Major cost items include surface water disinfection, intake screen modifications, grating replacement at raceways, and remote monitoring of wells 1-6. The cost of aging pipeline replacements are not included on the FWS list. See Section 6 for updated list of modernization items and related costs.

5.2.7 Operating Costs

The annual operating cost data provided by the FWS for the full Leavenworth Fisheries Complex is included as Appendix E-1 through Appendix E-3.

The information shows a total operating budget for Leavenworth NFH, Entiat NFH and Winthrop NFH of $3.652 million. Additional overhead of 26.08% added to the base operating costs brings the total operations budget to $4.605 million (Table E-1, Appendix E-1 and Appendix E-2).

Annual budget information provided for the MCFRO totals $1.30 million and for the OFHC totals $391,000. The cost information utilized for these budgets was provided as an FY 2014 budget summary from the Grand Coulee budget Fiscal Year 2014 (Appendix E-3). Annual operating costs for Leavenworth Fisheries Complex, inclusive of the MCFRO and OFHC total $6.296 million (Table E-1, Appendix E-1).

The annual operating costs provided by FWS did not break out all costs for each site. Labor costs for employees assigned to specific sites and some site specific operating costs (site maintenance, etc.) were provided. For the purpose of estimating total annual operating costs for each site, labor and some of the direct costs (which were not allocated by site) were allocated based on the current production numbers for each site (see Table 3.1 Production Targets and Biocriteria). The following assumptions were utilized:

- Labor costs for "Leavenworth Complex" employees were allocated at 48.58% for Leavenworth NFH, 16.19% for Entiat NFH and 35.22% for Winthrop NFH (see Tables E-2, E-3, and E-4 in Appendix E-1).
- Other operating expenses provided for the full Leavenworth Complex that were not provided as site specific costs allocated at 48.58% for Leavenworth NFH, 16.19% for Entiat NFH and 35.22% for Winthrop NFH (see Appendix E-2).

Based on the assumptions noted above, the estimated annual operating costs for Entiat NFH are $792,365. With allocation of overhead at 26.08%, assumed annual operating costs would be $999,072 (Table E-3, Appendix E-1).

5.3 Winthrop NFH Analysis

5.3.1 Land Issues

The Winthrop NFH has a land area of 42 acres. There do not appear to be any land issues associated with the modernization of the hatchery. At some point, the land area of the property may be become a limiting factor for the amount of groundwater supply that could be developed from the shallow aquifer that underlies the site.

5.3.2 Water Quantity and Quality

The water rights, quantity and quality of both surface water and groundwater supplies at Winthrop NFH are generally adequate and meet FWS biological criteria. There is a minor shortage of groundwater and little redundant capacity during peak flow periods. The replacement of obsolete Foster-Lucas rearing vessels with modern rearing vessels is a top priority that would allow the facility to utilize its water supply more efficiently. Some segments of the hatchery supply piping are aging and are undersized which limits operational flexibility. Disinfection of at least a portion of the surface water supply and degassing/aeration of the groundwater supply are recommended long term water quality upgrades. The evaluation of alternative rearing technologies address low water availability or make the best use of the available water are discussed in Section 6.

5.3.3 Biological Risks and Benefits

The effects the Winthrop NFH spring Chinook and steelhead programs may have on ESA-listed salmon are described in the HGMP's for each program (FWS 2012b[23] and FWS 2012c[24]). Program effects on bull trout are described in the FWS Biological Assessment (FWS 2014)[25].

ESA consultation with FWS and NMFS is in process and not complete yet. A description of effects each program may have on each of these species is presented by program below.

[23] FWS 2012b. Hatchery and Genetic Management Plan for the Winthrop national Fish Hatchery Spring Chinook Program.

[24] FWS 2012b. Hatchery and Genetic Management Plan for the Winthrop National Fish Hatchery Summer Steelhead Program.

[25] FWS 2014. Biological Assessment for the Operation and Maintenance of Winthrop National Fish Hatchery.

5.3.3.1 Spring Chinook Program

The Winthrop NFH program is a mitigation program operated as an integrated recovery program designed to act as a genetic reserve and safety net program for the spring Chinook conservation hatchery programs at the Methow Fish Hatchery. The program releases 600,000 spring Chinook each year. Of the 600,000 fish produced, 400,000 are released as yearlings in the Methow River and the remainder transferred (as eggs) to the Okanogan River.

Genetic Effects to Spring Chinook

According to the HGMP, Winthrop NFH spring Chinook composed 28.2 percent, 8.7 percent and 2.1 percent of the total natural spawning spring Chinook populations in the Methow River, Chewuch River and Twisp River respectively, from 2000-2011 (FWS 2012b). However, these pHOS levels were observed when the total number of spring Chinook released to the Methow River was 600,000 fish.

Going forward, the program has a goal of maintaining a pHOS value of less than or equal to 25 percent. The 25 percent pHOS target will be met by managing adult escapement at Wells Dam and the hatchery outfalls at Wells Hatchery, Methow Fish Hatchery and Winthrop NFH. Hatchery fish may also be removed from the system using well regulated conservation fisheries. The objective of the adult management actions is to effectively remove from the system ~90 percent of the returning Winthrop NFH and Methow Fish Hatchery adult spring Chinook.

The achievement of pHOS and pNOB objectives for the Winthrop NFH and Methow Fish Hatchery program will result in a proportionate natural influence (PNI) of ~0.67. This value is consistent with HSRG recommendations for an integrated conservation program affecting a population with high biological importance (HSRG et al. 2004). Achieving this level of PNI will ensure that the natural, rather than the hatchery, environment drives local adaptation and that population fitness increases over time.

Hatchery rearing of spring Chinook results in the production of precocious males (i.e. minijacks). Hatchery minijacks could spawn with naturally produced spring Chinook which may result in negative genetic impacts to the population. Harstad et al. (2014)[26] reported that from 11-38 percent of the male spring Chinook sampled at Winthrop NFH were minijacks. However, it is unknown if these minijacks successfully spawn in the Methow River.

Predation, Competition and Disease

The hatchery program is not expected to have significant predation, competition or disease effects on ESA-listed species (HGMP 2012b). The HGMP data were collected before the chiller was installed at Winthrop NFH. The chiller has shortened the rearing period for juveniles by approximately 3 months, which could substantially reduce precocity in males. To reduce impacts to natural populations hatchery fish are released at a time, location and physical condition that minimizes interactions between the two population components.

[26] Harstad D.L., D.A. Larsen and B. Beckman. 2014. Variation in Minijack Rate among Hatchery Populations of Columbia River Basin Spring Chinook. Transactions of the American Fisheries Society, 143:3, 768-778.

Minijacks produced from the program are likely competing with naturally produced salmonids for food and space in the Methow River. However, the extent of this competition and effect on other salmon species is not known.

Facility Structures and Operations

Hatchery intake and water delivery systems are operated consistent with NMFS criteria. The hatchery is also operated such that it is compliant with its NPDES Permit. Impacts to ESA-listed species from hatchery facilities and operations are expected to be minor.

With respect to bull trout, the FWS stated that Winthrop NFH operation and maintenance activities on Methow River bull trout and their critical habitat are minimal or discountable, or will be minimized through the implementation of conservation measures (FWS 2014). However, the FWS also concluded that the Winthrop NFH is likely to adversely affect Methow River bull trout and its critical habitat mainly through capturing, holding, and handling during broodstock collection activities.

5.3.3.2 Summer Steelhead Program

The Winthrop NFH summer steelhead program is operated as an integrated recovery program. The program goal is to produce 200,000 summer steelhead age-2 smolts for release into the Methow River basin. The program will be operated based on the following guidelines:

1. Manage adult escapement to achieve a pHOS < 0.25
2. Maintain a long term 12-year average Proportionate Natural Influence (PNI) of > 0.67.
3. Maintain a yearly PNI > 0.5
4. NOR brood stock extraction will never exceed 35 percent of the NOR run

Adult management actions will be tested from 2016-2022 to determine if pHOS goals can be achieved. Until the results of this test is complete hatchery production will not exceed 100,000 smolts.

Genetic Effects to Summer Steelhead

The summer steelhead program is to be operated consistent with PNI and pHOS guidelines as established by the HSRG (HSRG et al. 2004). Therefore, program effects on the genetics of ESA-listed summer steelhead are expected to be minor as long as the PNI and pHOS criteria are achieved.

Predation, Competition and Disease

The hatchery program is not expected to have significant predation, competition or disease effects on ESA-listed species (HGMP 2012c). To reduce impacts to natural populations hatchery fish are released at a time, location and physical condition that minimizes interactions. Hatchery fish are also volitionally released from the raceways. Unmarked fish that remain in the raceways are not released to the river to reduce residualism rates. The effectiveness of this action is currently being evaluated.

Facility Structures and Operations

See spring Chinook program for analysis findings.

5.3.4 Policy/Legal

Currently the Winthrop NFH meets US v. Oregon obligations (see section 4.7.2) and GCFMP objectives. There are not any known policy or legal issues presently confronting operations at Winthrop NFH.

5.3.5 Socio-Economic (Includes Harvest)

Winthrop NFH is located on the Methow River about 50 river miles northwest of its confluence with the Columbia River. The small community of Winthrop, with a population of about 400 in 2010, is located about a half-mile east of the hatchery. Other small communities in Okanogan County situated along the Methow River downstream of Winthrop NFH include Twisp, Carlton, and Methow.

Currently, Winthrop NFH operates two hatchery programs, a spring Chinook program and a summer steelhead program, providing harvest benefits in both the Methow and Columbia rivers. These benefits are generally smaller than those provided by the Leavenworth NFH and Entiat NFH hatchery programs, as summarized in Table 5-5. Available salmon recovery data indicate that no Treaty ceremonial or subsistence harvest is currently supported in the Methow River by either the spring Chinook or summer steelhead programs, although harvests by the Yakama Nation and the Colville Confederated Tribes could occur in the future (Cooper pers. comm.). The summer steelhead program, however, does support a significant sport fishery in the Methow River, predicted to provide a sport catch averaging 747 steelhead per year (Table 5-1). This catch would generate an estimated $348,800 in angler spending, supporting eight jobs and $253,200 in personal income, in the regional economy (Table 5-5). Additionally, the spring Chinook program is predicted to annually provide an average of 884 hatchery surplus fish to Columbia River tribes, including the Colville Confederated Tribes, the Spokane Tribe, the Yakama Nation, the Kalispell Tribe, and possibly the Coeur d'Alene Tribe. As described for Leavenworth NFH, surplus salmon are provided directly to tribal members for food, but can also be used for ceremonial purposes or even processed and distributed back to tribal members (Cooper pers. comm.).

Table 5-5. Estimated Regional Economic Impacts of Winthrop NFH Operations

Impact Category	Commercial Ex-Vessel Value	Sport Angler Spending	Jobs[1]	Personal Income
Spring Chinook Program				
Methow River				
Treaty ceremonial and subsistence	N/A	N/A	N/A	N/A
Hatchery surplus	N/A	N/A	N/A	N/A
Columbia River				
Tribal commercial	$5,200	N/A	0.2[2]	$8,300[2]
Sport	N/A	$8,400	0.2[2]	$6,100[2]
Subtotal	$5,200	$8,400	0.4[2]	$14,400[2]
Summer Steelhead Program				
Methow River				
Sport	N/A	$348,800	7.9[2]	$253,200[2]
Treaty ceremonial and subsistence	N/A	N/A	N/A	N/A
Hatchery surplus	N/A	N/A	N/A	N/A
Columbia River				
Tribal commercial	$1,200	N/A	0.2[2]	$7,200[2]
Sport	N/A	$220,400	4.5[2]	$160,000[2]
Subtotal	$1,200	$569,200	12.6[2]	$420,400[2]

Impact Category	Commercial Ex-Vessel Value	Sport Angler Spending	Jobs[1]	Personal Income
Total	$6,400	$577,600	13.0[2]	$434,800[2]
Winthrop NFH Operations				
Direct Effects	N/A	N/A	7.0	$487,300
Secondary (Indirect & Induced) Effects	N/A	N/A	10.0	$547,400
Total	N/A	N/A	17.0	$1,034,700

Notes:
Values are shown in 2013 dollars.
N/A = not applicable.
[1] Includes full- and part-time jobs.
[2] Includes direct and secondary (indirect and induced) effects.
Source: Project team estimates generated using fishery harvest estimates, operations budget expenditures, impact factors, and IMPLAN input-output model software and data files for Chelan and Okanogan counties.

In the mainstem Columbia River, the Winthrop NFH spring Chinook program contributes to both a commercial tribal fishery and sport fishery, with catch of Winthrop NFH salmon predicted to annually average 128 and 18 salmon, respectively (Table 5-1). These catch levels would generate an estimated $5,200 in tribal ex-vessel commercial fishing revenue, $8,400 in sport angler spending, $14,400 in personal income, and a small number of jobs in the regional economy (Table 5-5). The benefits of the steelhead program are larger, supporting a predicted harvest of 157 steelhead in the Columbia River commercial tribal fishery and 472 steelhead in the sport fishery. The predicted commercial tribal harvest of Winthrop NFH steelhead would generate an estimated $1,200 in ex-vessel value, $7,200 in personal income, and a small number of jobs. The catch of Winthrop NFH steelhead in the Columbia River sport fishery would generate an estimated $220,400 in angler spending and $160,000 in personal income, and support an estimated five jobs in the regional economy (Table 5-5).

The operation of Winthrop NFH directly provides 7 FWS hatchery jobs and $487,300 in employee compensation. The spending of the hatchery and its employees within the two-county (Chelan and Okanogan) region generates additional secondary benefits, estimated at 10 jobs and $547,400 in personal income (Table 5-5).

The combined local economic benefits attributable to Winthrop NFH's hatchery operations and its summer steelhead sport fishery in the Methow River include an estimated 25 jobs and nearly $1.3 million in personal income. The community of Winthrop, where Winthrop NFH is located, would directly benefit from hatchery operations and the steelhead fishery, but benefits would also accrue to other nearby communities such as Twisp, Carlton, Methow, and Pateros. Because these communities are relatively small, angler and hatchery-related spending also likely leaks to larger communities in the region, such as Chelan, Omak, Wenatchee, and even Spokane.

In addition to harvest- and operations-related benefits, Winthrop NFH provides recreational, educational and cultural benefits to visitors and the local area. According to a recent assessment by the FWS (2007), an estimated 3,000 people visit Winthrop NFH annually for hatchery tours, special events, and walk-in visitation. The main public event at the hatchery is the Kid's Fishing Day, drawing from 400 to 500 people each year. This event also provides educational opportunities. Additionally, the Methow Valley Sports Trail Association uses part of the hatchery grounds for a cross-country ski trail. Other recreational, educational, and cultural benefits provided by Winthrop NFH (U.S. Fish and Wildlife Service 2007) include:

- Educational benefits provided to visitors and school groups through guided and self-guided tours of the hatchery facilities, assisted by way of a brochure and on-the-ground signage. The hatchery serves schools from throughout north central Washington, primarily from the Methow Valley. Many tours are conducted for adult groups, including Elderhostel, tour bus companies, community school and several special interest groups.
- Recreational and educational benefits provided by a hatchery-hosted fishing day for the physically challenged.
- Education benefits provided by the Watershed Watchers event developed for local 7th grade science classes. This is a one-day event that involves a number of watershed related educational activities for the students.
- Research benefits from providing a study population for evaluating conventional versus natural rearing techniques.

The ongoing economic benefits of Winthrop NFH's hatchery operations and its summer steelhead sport fishery in the Methow River include an estimated 25 jobs and nearly $1.3 million in personal income. These benefits, as well as the cultural, educational, recreational and community benefits of Winthrop NFH described in the introductory section, would continue under the Winthrop NFH Existing Site Alternative.

In addition to these benefits, capital spending by Winthrop NFH on hatchery maintenance and improvements over the 20-year planning period would generate a small level of local and regional economic benefits. Preliminary estimates of capital spending over the planning period include an average of $50,000 to be spent annually for small projects and an average of $1 million to be spent every four years on large projects (Reiser pers. comm.). Note that funding for large projects is dependent on annual Congressional appropriations. As a result, the timing and magnitude of spending on large projects is unpredictable.) Assuming that about 50 percent of capital spending occurs within the two-county region (Chelan and Okanogan counties), spending on small projects would annually support an estimated one job and about $21,000 in personal income. During years when large projects are being constructed, capital spending would support an estimated 8 jobs and $400,000 in personal income. The community of Winthrop, where Winthrop NFH is located, would directly benefit from capital spending, but benefits would also accrue to other nearby communities such as Twisp, Carlton, Methow, and Pateros. Because these communities are relatively small, larger communities in the region, such as Chelan, Omak, Wenatchee, and even Spokane, could benefit from capital spending on projects at Winthrop NFH.

5.3.6 Capital Costs

In the 2011 Special Inspection, Reclamation and FWS identified capital and deferred maintenance spending of $5.2M for modernization of Winthrop NFH. The cost of replacing the 36-inch surface water delivery pipe from the screen chamber to the valve vault is not included in this total and it is known to be in poor condition. The major work items on the list are replacement of the three banks of obsolete Foster-Lucas rearing ponds, raceways, and associated piping. See Section 6 for an updated list of upgrades and associated costs. he major work items on the list are centered on replacement of the three banks of obsolete Foster-Lucas rearing ponds and associated piping. See Section 6 for updated modernization items and related costs.

5.3.7 Operating Costs

The annual operating cost data provided by the FWS for the full Complex is included as Appendix E-1 through Appendix E-3.

The information shows a total operating budget for Leavenworth NFH, Entiat NFH and Winthrop NFH of $3.652 million. Additional overhead of 26.08% added to the base operating costs brings the total operations budget to $4.605 million (Table E-1, Appendix E-1 and Appendix E-2).

Annual budget information provided for the MCFRO totals $1.30 million and for the OFHC totals $391,000. The cost information utilized for these budgets was provided as an FY 2014 budget summary from the Grand Coulee budget Fiscal Year 2014 (Appendix E-3). Annual operating costs for Leavenworth Fisheries Complex, inclusive of the MCFRO and OFHC total $6.296 million (Table E-1, Appendix E-1).

The annual operating costs provided by FWS did not break out all costs for each site. Labor costs for employees assigned to specific sites and some site specific operating costs (site maintenance, etc.) were provided. For the purpose of estimating total annual operating costs for each site, labor and some of the direct costs (which were not allocated by site) were allocated based on the current production numbers for each site (see Table 3.1 Production Targets and Biocriteria). The following assumptions were utilized:

- Labor costs for "Leavenworth Complex" employees were allocated at 48.58% for Leavenworth NFH, 16.19% for Entiat NFH and 35.22% for Winthrop NFH (see Tables E-2, E-3, and E-4 in Appendix E-1).
- Other operating expenses provided for the full Leavenworth Complex that were not provided as site specific costs allocated at 48.58% for Leavenworth NFH, 16.19% for Entiat NFH and 35.22% for Winthrop NFH (see Appendix E-2).

Based on the assumptions noted above, the estimated annual operating costs for Winthrop NFH are $1.285 million. With allocation of overhead at 26.08%, assumed annual operating costs would be $1.621 million (Table E-4, Appendix E-1).

5.4 Environmental Compliance – All Sites

Permitting and regulatory requirements are anticipated for modifications to the existing Leavenworth NFH, Entiat NFH and Winthrop NFH. The projects are located on land owned by the US Government and managed by the FWS. It is assumed that in-water work within Icicle Creek, Entiat River, and Methow River would be required upgrades to these facilities. The sections of river adjoining these facilities, where upgrades are planned, are designated critical habitat for the following fish species:

- Icicle Creek (Leavenworth NFH site) – steelhead and bull trout
- Entiat River (Entiat NFH site) – steelhead, bull trout and Chinook salmon
- Methow River (Winthrop NFH) – steelhead, bull trout and Chinook salmon

A list of permits, agency review time, submittal requirements, and supporting documentation for advancing and obtaining the permits to support project construction activities at Leavenworth NFH, Entiat NFH and Winthrop NFH, are summarized in Table 5-6. The review timeframes listed in Table 5-6 are estimated and are based on the recommendations presented in permit guidance documentation and McMillen's experience with other permitting projects in Washington.

Table 5-6. Permits and Approvals / Submittal and Review Requirements

Permit/Approval	Agency Review Time	Submittal / Document Type	Supporting Documentation
Federal			
FWS (Lead Agency) National Environmental Policy Act (NEPA)	~270 days (~9 months)	Categorical Exclusion (CE) or Environmental Assessment (EA) or Environmental Impact Statement (EIS)	-Wetland and Stream Delineation -Design Package
FWS ESA Section 7 Consultation	90 to 180 days (3 to 6 months)	Biological Assessment	-Design Package
NMFS ESA Section 7 Consultation Essential Fish Habitat (EFH)	90 to 180 days (3 to 6 months)	Biological Assessment	-Design Package
COE Section 404 Permit	180 to 270 days (6 to 9 months)	Joint Aquatic Resource Permit Application (JARPA)	-Wetland and Stream Delineation -Design Package
SHPO Section 106 Consultation	90 to 180 days (3 to 6 months	Cultural and Historical Survey Report	
U.S. EPA Construction General Permit	14 days	Electronic Notice of Intent (NOI)	-SWPPP (only if disturbing more than 1 acre)
U.S. EPA Hazardous Substance Assessment	90 to 180 days (3 to 6 months)		Assessment Report
State			
DOE 401 Water Quality Certification	90 to 180 days (3 to 6 months)	JARPA	-Wetland and Stream Delineation -USACE Review
WDFW Hydraulic Project Approval (HPA)	45 days (1.5 months) After SEPA	JARPA	-State Environmental Policy Act (SEPA) compliance
WDFW State Environmental Policy Act (SEPA)	90 to 180 days (3 to 6 months)	SEPA Checklist or NEPA documentation	-Design Package

Chelan and Okanogan Counties do not have jurisdiction over the projects since they are located on federal land.

The following in-water work windows have been established by the regulatory agencies to minimize impacts to fish species during construction.

WDFW

- Icicle Creek – July 1st though July 31st
- Entiat River – July 16th through July 31st
- Methow River – July 1st through July 31st

COE

- Icicle Creek – July 1st through August 15th
- Entiat River – July 1st through August 15th
- Methow River – Non Identified

SECTION 6
INFRASTRUCTURE ALTERNATIVES – 3 EXISTING SITES

6.0 Introduction

This section identifies alternatives for cost effective and programmatically viable infrastructure improvements to the existing fish production facilities at the Complex hatcheries. The alternatives include recommendations that address the following:

- development of water supplies to full utilize and preserve existing water rights,
- deferred maintenance items,
- replacement or modernization of obsolete or poorly functioning fish culture facilities and supporting infrastructure,
- alternative fish culture technologies that may increase fish health, the efficiency of fish production, energy, and water use.

The analysis in this section draws upon facility data provided by FWS, including (but not limited to) original design drawings, a 2011 Special Examination of the Complex by Reclamation and FWS, a 2014 FWS project list summary for all three facilities, site visits/interviews with hatchery operators conducted by the consulting team, and investigations into the latest water reuse and effluent management technologies.

6.1 Modernization and Alternative Rearing Methods Discussion

The need for long term planning to address the effects of climate change, declines in aquifer productivity, effluent management, and difficulty in fully developing available water rights is driving FWS to considering alternative rearing technologies for potential implementation at Complex hatcheries. These technologies may enable FWS to meet full production targets and maintain fish health under increasingly difficult environmental conditions. Alternative technologies may also be used to improve effluent (phosphorous) management and increase the redundancy in the water supply in case of mechanical failures. Three different alternative technologies involving water reuse scenarios have been evaluated for juvenile rearing at the Complex:

- Centralized Partial Recirculating Aquaculture System (PRAS)
- Decentralized PRAS – Optimized Airlifts
- Low Head Oxygen Supplementation – LHO's

Each of these rearing methods has the potential to reduce water demand by 50% to 75%. The general discussion of each technology below is followed by site specific alternatives and implementation costs for each facility. It should be noted that pathogen free groundwater is the recommended make-up water source for systems that employ water reuse technology in order to minimize disease concerns. If surface water were to be used as the make-up water source, for a reuse system, central filtration and UV disinfection would generally be recommended prior to use. Therefore, increased availability of groundwater would likely improve the success of water reuse systems.

The use of circular tanks as an alternative to the rectangular raceways presently used at the Complex is also discussed along with roof covers and refurbishing costs for outdoor rearing units.

6.1.1 Centralized Partial Reuse Aquaculture Systems

Centralized partial reuse aquaculture systems (PRAS) would be systems that are similar to the pilot project installed at Eastbank Hatchery in 2008, and Speas Trout Hatchery in Wyoming. These systems are typically applied to dual drain circular rearing vessels and consist of reuse modules that include particle filtration, a pump sump tank, recirculation pumps, carbon dioxide stripping tower, re-oxygenation, and could include UV disinfection or radial flow separators as options (Figure 6-1, before equipment was enclosed in a building). Suspended solids are concentrated in approximately 15 - 20% of the total flow which leaves the rearing tank through a center bottom drain. The remaining 80 - 85% of the flow leaves the tank through a side drain at the top of the water column and is combined with side drain flow from one or two other tanks. This clarified flow is then treated by the centralized PRAS equipment and returned to the tank along with first pass make-up water. These systems could be used on raceways, but the solids handling advantage of the circular tanks would be lost since solids would remain in tanks for longer periods, and water quality would tend to degrade from the supply end to the drain end of the raceway. This centralized PRAS treatment approach relies on relatively complicated and costly mechanical filtration and water reconditioning equipment compared to the other technologies under consideration.

Figure 6-1. Centralized PRAS at Eastbank Hatchery (Courtesy of PRAqua)

Published data (Eastbank 2008), indicates that PRAS provides adequate water quality for spring Chinook with a 75% reuse rate (Good 2008, Miller 2013) with groundwater as the make-up water source. Trout facilities in Wyoming have been able to increase production by three-fold with the same amount of supply water by replacing linear flow-through raceways with circular tanks on PRAS (Follet 2013).

The rotational flow of the circular tanks recommended for PRAS systems aids in concentrating waste solids to the bottom center of the tank relatively quickly and removing them from the reuse flow passively through the center drain. The solids can be removed through a microscreen drum filter, with a backwash flow carrying the concentrated solids to treatment facilities. The quick removal of the solids aids in reducing the amount of aqueous phosphorus created in the system.

These systems have recently been priced by McMillen's construction division for a now postponed pilot project at Leavenworth Hatchery, and were recently installed by FWS at Hagerman NFH. The approximate cost of PRAS systems is in the range of $90 to $125 per cubic foot of rearing volume (exclusive of demolition and site work costs). It is recommended that the centralized PRAS equipment be located indoors with climate controls to protect the equipment and electronics from temperature extremes, and precipitation. Roof covers over the rearing units are also recommended since they provide multiple benefits including improved predator protection, shade for fish, improved snow management and reduced thermal gain and algal growth.

6.1.2 Decentralized PRAS - Optimized Airlift Pumps

Decentralized PRAS utilizes low pressure air introduced to airlift pump units to circulate water flow, add oxygen, strip carbon dioxide, and reduce make-up water requirements by 50 to 75%, with performance similar to centralized PRAS systems. These systems were developed and optimized by the Freshwater Fisheries Society (FFS) of British Columbia and have been successfully implemented at three of their six resident fish hatcheries. Make up water flow rates and associated groundwater pumping costs have been reduced by 75% in raceways and 82% in circular tanks at trout production facilities.

The units consist of a vertical double wall baffle assembly with a fine bubble diffuser located between the walls near the bottom of the unit. Low pressure air is fed into the diffuser. As the bubbles rise, they draw water in through a screen located in the downstream face of the baffle and direct it out the top upstream side of the unit at the water surface, creating an upstream counter current at the water surface (Fig 6-2).

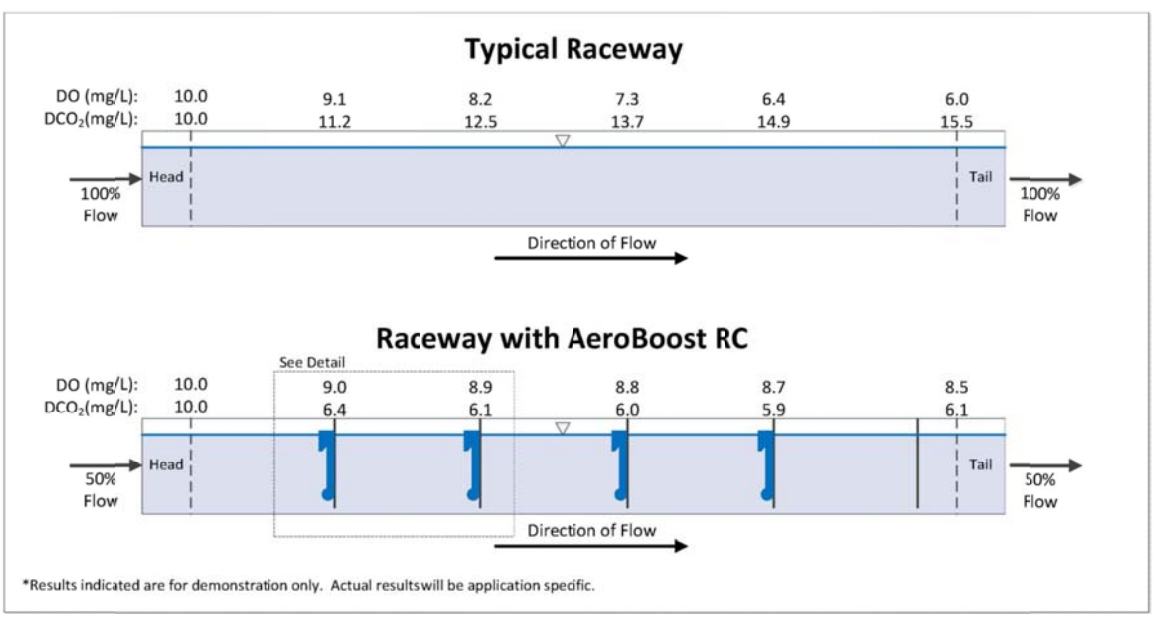


Figure 6-2. Aeroboost Performance (Courtesy of PRAqua)

The air bubbles re-oxygenate the water such that dissolved oxygen levels are maintained above target levels at all points along the length of the raceway. When installed in raceways typically on 10 to 11 foot centers, the baffle wall creates a gap of approximately 8 to 12-inches, between the bottom of the baffle wall and the raceway slab. This increases the velocity of the combined reuse and make-up water flow as it approaches the baffle, effectively sweeping solids downstream to assist in raceway cleaning. This accelerates the solids removal and deposits it within the quiescence zone at the downstream end of the raceway which can be effectively vacuumed and discharged to treatment facilities. Installed in circular tanks, the airlifts help induce the radial flow which collects the wastes in the center drain as discussed above. In either type of rearing vessel, it should be noted that reductions in make-up water equate to a longer turnover time which would elevate disease concerns if untreated surface water is used as the make-up water source.

Currently, FFS has an agreement with Pentair (Formerly PRAqua) to market the airlift units, trademarked as Aeroboost units. Compared to the more complicated centralized PRAS described above, the air lift units provide an economical option for reducing water use and offer improved effluent management opportunities as well. The units do not require major modifications to existing infrastructure in either circular tank or raceway applications, however research and testing to date has utilized a minimum water depth of 38-inches. The manufacturer has indicated that the airlifts would be less efficient if used in shallower water depths (such as the 8 x 80 ft raceways which are operated at 24 - 36 inches depth) and is not presently recommending them for these shallow depths. The major capital cost is the airlift units themselves, the air blowers, power supply, and the low pressure air piping. The cost of retro-fitting existing raceways with Aeroboost units is approximately $30 per cubic foot of rearing volume, with a potential water demand reduction of 50% to 75% depending on water depth and site specific water quality parameters. Airlifts are more cost-effective when used in circular tanks since the number of airlift assemblies is roughly half of what is required for a raceway of similar volume, resulting in a unit cost of approximately $16 per cubic foot.

The Aeroboost units could be used in either first pass or serial reuse configurations. Since there is an increased risk of disease with serial reuse, the first pass configuration is used for this alternatives analysis.

Figure 6-3. Airlifts in Trout Raceway (Courtesy of FFS)

6.1.3 Oxygen Supplementation

FWS biological criteria recommend at least 80% dissolved oxygen (DO) saturation. At each Complex hatchery, many of the outdoor rearing raceways are configured for serial reuse of second or third pass water, but do not include any provisions for efficiently reconditioning (re-oxygenating) the water prior to reuse. FWS staff have indicated that dissolved oxygen does not appear to be a limiting factor in these serial reuse applications under present operations. However, rearing densities are lower than FWS targets, particularly at Leavenworth and Entiat NFH. Calculations indicate that oxygen may become limiting if densities were increased to target values. It should be noted that there would be major disease concerns with utilizing untreated surface water in serial reuse scenarios, with or without oxygen supplementation.

Several methods of increasing dissolved oxygen levels by introducing oxygen gas into the supply water are widely used in the aquaculture industry. Low head oxygenators (LHO's) are a technology that provide a high (90%) gas transfer efficiency with low energy use. LHO's consist of a compartmentalized aluminum box and are typically mounted partially submerged, at the upstream end of a raceway (Fig. 6-4). The LHO is positioned so that the incoming piped or open channel flow enters the top of the unit and flows downward through a perforated distribution plate creating a controlled gas to liquid exposure in a mild vacuum inside the unit. LHO's would be well suited to retro-fit the Complex raceways since they only need 1.5 to 2 feet of head differential to provide high gas transfer efficiencies. There is typically 2 to 3 feet of head differential between the banks of rearing units at the Complex hatcheries. Oxygen gas from a LOX tank or on-site oxygen concentrators (Fig 6-3), is introduced at one end of the LHO and is exposed to the diffused water trickling through from the diffuser plate. The only moving parts in this system are associated with the oxygen concentration equipment (if used instead of LOX).

Figure 6-4. LHO's at Colville Resident Fish Hatchery

The recommended configuration for oxygen supplementation at Complex facilities would be to utilize first pass water at normal flow rates in the upper most bank of raceways at a given facility. The effluent from the upper raceway would be routed to the supply channel at the next bank of raceways via existing reuse piping. LHO's would be installed at the head end of each raceway in the second bank (and third bank if applicable), to boost DO to near full saturation. A 50% water demand reduction could be realized, eliminating the use of first pass water in the second bank of raceways (or by 67% in a three pass system) while still meeting DO and water turnover rate criteria. As part of the system, DO sensors are typically mounted at the downstream end of each raceway to monitor and provide alarm notification if DO drops below an adjustable set-point. An automatic oxygen dosing system could be included at little additional cost to provide improved energy efficiency. LHO's could also be utilized on new circular tank installations as well if they were arranged in a serial reuse configuration.

The approximate installed cost of this technology is $8 per cubic foot of rearing volume based on quotes from Water Management Technologies for an onsite oxygen generation system. The LHO alternative uses roughly 12% of power needed for the PRAS alternatives. There would be increased disease risks associated with serial reuse, at the existing raceway banks since the existing piping is configured such that all effluent from upper banks is combined into a single large reuse pipe that outlets into a common supply channel for the downstream bank. This risk factor could be mitigated by retro-fitting the raceways with dedicated serial reuse pipes from each upper bank raceway to a corresponding middle or lower bank raceway. This configuration is used a Chief Joseph Hatchery. These piping modifications would roughly double the cost per cubic foot of rearing volume. Another way to reduce disease risk would be to install in-channel UV sterilization treatment as a retrofit to the main serial reuse pipe that connects raceway banks, or as a drop-in assembly in either the existing supply or drain channels.

Using LHO's in raceways would have limited benefits for phosphorous management since brushing or vacuuming would still be needed. The higher turnover rates realized with LHO's would help to flush solids to downstream ends of raceways.

6.1.4 Circular Tanks

The recent pilot testing at Eastbank Hatchery compared fitness and survival results of spring Chinook reared in flow-through concrete raceways vs. 30-foot diameter circular tanks on centralized PRAS. Limited data indicated circular tanks may produce stronger swimming fish with better downstream smolt migration as noted above. Information on the Eastbank pilot program presented at the Northwest Fish Culture Conference in December 2014 (Willard 2014) indicate that in 2012-2013, the SAR for fish reared in circular tanks were lower than or about the same as the SAR for fish reared in raceways. It was concluded at the conference that there is not yet enough data on SARs to determine if there is a clear advantage to using circular tanks in achieving higher adult return rates.

With some of the Complex rearing units (8 x 80 ft raceways and/or Foster-Lucas ponds) in need of major refurbishment or replacement, consideration has been given to replacing the concrete rearing units with dual drain fiberglass circular tanks. Dual drain circular tanks have several documented benefits (Summerfelt 1998) over rectangular raceways including:

- Adjustable rotational flow velocities that produce stronger swimming fish that have faster downstream migration speeds and survival rates.
- More uniform mixing of the water column inside the vessel and improved water quality that may increase allowable loading densities at reduced water flow rates. (Water exchange rates are not increased).
- Rapid, self-cleaning, settleable solids flushing with concentration of wastes in the bottom drain flow. This results in reduced labor costs for vessel cleaning and increases the efficiency of TSS and phosphorous removal from hatchery effluents.

Other advantages include long lasting smooth interior vessel surfaces (less prone to freeze/thaw damage and roughening compared to concrete), and similar service life. FWS has stated a preference for using circular tanks instead of raceways for new or replacement outdoor rearing units primarily due to the improved solids handling issue. The cost of newly installed 26 to 30-foot diameter FRP circular tanks is in the range of $20 per cubic foot of rearing volume, not including the cost of supply and drain piping or a roof cover. In comparison, recent costs from McMillen construction indicate the cost of 10’ x 100’ concrete raceways is in the range of $25 to $28 per cubic foot of rearing volume.

6.1.5 Roof Covers for Outdoor Rearing

Roof covers for outdoor rearing units are recommended at all facilities, with fencing and bird netting incorporated to increase bio-security and reduce predation. The covers would provide shade, reduce temperature gain and algal growth in the summer, and potentially reducing the use of groundwater for tempering. During the winter, snow accumulation on/around the rearing units will be reduced, providing increased personnel safety.

6.1.6 Alternatives Comparison Criteria and Flow Schematics

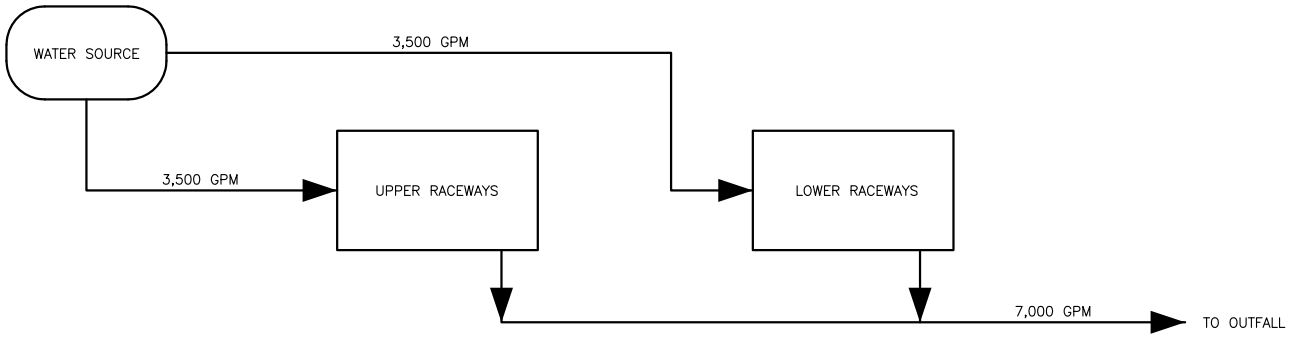
Table 6-1 below provides a unit cost summary of alternative rearing technologies and rearing vessels options on a cost per cubic foot of rearing volume basis to facilitate the comparison of alternatives. Energy costs are also shown on a per cubic foot per day basis. Decentralized PRAS and LHO’s can easily be retrofit to existing raceways or incorporated into the design of new rearing units. Figure 6-5 provides flow schematics illustrating how Airlifts and LHO’s could reduce water demand by 50% in an existing two bank raceway system such as the 10 x 100 ft banks at Leavenworth NFH.

The centralized PRAS would be difficult and costly to retrofit at the existing raceway rearing units and is better suited to new circular rearing units. Figure 6-6 provides a flow schematic of a centralized PRAS system applied to a new circular tank.

Table 6-1. Criteria for Alternatives Comparison

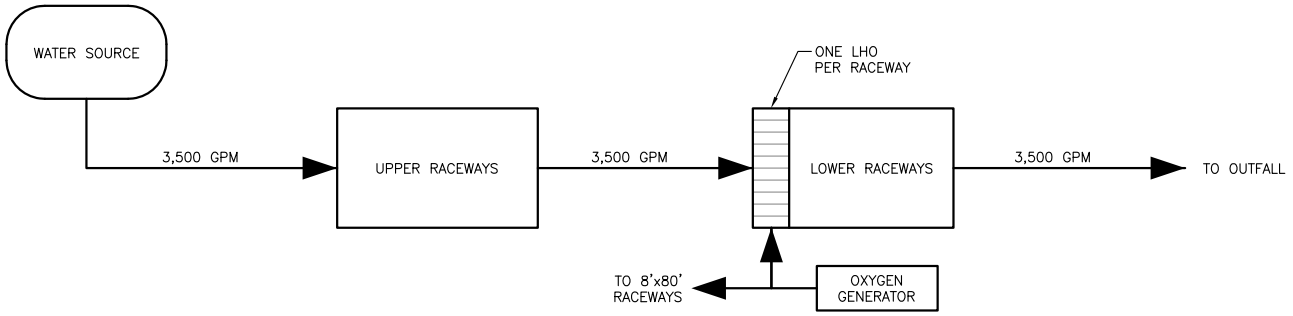
Description	Unit Cost of Rearing Volume	Power Consumption Kwh/day/Cu. Ft	Potential Pathogen Issues	Potential Water Use Benefit
Central PRAS – w/Equip. Bldg.	$125 cf	0.033	Disinfection optional	50% to 75%
LHO – w/Serial Reuse	$8 cf	0.004	No disinfection	50%
AeroBoost - Raceways, No Bldg.	$30 cf	0.031	No disinfection	50% to 75%
Aeroboost-Circulars, No Bldg.	$16 cf	0.005	No disinfection	50% to 75%
Surface Water Filtration – 40 micron, No Sump or Bldg.	$16,000 per cfs	Minimal		Allows Surface Water Reuse
Surface Water UV Disinfection – 90,000 mw/cm2. No Bldg	$18,000 per cfs	TBD	Not Applicable	Allows Surface Water Reuse
Circular Tanks – FRP, 26’ Dia.	$20 sf	Not Applicable	No	Reduced Cleaning effort - Improved Solids Management and Flow Mixing
Concrete Raceways 10 x 100’s	$28 sf	Not Applicable	No	Not Applicable
Refurbish Concrete Raceways	$18 sf	Not Applicable	No	Not Applicable
Roof Covers at Outdoor Rearing	$45 sf	Minimal	No	Not Applicable

The expected life spans of fiberglass tanks and concrete raceways with roof covers is on the order of 30 years. Rearing unit concrete refurbishing would have a shorter expected service life of 15 years.



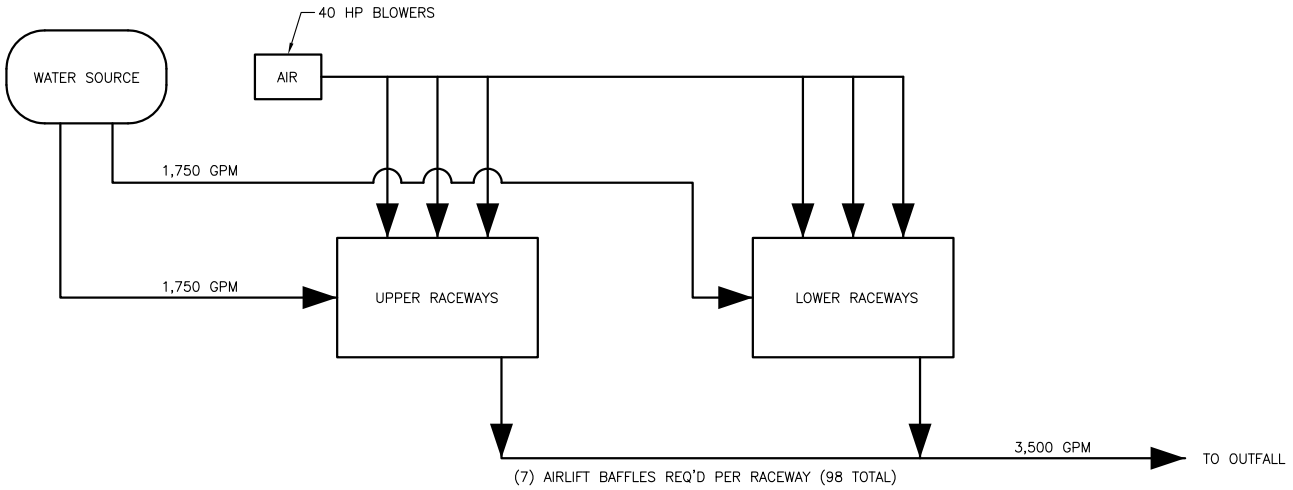
SINGLE PASS FLOW – THROUGH (EXISTING)

SCALE: NONE



SERIAL REUSE – LHO'S

SCALE: NONE



INTERNAL REUSE – AEROBOOST

SCALE: NONE

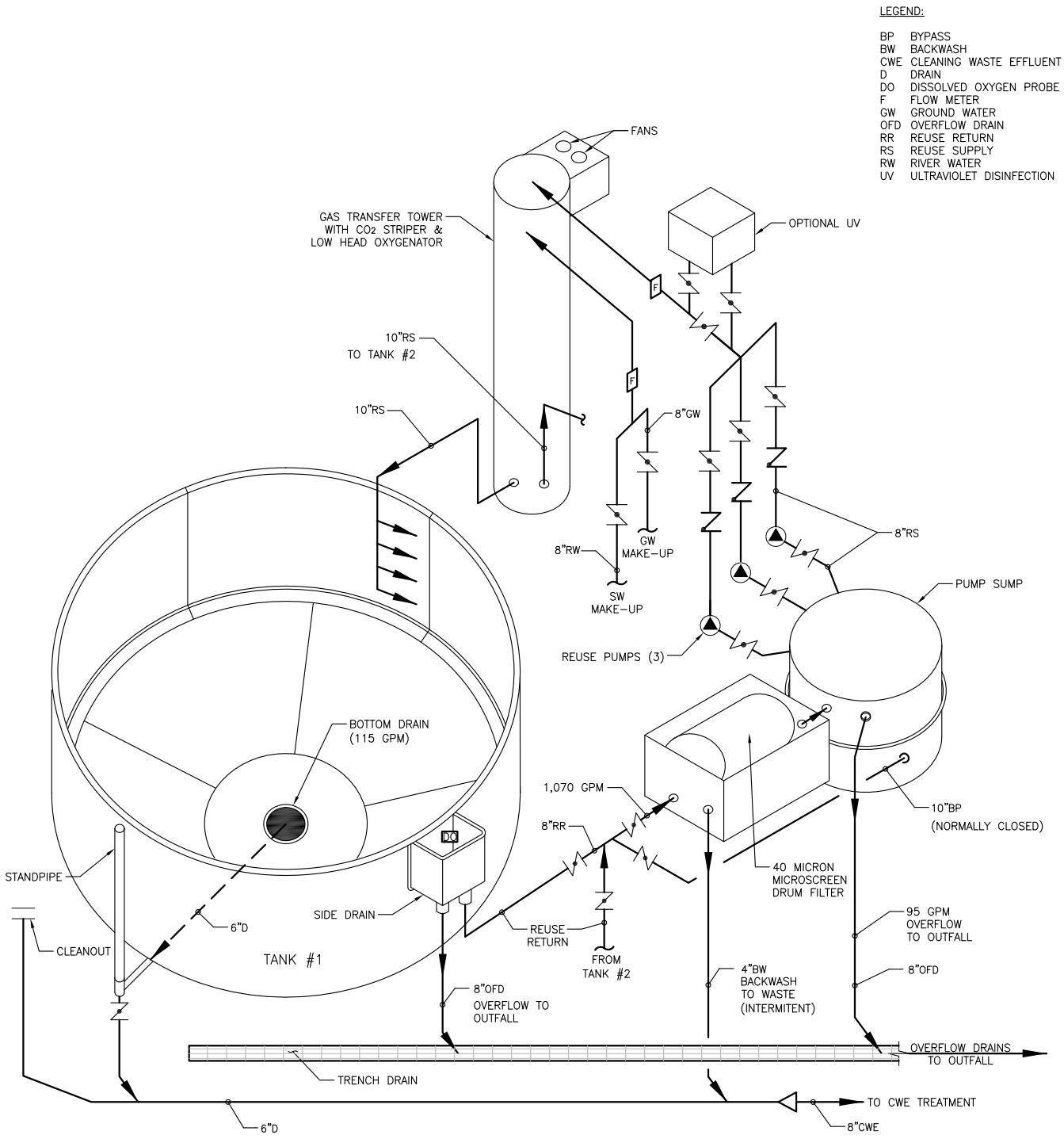
McMILLEN, LLC

1401 SHORELINE DR.
BOISE, ID 83702

OFFICE: 208.342.4214
FAX: 208.342.4216

LEAVENWORTH NFH
EXISTING RACEWAYS
ALTERNATIVE REARING FLOW SCHEMATICS

FIG. 6-5



REUSE SCHEMATIC

SCALE: NONE

McMILLEN, LLC

1401 SHORELINE DR.
BOISE, ID 83702

OFFICE: 208.342.4214
FAX: 208.342.4216

LEAVENWORTH NFH

REUSE SCHEMATIC

FIG. 6-6

6.2 Leavenworth National Fish Hatchery

Alternatives considered for upgrading the major infrastructure components of Leavenworth NFH are discussed in the following sections. These alternatives are organized by functional area and were determined to meet program goals while minimizing costs. Summary tables showing priorities, and estimated costs are provided at the end of this Section.

6.2.1 Surface Water Supply

The surface water intake and delivery pipeline (to the screening chamber) alternatives are being addressed by Reclamation under a separate process and FWS has excluded the development of alternatives and related costs from the scope of this analysis. The system is aging and in need of updating to ensure long term serviceability. It is presently capable of delivering the full 42 cfs water right by gravity flow to the hatchery screen chamber for fish propagation purposes, although flows may be restricted during severe winter icing events. The evaluation of the surface water supply for this analysis begins with the storage and controlled release facilities at Snow and Nada Lakes. The evaluation then skips downstream to the surface water connections to the screen chamber at the main hatchery site, and discusses a central disinfection treatment to address persistent disease issues.

6.2.1.1 Snow and Nada Lakes

As discussed in Section 2, the outlet control valve from Upper Snow Lake needs to be replaced. The guard gate for the outlet, while still functional, should also be considered for replacement given its age. Reclamation is presently conducting feasibility studies for replacing the guard gate and outlet valve. Given the control valve's remote location, the valve is only adjusted a few times a summer. Providing for remote operation of the valve could allow the valve to be adjusted to more closely meet water demands. In order to provide remote control, the control valve would be provided with a motorized actuator connected to a battery bank charged by a solar panel array. The valve actuator would then be linked via radio to the hatchery. Based on preliminary investigations by Reclamation, two repeater stations would be required to connect the valve via radio to the hatchery. Quotes were obtained from valve manufacturers for supply of a new guard gate and control valve. Costs for installation of the new valves along with cleaning and painting of the existing piping, and supply and installation of the optional telemetry equipment were estimated as shown below.

The 2008 inspection reports for Upper and Lower Snow Lake Dams indicate both dams are in poor condition. While both structures are listed as Low Hazard, it is likely that some repairs to maintain the integrity of the structures will be required in the future. For the purposes of this report it was assumed that the following tasks would be required: repair to the deteriorated mortar on both structures, removal of wood debris from the area of the flap gate on Upper Snow Lake Dam, basic structural improvements to Upper Snow Lake to address stability deficiencies, lowering the crest of Lower Snow Lake Dam, and pedestrian improvements over the crest of Upper Snow Lake Dam to address potential safety concerns.

6.2.1.2 Surface Water Disinfection

Surface water disinfection would be a recommended pre-requisite to utilizing surface water as make-up to water reuse systems. The present surface water intake has a gravel bottomed entrance channel that attracts spawning fish in Icicle Creek. Spawned out dead adults are frequently observed at the intake trash rack. A proposed re-configuration of the intake may mitigate this problem, however there will still be spawning fish in the creek above the intake, particularly in the late summer. The hatchery presently uses

scarce groundwater and high surface water turnover rates in rearing units to mitigate for disease issues related to the presence of the spawning fish. A surface water disinfection system, consisting of microstrainer drum filtration followed by UV disinfection is a proven approach to reducing pathogen loads in surface water supplies. The most prevalent surface water pathogen issue at Leavenworth NFH is Ich, a protozoa which requires relatively high UV dosing to neutralize. Fortunately, Icicle Creek has low turbidity during the late summer period when Ich is most prevalent. This will improve the transmissivity and effectiveness of UV treatment. USFWS has indicate that any surface water that is to be utilized as make-up water for rearing units on RAS systems be pre-treated with filtration and disinfection.

6.2.2 Groundwater Supply

The production of the existing well field falls far short of meeting the groundwater demand at Leavenworth NFH. The hatchery typically uses less than half of its 14.9 cfs water right due to well capacity limitations and at times uses less than 1 cfs to allow aquifer recharge. The FWS has been working to improve the productivity of the well field for several years. The ability to fully develop and utilize groundwater rights is a top priority at Leavenworth NFH in order to provide maximum long term operational flexibility, mitigate the effects of climate change, and preserve value to the government.

A key component of groundwater source development at Leavenworth NFH is to improve aquifer recharge and related wellfield production, which has diminished recently with operational changes at Structure #2. With more flow diverted to the historical Icicle Creek channel at Structure #2, the hatchery channel is dewatered for up to 9 months each year, and well yields have correspondingly declined significantly (Croci pers. comm. 2014). A pump back system, which would intercept the hatchery overflow drain water just upstream of the existing outfall, and lift it back into the hatchery channel, was pilot tested in late summer of 2015 and appears to help with aquifer recharge. In order to obtain regulatory approvals for the pump back project, Leavenworth NFH is conducting long term water quality testing at the outfall to demonstrate that the overflow drain water meets water quality standards before it infiltrates. A separate study (per Anchor QEA 2014), looked at full flow (56cfs) and 50% flow (28 cfs) pumpback alternatives.

As part of this study, two investigations related to improving groundwater supplies were performed:

- Geophysical modeling of subsurface conditions at selected locations in the hatchery vicinity.
- Excavation of test pits and pumping to determine possible yield of a new infiltration gallery system located on the Hatchery Island.

The results of these efforts is summarized below and detailed in Appendix B- Water Supply Reports.

6.2.2.1 Geophysical Modeling

The groundwater supply system at Leavenworth NFH is being investigated in a separate study: *Groundwater Source Evaluation at Leavenworth NFH*, by Aspect Consulting under a contract with Chelan County. The geophysical modeling associated with the Aspect Consulting work was added to the scope of work for this study in November of 2014. This subsection summarizes the study progress to date as it applies to potential alternative improvements.

A geophysical survey was performed at the Leavenworth NFH in December 2014. The purpose of the survey was to use earth resistivity soundings to identify areas with the best potential for additional

groundwater development to supply the hatchery. The survey was completed in three areas: 1) Hatchery Island (East Area), 2) a county-owned parcel north of the hatchery (West Area), and 3) an area south of the hatchery between wells PW-1 and PW-2 (South Area). The results are summarized below with more detailed reporting provided in Appendix B – Water Supply Reports.

Hatchery Island (East Area) - There is an apparent coarser grained layer (orange and yellow) extending down to about 60 feet. This unit overlies deposits with higher fine-grained content (green) to the top of bedrock at a depth of about 200 feet. This is generally consistent with the log for well PW-9. North of well PW-9 there is little variation in the geophysics results, but east, west, and south of this well the soils between depths of 60 and 200 feet grade into what appears to be more fine-grained deposits (blue shading on the sections). There are a few limited areas just above bedrock that could be coarse-grained deposits, or could be local bedrock knobs; in either event there does not appear to be a laterally extensive deeper sand and gravel unit to tap at the island.

Well PW9 was screened between depths of 80 and 200 feet and tested at 400 gpm with 50 feet of drawdown before collapsing. That yield and drawdown are marginal for meeting hatchery water demands. Assuming this is representative of what a new well would yield, as an initial estimate a well field on the island with 3 or 4 wells may sustain on the order of 1,000 gpm, allowing for some loss in production due to drawdown interference between wells. Well locations would be limited to area north of PW-9, based on the apparent finer-grained deposits at depth to the east, west, and south. Alternatively, developing the shallower deposits on Hatchery Island with a groundwater collector, similar to the systems at Winthrop and planned for Entiat, is more likely to achieve the desired yields, assuming the presence of coarse sands and gravels is confirmed. Non-pumping depth to water at PW9 was 12 feet in November 1979. Assuming depth to water of about 20 feet during summer low water conditions and that the coarse deposits extend to a depth of about 60 feet, there is about 40 feet of available drawdown to operate the collector system.

County Parcel (West Area) - The geophysics indicates fine grained materials (blue) in the upper 100 feet, overlying moderately coarse material (green) to near the top of bedrock. Because of surface interferences from power lines and fences the top of bedrock could not be accurately imaged, and there may be some gradation to coarser grained materials with depth immediately above bedrock. The presence of coarser materials is not definitive and if present appear to be only a thin unit.

Between Wells PW-1 and PW-2 (South Area) - Geophysics results indicate moderately coarse material, similar to what is inferred on Hatchery Island at depth. Similar to the west area, the top of bedrock could not be accurately imaged, and there may be some gradation to coarser grained materials above the bedrock contact. The log for well PW-2 at the south end of the south area line shows cobbles with clay at the bedrock contact, while PW-7 shows alternating layers of clay and cobbles above bedrock; these wells currently produce about 600 and 300 gpm, respectively. The geophysics did not indicate any target area that would be significantly different than what is already tapped by nearby Leavenworth NFH wells, and I'd expect additional wells in this area to have similar yields.

Recommendations: Based on the above, the most promising target is the shallower deposits on Hatchery Island for development of a groundwater collector system. Prior to the geophysical survey our recommended scope included:

- Assess existing well 10 (which was drilled but never put in to service),with video and pump test.
- Construct test/production well at a location selected based on geophysics.

- Prepare Action Plan and PM/meetings.

Aspect Consulting recommends retaining the assessment of well PW-10 and development of the action plan, but modifying the test well task to complete shallower exploration borings (~60 feet depth) and a pumping test on Hatchery Island to confirm the presence and depth of the coarse-grained layer, assess depth to groundwater and yield, and collect geotechnical and grain size data to support collector design. Although outside the scope of the current authorization, once funding is in place, we also recommend reconvening the IWG Groundwater Technical Committee to get stakeholder concurrence on the approach for improving water supply.

6.2.2.2 Well No. 10 and Infiltration Gallery Feasibility

As recommended in the above work, FWS authorized the Well 10 investigations and pump test on Hatchery Island. The Well #10 work was conducted in May of 2015. It was decided to conduct the Hatchery Island pump tests in late August of 2015 during the low flow period of a low snow pack/severe drought year in order to observe a worst case condition. These 2015 drought year test conditions may be representative of typical future conditions if climate change predictions are accurate. The following is a summary of these investigations.

- Completed pumping test of Well 10, which had been drilled but never put into service, in May 2015. The well was pumped at 200 gpm with a temporary pump and showed 25 feet of drawdown. This well could sustain on the order of 150 gpm (~0.3 cfs), a relatively small component of targeted yield improvements.
- Completed test pits on Hatchery Island in May of 2015 to confirm presence of gravels inferred from earlier geophysical survey. Test pits showed finer sand to a depth of about 10 feet, overlying coarser gravels and cobbles to depths of 20+ feet.
- A shallow observation well was installed on Hatchery Island and including a pressure transducer to monitor seasonal low water level. Levels dropped about 3 feet over the start of the summer, tracking changes in Icicle Creek stage, but held steady over June while the hatchery channel was hydrated. Levels then dropped another ~2 feet after the channel was drained, and started to increase again after the pilot pump back test started. Coarser gravels remained saturated even at lowest water level. This monitoring shows clear effect of channel hydration over distance of about 650 feet between channel and well.
- Two additional test pits were completed and pumped them with a dewatering pump to assess potential groundwater inflows to a horizontal collector system. Flow into the pits sustained pumping rates of about 50 to 75 gpm with about 2 feet of drawdown in the pits. This was a lower flow rate than expected given the coarse cobble/gravel shallow aquifer.
- A numerical groundwater model developed by BOR was acquired and used to assess potential groundwater collector yields based on the test pit pumping results. Two collector lateral completion depths were evaluated with the model. The first assumed collectors would be installed to about 12 to 13 feet bgs, or about 2 feet below the seasonal low water table. This model scenario indicated flows to the collector system of about 3 to 4 cfs during periods of high surface water and groundwater levels (e.g., during the spring freshet), with flows, decreasing to as little as 0.5 cfs during summer through winter low water periods. The second model scenario assumed collectors would be installed to depths of about 17 to 18 feet bgs, or about 7 feet below the seasonal low water table. This model produced peak flows to the

collector system of up to 5.5 cfs during the spring freshet, with minimum flows of about 2 cfs during the lower water periods.

See Appendix B for a technical memorandum dated October 7, 2015, detailing the testing and modeling work. The memorandum recommends including a new collector system as part of a Water Supply Action Plan for Leavenworth NFH. The proposed collector would have a depth of 18 to 20 feet bgs and would provide estimated seasonal yields of 2 to 5.5 cfs. Water quality testing of the observation well did not detect phosphorous above the detection limit of 0.07 mg/l.

6.2.3 Supply and Drain Piping

The existing piping at Leavenworth NFH is a conglomerate of differing pipe sizes, and materials including welded steel, asbestos-cement, and PVC. There are valves that have not been operated in over 20 years. A portion of the water supply piping, from the screen chamber down to the hatchery building is to be replaced in the summer of 2015. The main surface water supply pipe is to be replaced with a 48-inch C900 PVC pipe from the screen chamber to the hatchery building. A majority of the connections to existing branch lines will not be made due to unsound existing pipe. The branches to Foster-Lucas ponds will not be connected to the new mains. The pipe is sized to convey the full surface water right to just outside the hatchery building near the middle bank of the small Foster Lucas ponds. In addition, two existing groundwater pipes will be replaced by a single 30-inch C900 PVC pipe and will connect to the existing piping just outside the hatchery building.

The remaining water supply and drain system needs to be investigated to determine the pipe condition, materials, and layout. This would be achieved through a video surveying of the piping systems. The video should reveal the pipe material and condition. This will help confirm and prioritize the pipe runs that require replacement.

The surface water and groundwater pipes from the headbox to the hatchery building are to be replaced in 2015 under a contract that has recently been awarded for construction. With the planned abandonment of most of the Foster-Lucas ponds, the amount of new supply and drain piping to rearing units is highly dependent upon the outdoor rearing alternatives chosen for the hatchery and is described in Section 6.2.6. The transmission piping from the wells to the hatchery headbox represents a significant amount of piping that may need to be replaced. As an alternative to video inspection, this piping could be pressure tested to help determine integrity and potential leakage rates. Table 6-2 below provides a summary of the estimated lengths of piping that will need to be investigated and replaced as needed. The piping that is scheduled to be replaced in 2015 is not included in the table.

Table 6-2. Summary of Potential Pipe Replacements – Leavenworth NFH

Description	Pipe Length (LF)
10" GW Wells 1,2,3,& 7	890
14" GW Wells 1,2,3,& 7	1,625
10" GW Wells 4, 5 &6	1,330
14" GW Wells 4, 5 &6	190
18" Drain from 8x80 to Adult Pond	375
24" Drain from 8x80 to Adult Pond	140
18" Drain from Screen to PA Pond	670
36" Drain to PA Pond	330
36" Main Drain from Raceways	125
48" Main Drain from Raceways	275

18" Cleaning Waste Drain from 10x100's	345
18" Main Drain from Screen	115
36" Main Drain from Screen	460
15" Drain from Hatchery Building	265
18" Drain from HB to PA Pond	675
18" Drain from Adult Pond	105
15" Drain from Adult Pond	110
24" Drain from Adult Pond	290
18" Drain from Hatchery Building	340

The water control valves associated with these pipelines should be replaced in conjunction with pipe replacements.

6.2.3.1 Reuse Pumps and Piping

During the December-February period, the hatchery building typically discharges more than 3,000 gpm of single use ground water. This effluent is routed through a reuse sump at Reuse Pump Station #1, located to the east of the hatchery building. A vertical turbine reuse pump mounted over the sump is used to provide approximately 2,000 gpm of flow the 10 x 100 ft outdoor rearing units, primarily if the surface water intake supply is blocked with ice. This reuse pump is outdated, requires frequent maintenance, and has no backup if failure occurs.

To provide a more efficient groundwater reuse system for these periods of extreme cold weather, the existing pump and piping should be replaced in order to reliably provide as much reuse flow as possible. This alternative consists of constructing a duplex duty/standby pump configuration. The pumps would be high volume low head pumps, each sized to provide full flow which allows one pump to be offline for servicing or repair while maintaining one in operation.

The duplex pumps would be located over the existing vault where the hatchery effluent collects. Two 60 Hp mixed flow pumps on variable frequency drives would provide up to 3,500 gpm each. A 16-inch distribution pipe would convey reuse flow to the 10x100 ft raceways or other points of use. The existing outbuilding would require replacement to provide protection for the pumps.

6.2.4 Adult Holding and Spawning and Fish Ladder

The existing half ice harbor fish ladder design currently passes both Chinook and coho efficiently. The hatchery has not identified any major concerns with the operation of the ladder or the attraction flows provided by the main hatchery drain at the ladder entrance. With modifications to the holding and spawning facility, the ladder may require minor modifications to insure the hydraulics through the ladder are maintained. A hole in the sidewall of the fish ladder requires repair. The ladder should be refurbished and coated with a fish friendly epoxy paint to increase the longevity of the ladder as well as seal any potential leaks within the ladder.

The current adult holding and spawning facility is functional but has the following deficiencies:

1. Operators are exposed to the elements, making sorting, handling, and spawning difficult and a safety concern.
2. Security around the ponds is not adequate to prevent poaching.
3. During the summer months, warmer water temperatures from the surface water supply creates fish health issues with long term holding and increased densities.

4. Handling of the fish is excessive and creates stress on the fish
5. Additional holding may be required for future Leavenworth NFH and Tribal goals.
6. During the coho adult return period, low river water levels at the ladder entrance require that fish jump to enter the ladder, which they are typically able to do successfully.

To correct the above deficiencies, the following section discusses an efficient layout and process for collecting, sorting, and spawning. If found to be structurally deficient, the holding ponds could be removed and reconstructed in a similar configuration within the same footprint allowing for flexibility and potentially adding ponds for future collection goals.

The existing adult holding ponds require rehabilitation to extend their service life similar to the fish ladder. The holding ponds have sufficient volume to accommodate the required number of broodstock per Table 3-2. The anticipated holding volume of one pond upon re-habilitation and minor modifications would be more than 10,000 cubic feet at a 5 foot water depth. The existing crowders would be removed and recycled. Crowders with controls and crowder screen configurations that conform to the new collection channel would be designed for efficient collection of fish.

Three crowders would be required; one for the crowding channel discussed below and two holding pond crowders. The crowders would be design to accommodate the new layout with the crowding channel. The upstream end of the adult holding ponds would be removed and replaced with a new collection channel approximately 6-feet wide by 33-feet in length. The collection channel would be designed with upwell diffusers to provide the water flow through the channel and into the holding ponds. The existing diffusers in the holding ponds would be maintained. The existing water supply pipe would be replaced/rehabilitated as discussed in the sections above. As additional cooler groundwater sources are developed, it could be delivered to the adult holding ponds to reduce warm surface water temperatures. A motorized crowder would be used to concentrate the fish to the west side of the collection channel and into a fish lock or pescalator. The fish lock or pescalator would elevate the fish to a height which will allow gravity flow of the fish into the sorting and spawning area. A variable frequency control pump would be placed next to the lock and be fed directly off of the existing main supply to the adult holding ponds to fill the lock. If a pescalator is utilized, the pump would not be required. The pescalator operates on the Archimedes screw pump principle and would transport the fish to the required height through a three foot diameter tube. The fish would be discharged from the fish lock/pescalator down a flume, across a dewatering screen and placed into an electro-narcosis or CO_2 tank to sedate the fish. The sedation tank would be located in the spawning building.

The spawning building would be enclosed and provide sufficient space for spawning, carcass racks, totes, and egg handling. Heat and proper ventilation would be provided for a comfortable work environment. The building would contain an ergonomic sorting table with fish sorting tubes located along the back of the table for ease of sorting. Roll up doors would be provided to accommodate carcass tote removal. Utility water would be provided from a small sump located off of the holding ponds for wash down water. A waste collection system would be incorporated to collect spawning fluids and disinfectant conveying them to a waste holding tank.

A security fence would be placed around the adult holding ponds to prevent predation and poaching. A cover, similar to the cover over the 10x100 raceways, would be incorporated to provide protection from the elements as well as shade the ponds, helping to maintain cooler water temperatures.

Optionally, a third pre-sort holding pool could be constructed to the east of the existing ponds to collect incoming fish. This third pond would have a crowder and be connected to the collection channel. The

pre-sort channel would allow fish that have been sorted to remain separated from recent arriving fish and provide additional holding during peak migration periods.

6.2.5 Incubation and Indoor Rearing

FWS prefers to utilize first pass groundwater for the hatchery incubation and early rearing, however adequate amounts of groundwater are not available. Currently, indoor early rearing units are operated at densities higher than FWS fish health targets due to an insufficient number of early rearing tanks. This is accommodated by increasing the flow to insure water quality is maintained for fish health. At maximum biomass, there is a calculated deficit of 6,100 cf. To keep densities below the target density index of 0.15, a total of 191 troughs would be needed. Currently the hatchery operates 122 troughs. A potential solution is to utilize the existing troughs at a density index of 0.24 and increase flows to a flow index of 1.0. Utilizing this rearing strategy would allow the hatchery to maintain the existing indoor rearing facilities with no additional modifications. An additional 2 cfs of groundwater would be needed during the last few weeks of indoor holding in February to meet these criteria. Other FWS hatcheries are operating at even higher early rearing densities (0.3 Sawtooth and McCall), and are achieving project goals, however this would need to be evaluated by FWS fish health personnel and monitored to determine if acceptable. FWS is considering replacing the indoor troughs with circular tanks which are thought to allow higher density loading rates.

Another alternative is to meet FWS density index targets with additional early rearing space by adding an 8,000 sf building, 69 troughs, and piping. This would require a maximum total groundwater flow of over 2,500 gpm for all 191 troughs. During the final stages of indoor rearing the water supply is mixed with 10% surface water reducing the demand on the groundwater system. As noted above, the hatchery is operating in a groundwater deficit during this period. If an adequate groundwater supply is not developed, additional surface water could be blended in at a higher rate during February, (approximately 25%), to achieve the required rearing flows. The FWS is not in favor of using higher percentages of surface water during early rearing (Collier pers. comm.) since this would introduce other issues such as reduced growth rates due to the colder water and potential fish health issues at the early rearing stage.

If development of additional groundwater supplies is not successful, the water reuse system described in Section 6.2.3.1, presently used to supply the 10 x 100ft raceways, could be modified to route second pass flow back to the indoor rearing troughs. This introduces potential fish health issues, but would aid in maintaining the required temperature and flow rates for the target growth rate. The reuse system would be tapped off of the reuse pumps discussed in Section 6.2.3.1. A new 10-inch reuse pipe would provide up to 3 cfs of reuse groundwater from Pump Station #1 into the hatchery. Once in the hatchery, the water would be discharged into aeration columns to strip CO_2 and add oxygen. FWS fish health staff have indicated that UV disinfection should be incorporated if this alternative is advanced. The re-oxygenated and disinfected flow would be introduced at the head end of the troughs through a separate piping system and mixed with the first pass flow. This would reduce the first pass groundwater flow rate to indoor early rearing by up to 50%, and make the limited groundwater supply available for other uses.

6.2.6 Juvenile Rearing and Release

6.2.6.1 10 x 100 Ft Raceways

The 10x100ft raceways are functioning well, producing quality chinook smolts and providing approximately half of the 112,600 cubic feet of rearing volume recommended for the spring Chinook program. They are the most recent addition to the production facilities at the hatchery, being completed in

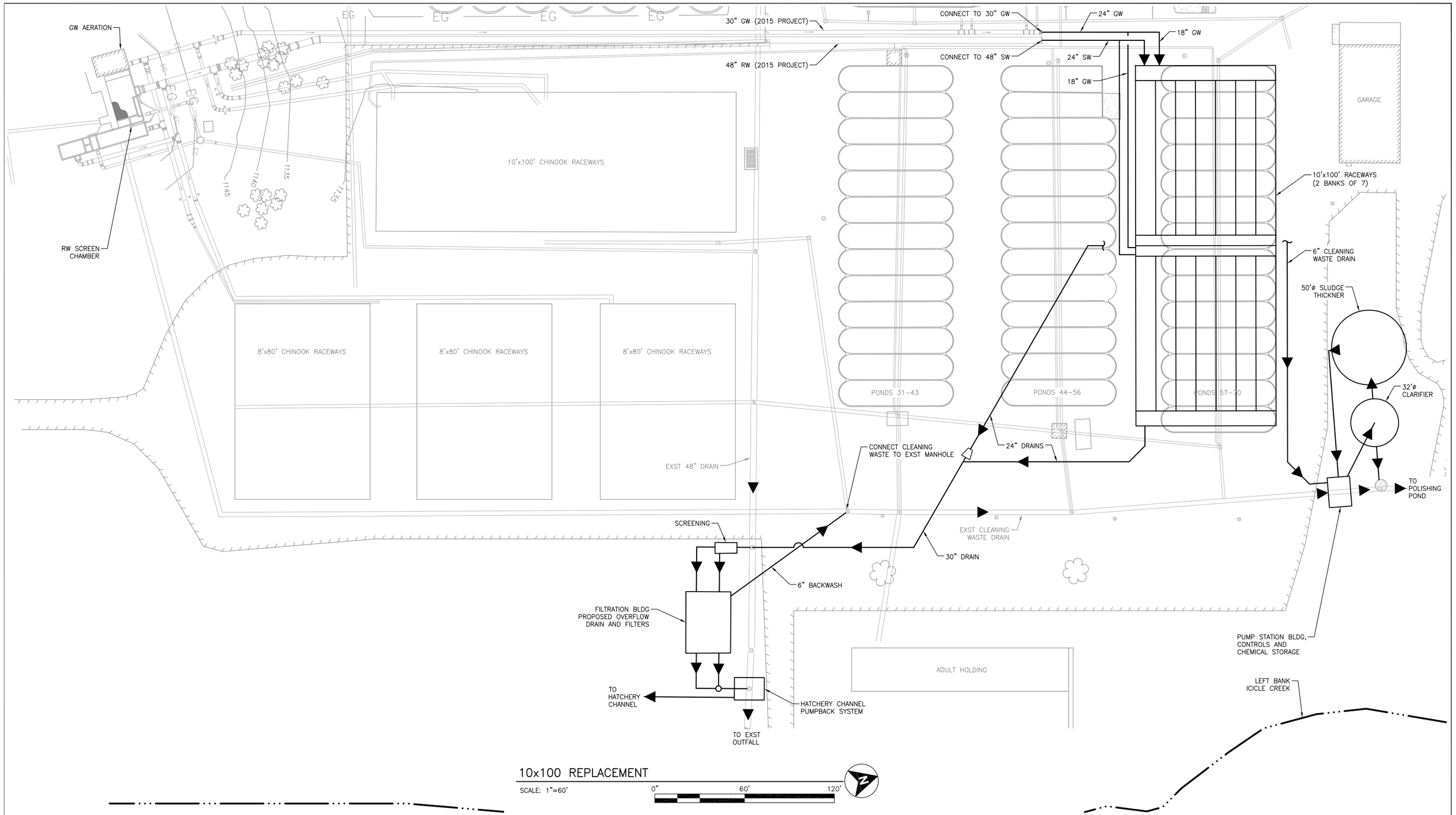
1996. It is recommended that these raceways be retained with minor repairs to the existing joints and concrete to be performed.

6.2.6.2 8 X 80 Ft Raceway Replacement

FWS may choose to refurbish or replace the 45 aging 8 x 80ft raceways. The following paragraphs discuss replacement and refurbishing alternatives. Modifications to the existing water supply and drain systems are discussed in Section 6.2.3 above.

Replacement: In the event that FWS chooses to abandon or demolish the 8 x 80ft raceways, two alternatives have been identified for providing 56,600 cubic feet of new outdoor rearing volume needed to complement the existing 10 x 100ft raceways. The first is to replace them with 14 of the 10 x100ft raceways in a similar configuration to the existing 10 x 100's as illustrated in Fig 6-7(note that this layout includes phosphorous management facilities which are described in Section 6.2.8.3 below). The 10 x 100 ft raceways are an operationally familiar system to the hatchery, however water demand and phosphorous management would still be a concern. A second option would be to construct 18 new circular tanks. In either case, the new units could be installed within the northern most portion of the small Foster Lucas pond footprints in order to reduce disruption of current fish production. Depending on the configuration selected one or two banks of the small Foster-Lucas Ponds would be demolished with the concrete and rebar recycled. The crushed concrete could be used as a base aggregate material for the tanks and roof cover foundations.

10 x 100ft Raceway Option: New 10 x 100 raceways would be configured in two banks of seven raceways each with provisions for incorporating either single pass or serial reuse with water reconditioning (Fig. 6-7). Both groundwater and surface water supplies would be routed to the head trough of each bank. For single pass water supply the recommended flow rate would be approximately 1.3 cfs per raceway. A 24-inch surface water supply and 18-inch groundwater supply would be required to each bank. In order to comply with the long term phosphorous management plan, 24-inch overflow drains would be routed south from each bank to connect to the existing 48-inch main drain upstream of the proposed filtration system.



REV	DATE	BY	DESCRIPTION
0	...	...	...

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN, LLC

1401 SHORELINE DRIVE
SUITE 100
BOISE, ID 83702

OFFICE: 208.342.4214
FAX: 208.342.4216

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

UNITED STATES FISH AND WILDLIFE SERVICE

REPLACE 8x80's WITH 10x100 RACEWAYS

DESIGNED J. HARPER

DRAWN D. LITA

CHECKED

ISSUED DATE 12/09/14

FIGURE

6-7

SCALE: AS NOTED

Circular Tanks Option: As noted above, circular tanks offer several advantages over the current Leavenworth NFH raceways in terms of waste removal efficiency, water quality, and controllable swimming velocities that may increase the fitness and survival levels of the fish. To accommodate the recommended 56,000 cf rearing volume, a total of 18 circular tanks would be required, at 3,185 cf of rearing volume each, to meet the density index targets for the spring Chinook program. A potential layout of the 18 circular tanks is shown in Figure 6-8.

With the small Foster-Lucas ponds potentially being demolished for the spring Chinook program above, the Yakama Nation Coho program would require approximately 39,200 cf of replacement rearing space at present acclimation numbers. This could be achieved in two banks of the existing 8 x 80 ft raceways. Due to the temporary nature of the coho program at Leavenworth, the 8 x 80s would provide sufficient rearing volume without significant modifications.

An additional alternative considered was to replace the existing 8 x 80s with large ponds. Both Lyons Ferry Hatchery and McCall Hatchery are FWS facilities that produce high quality spring Chinook and have good returns utilizing large lakes and large concrete ponds respectively. Leavenworth NFH has sufficient property to make this a viable option. However, this type of pond is difficult to clean efficiently. Due to the phosphorus management issues, this alternative was discarded and not pursued further.

Refurbishing: Similar to the project that was recently completed at Entiat NFH, the Leavenworth NFH 8 x 80ft raceways could be rehabilitated by patching and repairing concrete, then sealing with a fish friendly epoxy paint to maintain a smooth finish, and to protect the refurbished concrete. This would extend their service life by 25 to 30 years. It is recommended that if the 8 x 80 ft raceways are retained, they have a metal roof cover with fencing and bird netting similar to the existing 10 x 100 ft raceways. The cover would be approximately 350 ft by 140 ft to cover all the raceways.

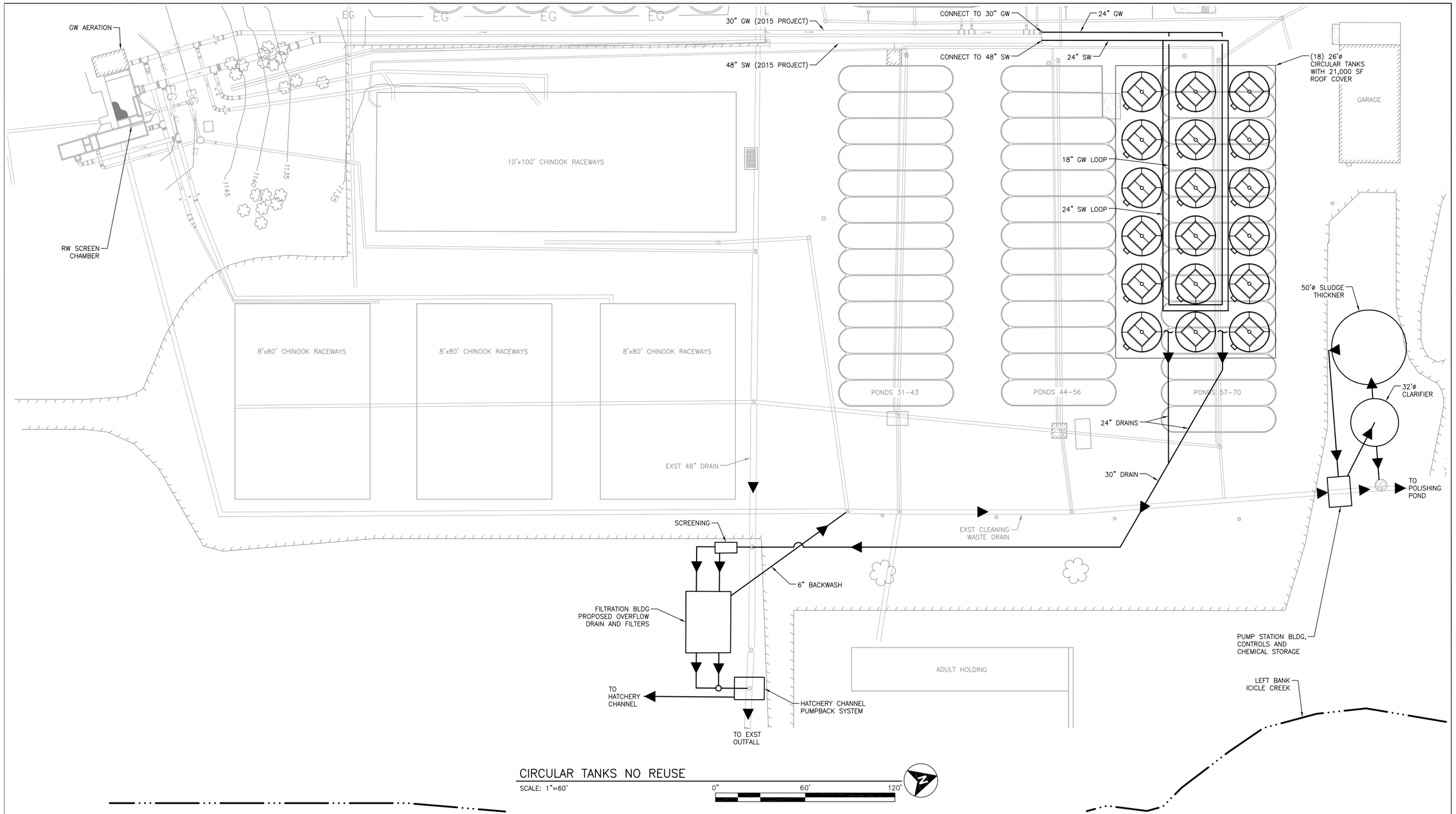
Under this scenario, the Yakama Nation coho program would require separate facilities. Due to the coho program being temporary at the Leavenworth NFH, fiberglass circular tanks or troughs could be procured by the Tribe and installed within the existing Foster-Lucas ponds footprints. The small Foster-Lucas ponds could be demolished and the depression created filled with circular tanks or troughs. Once most of the coho program moves to a new facility, the tanks or troughs could be disassembled and moved to the new site. Costs for temporary tankage would need to be covered by YN and are not included in this report.

6.2.7 Alternative Rearing Strategies

The alternative rearing strategies discussed in Section 6.1 above could be selectively applied to Leavenworth NFH in order to address water availability issues, improve phosphorous management, and perhaps reduce energy costs.

6.2.7.1 Alternative Rearing - Existing 10x100 Ft Raceways

To address water availability issues and potentially improve effluent treatment, the 10 x 100ft raceways could be retro-fit with LHO's or the Aeroboost airlift units. An advantage of the airlifts is the sweeping flow they create along the bottom of the raceway, accelerating waste removal and reducing cleaning effort. The Aeroboost system would be need to be installed on all 14 raceways in order to achieve maximum water use benefits, however they would not rely on serial reuse to achieve the water use benefit and total residence time of water in each rearing unit would be increased by 50 to 75%.



REV	DATE	BY	DESCRIPTION
0	...	...	...

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN, LLC
1401 SHORELINE DRIVE
SUITE 100
BOISE, ID 83702
OFFICE: 208.342.4214
FAX: 208.342.4216

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

UNITED STATES FISH AND WILDLIFE SERVICE

REPLACE 8x80's WITH (18) CIRCULARS

DESIGNED J. HARPER
DRAWN D. LITA
CHECKED
ISSUED DATE 12/09/14

FIGURE
6-8

SCALE: AS NOTED

The LHO's would only need to be installed on the 7 lower bank raceways and provide a more cost effective solution, however serial reuse is required to achieve water use benefits. Water exchange rates would not be reduced under LHO scenarios. Other trade-offs are that with LHO's the rearing portion of the raceways is not obstructed with baffles at 10 feet on center as is required with the Aeroboost system, however the solids flushing and removal would be better with the baffles. A vacuum system cleaning system is recommended for both alternatives as part of the long term phosphorous management plan.

6.2.7.2 Alternative Rearing - Existing 8x80 Ft Raceways

Replacement: Water reuse could be incorporated into the replacement options for the 8 x 80ft raceways described in Section 6.2.6.2 above. This alternative would include either centralized PRAS in conjunction with the 18 circular tanks, or an LHO system that could be incorporated on circular tanks or a new bank of 14 of the 10 x 100 raceways. The benefits of adding the full PRAS units with circular tanks is the ability to reduce the flows by up to 75%, and utilizing center drain solids collection, phosphorus could be effectively captured and removed to a treatment facility. Every two tanks would have a microscreen drum filter, pump sump, dual pump station, and degassing towers. Due to the high DO in the water supply, the circular tank operation would be conducted in the following manner. The influent water supply would be discharged directly into the aeration tower head tank just below the gas transfer tower. The water flows from the head tank and discharges into the circular tanks imparting a rotational flow that will consolidate wastes to the center where the effluent drain pipe is located. Effluent water leaving the tank from the center drain would account for approximately 20% of the design flow of 525 gpm and be processed through the micro-screen drum filter. During reuse operations, all other water would be discharged into the side drain where it would be piped into the micro-screen drum filter and subsequently into the pump sump. Two pumps would then lift reuse flow up into a gas transfer tower where the CO_2 would be stripped and re-oxygenation process would occur. The reuse water would be collected in the head tank where gravity flow would discharge the water back into the circular tanks. An immersion heater could be included in the sump pump to aid in maintaining water temperatures above freezing during winter months if adequate amounts of groundwater are not available. The cost of this system would be quite high compared to other alternatives.

Similar to the LHO option described for the existing 10 x 100 raceways, the lower 7 raceways of a new 14 raceway bank of 10 x 100's could be outfitted with LHO's to allow serial reuse and a corresponding 50% decrease in water demand.

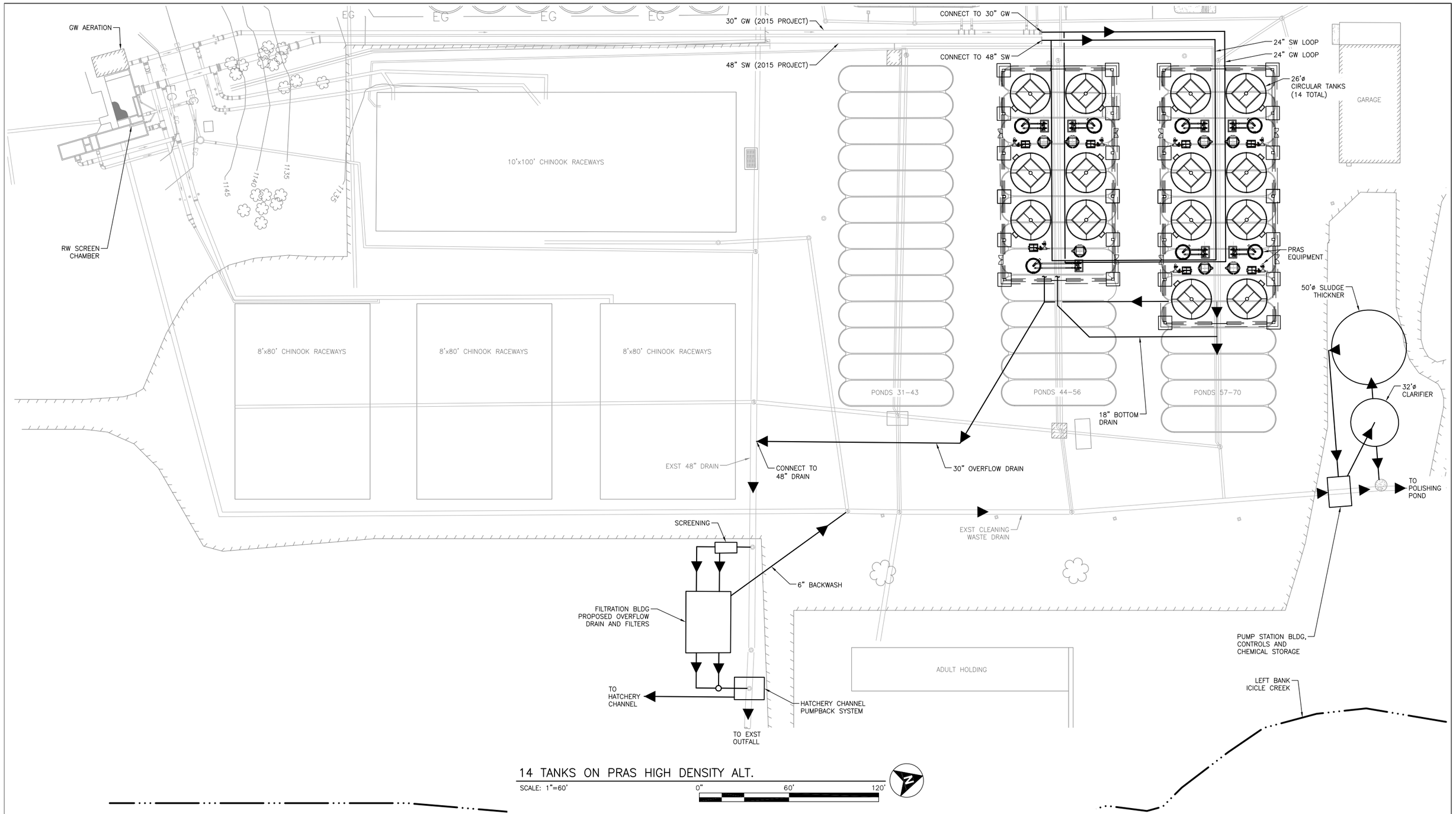
A third option would be to outfit the 18 circular tanks or 14 new raceways with Aeroboost units to decrease make-up water supply flows by up to 50%. This would aid in phosphorus removal and cost significantly less than the PRAS units. A total of four airlift units would be required at each circular tank vs. eight airlift required for a 10 x 100 raceway.

Refurbishing: If FWS decides to refurbish the 8 x 80ft raceways instead of replacing them, they could be retro-fit with LHO's in order to reduce water demand in a cost effective manner. Aeroboost units were looked at as well and the manufacturer does not recommend them for this application due to the shallow water depth in these raceways.

The LHO's would be installed between at the upstream end of the middle and lower banks of the 8 x 80's to provide fully saturated DO levels. The LHO would recondition the full flow from the upstream bank of raceways and discharge it to the next bank with oxygen levels near saturation. If a three pass reuse were implemented the required flow is reduced by 66%. These LHO units would be similar to those discussed in Section 6.1.

6.2.7.3 Circular Tanks with Increased Rearing Densities

This alternative would utilize higher rearing densities to produce the entire 1.2M spring Chinook in a total of 14 new circular tanks. This alternative is based on a pilot centralized PRAS circular tank project that FWS initiated in the fall of 2012. This would include 7 centralized PRAS modules comprised of two 26-foot diameter by 6.5-foot high dual drain circular tanks, a 1050-gallon per minute (gpm) carbon dioxide (CO2) stripper, a micro-screen drum filter, two pump stations, a pump sump, and associated support equipment. It would be recommended that the make-up water for this alternative be groundwater or disinfected surface water. The rearing tanks and re-use equipment would be completely enclosed in a pre-engineered metal building structure. The circular tanks would be loaded with approximately 85,000 Chinook each in a volume of 3,185 cubic feet and a 50% make-up flow rate of 525 gpm for the pilot project. An experimental loading density of 0.3 lb/cf/in was to be used vs. the 0.11 lb/cf/in that FWS established for the present alternatives analysis. At this higher loading rate, a total of 14 of the 26-foot circular tanks could accommodate the 1.2 million Chinook smolt production (See Fig 6-9). Funding for the 4 tank pilot project was re-directed to pipe replacement projects in 2013 and the project has not been implemented. These loading rates were to be evaluated as part of the pilot project and it may still be beneficial to determine if they would be acceptable.



14 TANKS ON PRAS HIGH DENSITY ALT.

SCALE: 1"=60'

0" 60' 120'

REV	DATE	BY	DESCRIPTION
0	...	...	...

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN, LLC
1401 SHORELINE DRIVE
SUITE 100
BOISE, ID 83702
OFFICE: 208.342.4214
FAX: 208.342.4216

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

UNITED STATES FISH AND WILDLIFE SERVICE

14 TANKS ON PRAS HIGH DENSITY ALT.

DESIGNED J. HARPER
DRAWN D. LITA
CHECKED
ISSUED DATE 12/09/14

FIGURE
6-9

SCALE: AS NOTED

6.2.8 Effluent Treatment

An additional task was authorized in October 2014 to develop both short term and long term phosphorous management plans for the Complex, with a major focus on Leavenworth NFH due to the TMDL/draft NPDES permit conditions for hatchery discharges. Short term management is intended to reduce phosphorous discharges by incorporating best management practices into hatchery Standard Operating Procedures (SOP), and does not require any major capital expenditures. The long term management plan provided alternatives analysis and recommendations for modifications to the hatchery that would utilize water treatment technologies to reduce TP and may require major capital expense. Alternatives considered include modifications to the rearing ponds, and pollution abatement ponds, incorporation of water reuse, the construction of additional treatment facilities, and modifications to the outfalls, effluent and cleaning waste handling and treatment.

6.2.8.1 Short Term Phosphorous Management Plan

The short term management plan for phosphorus is intended to reduce phosphorous discharges by incorporating low cost best management practices into hatchery Standard Operating Procedures (SOP). Major capital expenditures to address phosphorus treatment will be covered under the long-term phosphorus plan in the next section.

The following items were reviewed to determine possible short-term solutions to reduce phosphorus discharged from the hatchery:

- Methods to eliminate direct discharges of waste to Icicle Creek and redirect them to the pollution abatement pond;
- Changes that would reduce the amount of flow to the pollution abatement pond;
- Changes in operation of the pollution abatement pond that would enhance phosphorus removal; and
- Ways of reducing phosphorus entering the hatchery flow.

Two flow paths at the Leavenworth NFH have operations that create waste containing concentrated amounts of TP, and do not have a convenient method of directing the waste to the pollution abatement ponds. The first are the Large Foster-Lucus (LFL) ponds which have stand pipes that are connected to the 48-inch diameter main drain that discharges at Outfall #1. The Yakama Nation currently uses 2 LFL ponds for its coho program and the cleaning process for these ponds is to pull the standpipes and broom the waste to the standpipe opening. Although the cleaning of these ponds is less frequent than other ponds or raceways on the Leavenworth NFH site, this waste should be directed to the pollution abatement ponds. This could be accomplished by vacuum cleaning with the cleaning waste directed into existing cleaning water standpipes at the 10 x 100 raceways.

The second flow path is the 7 cfs of untreated effluent from early rearing troughs in the hatchery building which is routed directly to Icicle Creek via Outfall #1 The hatchery building currently has two effluent pipes that exit the building to the south. One handles all effluent collected in drain trenches on the east side of the building and the other handles effluent from the west side. The two pipes each discharge to separate manholes where the flow can be directed to the pollution abatement ponds or directly to the river. Since there is only one pipe leading out of the building (on each side) the cleaning waste and pass-through life support water are mixed. It is not possible to re-direct the pass-through life support water while cleaning each raceway. Therefore the untreated effluent is directed to the river via Outfall #1, or is pumped for reuse in the 10 x 100 raceways. If the combined 7 cfs of flow from the hatchery building

drains were directed to the pollution abatement ponds instead of to Outfall #1, it would overwhelm the ponds capacity. The early rearing toughs are typically utilized December-February or early March which is mostly outside the proposed TP restricted period, however, the discharge of untreated cleaning waste will likely be prohibited under future permit conditions.

A possible low cost solution would be to install a small cleanout on the 15-inch concrete pipe in the southeast corner of the hatchery building and direct waste to this pipe. This would also include a recommendation to start vacuuming the waste in the hatchery building. A temporary or permanent pipe could be run into the hatchery building and the vacuum hose connected during cleaning operations. The vacuuming process may be difficult to implement due to the small size of the fish in the early rearing troughs. For the infrequent cleaning of the LFL ponds a temporary hose could be run from the LFL ponds to the cleanout.

This recommendation includes capital cost to improve the effluent drain pipes around the hatchery building and might not be the best long term solution, however, since this is a recommendation to address potential NPDES compliance issue it has been included in the short term recommendations.

The flow data illustrated in Figure 2-4 indicates there is a significant base flow of approximately 2 cfs that is conveyed to the pollution abatement pond through the cleaning waste piping system. This indicates some leakage into the system. A potential source of leakage is the seal around the standpipes which presently consists of a metal flange ring that seats against the concrete bottom of each raceway. There are 59 standpipes on the raceways presently used for the spring Chinook program. We recommend testing to determine if this is a source of leakage. If there is leakage, it is recommended that FWS retrofit the standpipes with gasket type seals affixed to the flange rings. The pollution abatement ponds are settling basins that depend on detention time to remove particulate from hatchery effluent. Any reduction in flow through the ponds improves the treatment effectiveness.

As noted in Section 2 above, background levels of TP are present in both surface water and groundwater sources. Maximizing the use of groundwater from wells with low TP (Wells 1, 3, and 7) is a short term recommendation to somewhat reduce the TP contribution from the hatchery water sources.

Another short term TP source reduction involves the potential use of low phosphorous (LP) fish feed. The FWS feed scientists at Abernathy Fish Technology Center have been contacted for advice on potential feed or diet modifications. Their work is in process and experimentation should continue to determine if a mix of feed regimes can reduce phosphorus and maintain fish health. Complex managers have recommended an evaluation which would test the effectiveness of switching between LP and regular feed for short intervals such as every other day, every few days or every other week, or using a portion (half and half) of LP and regular feed on a daily basis.

A short-term treatment efficiency recommendation is to modify the operation of the two pollution abatement ponds. The Idaho Waste Management Guidelines for Aquaculture Operations states that linking offline settling ponds in parallel improves overflow rate and weir rate. The resulting reduction in water velocity and solids entrainment make the parallel application superior. The two Leavenworth NFH pollution abatement ponds were constructed with a common upstream flow diversion box that controls the flow to each pond. The two outlet pipes in the flow diversion box are at different elevations, with one pipe lower than the other. The invert of the pipe directed to the south pond is 0.82 feet lower than the pipe to the north pond. If the isolation gates in the box are both open, most, or all of the cleaning waste flow would be directed the pond with the lower elevation pipe. A simple, low cost improvement would be to

install a short, 0.9-foot high steel plate weir mounted in the distribution box upstream of outlet pipes. The weir would be set to distribute flow to both ponds equally. This small change would allow the ponds to operate in parallel which would provide better treatment. For pond maintenance, one pond would still be isolated, dewatered and sediment removed while the other pond remains in service.

In summary the short term phosphorous management recommendations are:

- Avoid direct discharge of untreated cleaning waste: Provide a waste only pipe in the southeast corner of the hatchery building to redirect discharge cleaning waste effluent from the building. Route cleaning waste from the LFL ponds to the pollution abatement ponds instead of to Outfall #1.
- Reduce leakage into the cleaning waste piping system by adding gaskets to standpipes and investigating infiltration if standpipes are not found to be the source of the base flow.
- Reduce TP entering the effluent system: Minimize the use of groundwater wells with high TP levels during restricted periods. Use low phosphorus fish feed to the extent possible during the restricted discharge periods, without impacting fish health.
- Improve treatment efficiency: Place a small weir in the flow diversion box to allow pollution abatement ponds to operate in parallel, thus improving the settling function of the ponds. Implement vacuum cleaning of raceways and ponds to reduce flow rates to the pollution abatement ponds

6.2.8.2 Long Term Phosphorous Management Plan

The long term phosphorus management plan includes implementation of the short term recommendations, implementation of a monitoring plan that confirms the NPDES permit conditions are met, reductions in phosphorus sources to the extent possible, and construction of a treatment system that removes phosphorus from the Leavenworth NFH effluent. Prior to developing a detailed design or constructing an effluent treatment system, an initial recommended step would be to conduct a pilot test using actual hatchery effluent. The cost of this initial step is minimal and would provide data to optimize the design elements and help to determine if the future project would meet draft permit conditions.

Treatment options for TP removal to the microgram level were investigated. Biological, physical, and chemical treatment methods were evaluated. Biological treatment options were discarded due to performance issues, thermal gain issues, and inability to function properly under continuous service conditions. Standalone physical and chemical treatment systems were found to be overly costly and impractical. A recommended treatment system that incorporates a combination of physical and chemical treatments was developed and is based on a successfully operating system at a fish hatchery in Michigan.

Under the recommended alternative, the main 48-inch hatchery overflow drain that presently discharges at Outfall #1 would be intercepted so that all flow could be treated with microscreen filtration prior to discharge at Outfall #1. A second effluent stream consisting of hatchery cleaning waste flows would be combined with the microscreen backwash flows (for a combined flow of 500 to 800 gpm), and would be intercepted, pumped, dosed with coagulant chemicals and routed through an elevated clarifier basin. The clarified effluent would then be routed to the existing pollution abatement ponds for polishing prior to discharge at Outfall #2.

Conceptual layout of the proposed effluent treatment system is shown in conjunction with the alternative layouts illustrated in Figures 6-7, 6-8 and 6-9 above. The improvements include the following:

1. *Flow control manhole:* A 96-inch manhole with flow control gates on the existing 48-inch drain line. The gates would allow the continued flow with a straight discharge to Outfall 1 or would allow the entire flow to be diverted to a prescreening structure.
2. *Pre-screening structure:* A concrete structure containing a 60-inch traveling screen with ¼-inch openings that screens out large debris entering the disc filter building. The pre-screen is designed to protect the fabric of the disc filter. Once the flow passes through the pre-screen two 48-inch slide gates would direct flow to either or both of the disc filters. There is expected to be very little material buildup on this screen and therefore the screened material would either fall on the ground or into a dumpster. The cost of this structure does not include a roof covering.
3. *Disc filter building:* A 30-foot by 50-foot building with a large concrete sump and two Hydrotech HSF 2112 1A disc filters with 20 micron filter elements, inlet wing walls and high pressure rinse system.
4. *Piping and manholes back to the 48-inch effluent pipe:* The existing manhole on the 48-inch pipe would need to be replaced and lowered to provide a positive flow to the river and account for an 18-inch headloss drop through the disc filters. This would require dropping the pipe invert out to the outfall. If the pump back system to the side channel of Icicle Creek is constructed the disc filter effluent could be directed to this new structure.
5. *Backwash piping:* An 8-inch backwash line to convey disc filter backwash to the existing cleaning waste pipe.
6. *Pump station*: A new pump station would be constructed on or near the cleaning waste effluent line. This pump station will be constructed to lift 600 gpm up to the clarifier with a 30-foot rise in hydraulic grade line. The pump station or upstream manhole would be designed to allow bypass of the clarifier. A chemical storage room to store dry and wet chemical feed would be required next to the clarifier.
7. *Clarifier:* Effluent from the pump station would discharge to a 32-foot diameter CONTRAFLO® Solids Contact Clarifier in a concrete circular tank. A building is not included in the cost of the clarifier.
8. *Sludge tank:* A 50-foot diameter WesTech Thickener Mechanism with concrete tank. This would provide storage and settling of sludge.
9. *Monitoring Equipment:* Four new sampling stations for the intake, Outfall 1, Outfall 2 and the fish ladder.
10. *Lab:* A small lab bench with equipment for Leavenworth NFH to perform total phosphorus and other applicable water quality analysis.

The phosphorous treatment recommendations presented here have been selected to achieve the proposed TP mass limits under the present hatchery configuration, or with minor modifications, for the water reuse and rearing unit alternatives that have been identified in this study. A complication would be if large quantities of additional well water with high soluble TP levels were added to the hatchery flow during the restricted periods. In that case, a significantly larger chemical treatment process would be required in order to meet the proposed TP mass limit.

The implementation costs for the treatment system are summarized in Section 7. This long term plan is contingent on formalization of permit conditions and the pilot study demonstrating the disc filters and clarifier remove sufficient TP to meet the permit conditions. If the pilot study does not demonstrate sufficient TP removal using the system described above the next step in the pilot study would be to test the full flow of the hatchery flowing through a clarifier.

6.2.9 Support Facilities

A seismic evaluation of the hatchery building and the assorted hatchery support structures and residences was performed in 2003. Several structural deficiencies under seismic load were identified in the hatchery building. The building is listed on the historic register and any modification to the building would need to maintain the historic appearance of the building.

The 2003 seismic evaluation also noted several structural deficiencies under seismic load in the shop and vehicle building. The costs for repairs in 2003 were estimated to be $392,000. In 2014 dollars the cost would likely be over $600,000. The 2011 special inspection found the MCRFRO structures to be in generally good condition. A couple of improvements suggested include replacing the fluorescent light fixtures with more energy efficient fixtures, and constructing a covered walkway between buildings No. 2 and No. 3. It has also been suggested that a biologist station for coded wire tag retrieval be constructed in one of the buildings. The irrigation system around the hatchery building has several leaks and is in need of rehabilitation.

6.2.10 Power, Lighting, Controls, and Alarms

6.2.10.1 Provide Emergency-Generator for Wells 1, 2, 3 & 7

The existing truck-mounted engine generator is used to provide standby power to Wells 1, 2, 3 and 7. Whenever there is an outage, hatchery personnel must be alerted, go to the maintenance shop, drive the truck-mounted generator to the well sites, hook-up electrical connections and start the unit. This procedure takes time and typically occurs during periods of extreme inclement weather. The maintenance personnel must be very careful while making the electrical connections and during the start-up and shutdown operation of the generator. This potentially dangerous situation could be avoided if the emergency generator were located at the Well Pump service area and provided with automatic operation. Although personnel would still be required to respond during an outage, the response would be to verify proper operation; not to quickly get an alternative power source on-line and to get water flowing to prevent a possible fish kill.

6.2.10.2 Provide Updated/Consolidated Electrical ‘Present Condition’ Drawings

Current electrical site drawings, building plans and schematics are essential for training new personnel and daily O&M of the facility. Since this facility has been in operation for over 75 years, there have been numerous changes to the electrical system. In addition, the local electrical utility has installed 12,000 volt underground cables throughout the site. The electrical drawings for the facility received as part of this study were incomplete and not up to date. The information is totally inadequate in order to get a perspective of the electrical distribution at the hatchery.

6.2.10.3 Connected Load/Verification Study

Since the site has had so many changes over the years, it is important to determine the available capacity of the electrical distribution system. For future planning purposes, it would be beneficial to examine the usage and availability of existing power at various areas of the facility. This would assist in the potential siting of a spawning building, or other future structure.

6.2.10.4 Other Miscellaneous Items

Several other electrical items have been identified as beneficial additions to the facility. They include the following:

a. Add RV Hook-ups at the North 40 area of the site.
b. Provide an automatic gate at the hatchery entrance
c. Rework existing electrical outlets which are mounted at grade at the ends of raceways.
d. Remove fixtures with T12 lamps and provide fixtures with T8 lamps in the MCFRO Building

6.3 Entiat National Fish Hatchery

This sub-section discusses modernization alternatives for Entiat NFH.

6.3.1 Surface Water Supply

The following issues have been identified with the surface water supply system:

- Severe icing for the full width of the river at the intake location.
- NMFS restrictions on surface water diversion to 5% of stream flow when flow drops below 200 cfs May through October and 10% of stream flow when flow is less than 100 cfs in November through April.
- There are capacity problems with the surface water intake in late summer and during winter freeze-up when river flows drop and water depth at the intake may be only 12 to 16-inches.
- The remote location of the fish screens.
- Frazil ice clogging of the intake pipeline, fish screen, fish bypass pipe and sediment settling pond.
- Pathogen risks with spawning fish above the intake and from myxobolus parasite
- Turbidity and sand entrainment during spring run-off and freshet events.
- Hydraulic profile limits the amount of surface water that can be routed to the upper bank of raceways.
- Flow metering on 36-inch main line is several hundred feet downstream of the control valve at the intake and is time consuming and awkward for one person to make accurate flow adjustments.
- No flow metering capabilities on supply branches to each bank of raceways.
- Water quality problems, primarily algal growth in the Limekiln spring supply.

Improvements to address each of these issues are discussed below.

6.3.1.1 Intake Modifications

The primary concerns with the existing intake are the inability to deliver full water rights during low stream flow periods and worker safety issues with hatchery staff having to enter the river in front of the intake to manually remove ice during prolonged hard freezing events (Fig. 6-6). During freezing events

staff must also expend significant effort in the fish screen chamber at all hours of the day and night to remove accumulated slush and frazil ice from the top of the static side slope screens (Fig. 6-7).

Proposed modifications to solve these problems include:

- Relocate the fish screen function to the point of diversion on the right bank of the Entiat River. In addition to improved worker safety and reduced maintenance effort, these modifications would eliminate entrainment of ESA listed fish through the hatchery supply pipe and fish bypass pipes, and would also reduce the amount of sediment and debris that accumulates in the settling basin.
- Utilize self-cleaning coanda effect or travelling screens. A screen with horizontal travel would minimize icing problems.
- Install a groundwater diffuser de-icing system at the screen face to prevent ice build-up. There is presently a 4-inch groundwater pipeline that supplies 200-300 gpm to help de-ice the intake that may need to be upsized to deliver a higher flow rate depending on screen design details. The groundwater diffuser would also improve sweeping velocity at the screen face.
- Look at deepening the sill and/or adding a flushing channel at the intake trash rack/screen face to increase flow during low water events. The present intake trash rack and settling chamber is only 9 feet wide. Significantly greater length of trash rack and screen face would be required to comply with NOAA fish screen design criteria for a screen capable of passing the 22.5 cfs water right.
- Consider an effluent pump-back system to the outfall just downstream of the present intake. This would allow the hatchery to increase surface water withdrawals during restricted low stream flow periods.

The reconfigured screening system would need to function over a wide range of stream flows and river stages. During spring runoff, historical flows in Entiat River peak at 3,000 to 5,000 cfs (Reclamation Records). In late summer and during winter freezes the stream flow drops to 70 cfs (Chisam 2014), and the hatchery is allowed to divert only 10% of the stream flow.

Figure 6-10. Entiat NFH Intake - Icing at Trash Rack

Figure 6-11. Slush Accumulation Clogging Fish Screens at Entiat NFH

6.3.1.2 Screening Structure/Sediment Basin Modifications

Implementing the intake modifications described above would reduce head loss at the present screening structure by eliminating the existing sideslope screens. The sediment basin outlet weir could be raised a few inches which would improve the hydraulic profile conditions in the surface water supply pipe and

help to solve the flow restriction to the upper raceways. Alternatively, a new dedicated 16-inch supply pipe could be routed from the sediment basin to the upper raceways. The flow to the upper raceways may also be improved by adding a direct connection from the new infiltration gallery discharge pipe planned for 2015 construction according to FWS staff.

It is recommended that the surface water flow meter readout be transmitted from the screening structure area to provide a local indication at the intake control valve to allow a single staff member to make surface water flow adjustments and monitor flows more efficiently.

6.3.1.3 Surface Water Disinfection

The known presence of a neural myxobolid and spawning adult salmonids above the surface water intake are driving the need to consider disinfection of the surface water supply at Entiat NFH. If single pass surface water is to be used, this system would need to be designed to treat the average surface water flow demand of 10 cfs. The recommended system would include 40 micron mechanical pre-filtration followed by ultraviolet (UV) disinfection. Mechanical pre-filtration (utilizing a drum filter) is typically on the order of $15,000 per cfs of treated flow at a 40 micron screening level. Based on historical data from other projects, the cost of UV disinfection averages $9,000 per cfs of treated flow at a dose rate of 50 MJ/sec-cm2, with UV transmissivity in the 80-90% range. Including equipment enclosures, electrical work, yard piping and valves, and sitework the total cost of the system would be in the range of $600,000 for full flow disinfection. The size and cost of the disinfection system could be reduced by 30% to 40% if the design flow rate were lowered by incorporating water reuse technology on the outdoor rearing raceways.

6.3.1.4 Limekiln Spring Modifications

Algal growth and fouling problems have been noted with the water supply from Limekiln spring. Covering the spring pool with shade cloth or a solid roof cover would reduce the algal growth, but there may be a larger problem with the water chemistry enabling algal growth. Hatchery staff have suggested discontinuing the use of spring water for the summer Chinook program and instead re-routing the spring supply to provide gravity flow supply directly into the nearby public fishing pond. This would reduce bio-security concerns and eliminate the operational cost associated with the present pumped re-use supply from the pollution abatement pond up to the fishing pond. Rerouting the spring flow to supply the trout pond would require approximately 340 feet of buried 12-inch pipe.

6.3.2 Groundwater Supply

The groundwater supply system does not produce adequate flows during the mid-April through November time period when surface water is not used. The available groundwater flow averages 3 cfs, which is well below the typical demand of 7 cfs during this period. The construction of a new infiltration gallery and pumpstation designed by Reclamation is planned for implementation in 2015. The capacity of this new system is expected to be between 1500 to 4500 gpm depending on the efficiency of the proposed infiltration laterals. The funding for these improvements is already committed and no additional cost is included in this analysis for groundwater source increases.

If FWS is not able to develop adequate supplies of groundwater, water re-use alternatives may need to be implemented. Existing 24-inch RCP pipes allows for serial reuse of water between banks of raceways. A certain amount of re-oxygenation occurs by the water spilling over stoplogs at the drain and head ends of the raceways and staff have not noted any problems with dissolved oxygen levels.

The six existing wells are widely spaced around the hatchery site and are not monitored by a central alarm system. Alarm lights are used instead. The wells (and new infiltration gallery pumps) should have flow monitoring and pump failure alarms connected to an auto-dialer system to notify operators of potential flow interruptions.

6.3.3 Supply and Drain Piping

Much of the yard piping at Entiat NFH was replaced in 1978 when the Foster-Lucas ponds were replaced with the 8 x 80 ft raceways. It appears that the buried pipe used in 1978 was welded steel, asbestos concrete and/or reinforced concrete pipe. There have been problems with the durability of asbestos concrete pipe in other locations. It has failed under limited settlement and seismic induced stresses. Steel pipe often has corrosion issues and shortened service life in buried applications. The 1994 project that installed wells #5 and #6 utilized C-900 PVC pipe and should have good longevity. The older buried pipe runs, such as the 36-inch RCP surface water transmission line and initial well discharge piping from 1961, and the 1978 pipes should be investigated via potholing and/or internal video survey to determine condition and priority for possible replacement. The results of the survey should then be used to establish an implementation plan and budgets for piping replacement projects as funding allows. Table 6-4 summarizes the estimated lengths of piping and associated valves that will need to be investigated and replaced as needed.

Table 6-3. Summary of Potential Pipe Replacements - Entiat NFH

Description	Pipe Length (LF)
36-inch RW Pipe	1,025
8" Well #2	285
8" Well #3	770
8" Well #4	590
18" GW - Head Box to Bank A Raceways	125
12" GW - Raceways to Hatchery Building	330
12" GW - Headbox to Raceways	400
30" RW - Valve Chamber to Rearing Units	120
24" RW - Valve Chamber to Rearing Units	115
18" RW - Valve Chamber to Rearing Units	315
24" Main Drain from Raceways	620
12" Main Drain from Hatchery Building	140
18" Cleaning Waste Drain	400

6.3.4 Adult Holding Pond and Fish Ladder

Section 2 notes problems with adult hatchery fish not entering the fish ladder during low flow periods. They tend to hold in deep water under a bridge several hundred feet downstream of the ladder entrance. Extending the ladder to the downstream location, or constructing a new ladder and transport channel may be technically possible, but would be a costly project to implement. For the 2014 brood year, the hatchery was able to attract surplus brood fish with the existing facility. No costs for ladder entrance improvements are recommended or included at this time.

6.3.5 Incubation and Early Rearing

There are no proposed modifications to the incubation facilities at Entiat NFH, except that hatchery staff identified a need for a river water supply into the building to support a potential lamprey program and a desire to stop using the Limekiln Spring supply as a potential way to reduce or eliminate formalin use in the incubators.

6.3.6 Juvenile Rearing and Release

The three banks of 8 x80 ft concrete raceways were recently renovated and should provide many years of service life. Modifications recommended at the raceways include:

- Replace loud, high maintenance pumps that are used for cleaning waste vacuuming (Fig. 6-8). These are self-priming 7.5 hp pumps that are mounted at the downstream end of each raceway bank (3 total). Changing the pumps out with better performing equipment would be a relatively simple, low cost effort.
- Install flow meters on the groundwater and surface water supply lines to each of the three banks of raceways. There is space to install the meters on spool pieces inside the raceway supply channels. Three 18-inch meters would be needed for the surface water supply lines and three 12-inch meters would be needed for the groundwater supply lines.
- Grating modifications: The serrated surfaces on the existing gripstrut grating are tearing up vacuum hoses. FRP or smoother surfaced steel grating is recommended to preserve hose life. To solve a worker safety issue we recommend grating be added to eliminate a gap between existing grating panels at the tail end of each raceway – a total of 60 pieces, (two per raceway) 4’ long x 6” wide are required (Fig. 6-12).

Figure 6-12. Cleaning Waste Vacuum Pump and Grating Gap

The biological criteria review in Section 3 have identified a surplus of at least 7 raceways. FWS could modify operations to utilize 24 raceways (8 in each bank) which would reduce overall water demand and cleaning effort while still meeting production and density index targets. Water demand could be further

reduced by utilizing 20 raceways (2 banks) which would increase the density index to 0.13 lb.cf/in. for the last month prior to release, and keep it below the 0.11 lb.cf/in. target for the rest of the rearing cycle This change could result in significant capital and operational cost savings associated with groundwater development and pumping costs, surface water disinfection costs, and water re-use implementation. Hatchery staff have expressed concern that an unused raceway bank may be prone to accelerated weathering, which could be mitigated by routing overflow water though them and not loading them with fish.

A roof cover over the raceway area, (similar to the newer raceway banks at Winthrop NFH and Leavenworth NFH) is also under consideration. The existing predator barriers are outfitted with netting that requires replacement every 5 years and shade cloth that needs to be removed and re-installed seasonally. Solid metal roof covers similar to those used at Leavenworth NFH and Winthrop NFH are recommended as a long term improvement.

6.3.7 Alternative Rearing Technologies

Entiat NFH is short on groundwater most of the year and has seasonal issues with surface water availability as noted above. If the 2015 groundwater development project is not successful, the implementation of water reuse and/or oxygen supplementation, and/or surface water disinfection may need to be considered. FWS has recently invested over $500,000 in rehabilitation of the raceway concrete so it makes sense to take advantage of the long service life these raceways now offer. Retaining the raceways eliminates the PRAS and circular tank retro-fit alternatives described in Section 6.1.

The two remaining alternative rearing technologies, the low head oxygen supplementation (LHO), and Aeroboost systems were then considered. Due to the shallow depth of the 8 x 80 raceways, the Aeroboost manufacturer has declined to recommend that technology for this application. FWS staff has indicated that dissolved oxygen levels have not been a limiting factor with serial reuse in the existing raceways. This may in part be due to the low rearing densities (Using 30 raceways vs. the 23 required per calculated DI). Detailed dissolved oxygen calculations will be provided in the final report.

Similar to the system described for Leavenworth NFH, the LHO alternative would include installing LHO contactors at the upstream end of the middle and lower raceway banks to fully oxygenate serial reuse water. This alternative offers the lowest cost solution for reducing water demand. There are however, fish health concerns with serial reuse and this approach would need to be accepted by FWS fish health staff.

Figure 6-13. Serial Reuse Discharge into Raceway Supply Channel

6.3.8 Effluent Treatment

The only effluent system modification under consideration at the Entiat NFH is to discontinue the use of pumped pollution abatement pond water to the public fishing pond as described above. There are no costs associated with this item.

6.3.9 Support Facilities and Access

A small number of minor upgrades to aging support facilities have been identified:

- Repair/replace plumbing in Residence #3 and #4

The residence structures are quite old and would continue to have maintenance issues. Hatchery staff are presently required to live on station and pay $700 per month, which is the funding source for all housing maintenance and repairs. In the long term FWS may want to consider replacing at least two of these units with modern residences or allow staff to live off-site. The replacement of two residences is included on the list of recommended alternatives.

The adjacent agricultural operations are interfering with hatchery operations and creating potential safety issues. The hatchery manager has recommended purchasing a portion of this adjacent land which should be considered by FWS administration.

6.3.10 Power, Lighting, Controls, and Alarms

6.3.10.1 Retrofit/Replace Engine-Generator

The diesel engine generator should be evaluated regarding the possibility of adding an isochronous governor. In addition, the voltage regulator and the unit control panel would also have to be replaced. The need to manually 'fine-tune' the generator would be eliminated, resulting in additional time for hatchery personnel to attend to more critical issues during power outages. This addition (and/or the entire unit replacement) would also result in a more 'automatic' operation of the standby power source during times of utility power loss. Both options are included in this discussion because, although additional costs would be incurred, it may be more prudent to replace the entire unit instead of retrofitting an older generator.

6.3.10.2 Provide Consolidated Electrical 'Present Condition' Drawings

Since the hatchery has been in existence, there have been numerous changes and upgrades to the electrical distribution system. It would take an extended period of time for any new maintenance personnel to become familiar with the details of the existing installation. Electrical site drawings, building plans and schematics are essential in the daily O&M of the facility.

6.3.10.1 Replace Flowmeters

If 6 new flowmeters are supplied as part of the recommended upgrades to the raceways, the replacement of several other site flowmeters should also be considered. Several existing flowmeters (manufactured by various firms) are difficult to maintain, may be obsolete, and do not have spare parts readily available, and one existing meter is not functional. These should be replaced with a single model that is easy to maintain. Staff prefers the Sierra model flowmeters and are attempting to replace meters with this model when possible.

6.3.10.2 Correct Clearance Problems

Panels and electrical equipment which have cover-mounted devices and require manual operation (such as pushbuttons, selector switches, disconnect switches, etc.) are required to have clear working space in front of them (Ref: NEC – 110.26). Several of the existing pump stations (well Pump Stations #2, #3 and #4) have installations that do not meet this requirement. The panels and other equipment should be relocated within the pump house to allow for the necessary space. Required space is 4'-0" in front of 480V panels and 3'-0" in front of 120/208/240V panels.

6.4 Winthrop National Fish Hatchery

This sub-section discusses infrastructure alternatives considered for modernization of Winthrop NFH.

6.4.1 Surface Water Supply

The surface water supply system at Winthrop NFH is generally in good condition and functions reliably. There have been some issues with false readings from the pressure transducers at the intake which are used to adjust upward closing gates to set the diversion flow rates into the Foghorn Ditch. FWS is

working with Reclamation to resolve this problem. Previous reviews have recommended that the sluice gates at the diversion be cleaned and recoated to extend service life.

There are spawning salmon and steelhead in the Methow River above the Foghorn Ditch diversion. A fish barrier was proposed to be located just downstream of the intake to resolve this problem, however the project is on hold due to permitting issues. FWS does not think the fish barrier project would move ahead. Disinfection of the surface water supply may need to be considered if pathogen problems arise. A system similar to the microscreen and UV disinfection system proposed at Entiat NFH could be constructed immediately downstream of the existing screen chamber at Winthrop NFH. No other costs for surface water improvements are included at this time.

6.4.2 Groundwater Supply

The groundwater supply system at Winthrop NFH is pumped from shallow infiltration collectors into a piped delivery system. The system capacity barely provides adequate quantities of high quality groundwater for meeting fish production targets. There is a lack of redundant supply capacity during peak flow periods. The hatchery does have the flexibility to pump hatchery building effluent to rearing units if necessary. A new well is recommended to provide redundant flow capacity.

Unlike most pumped groundwater supplies at fish hatcheries, there is no gas-stabilization/aeration treatment of the groundwater at Winthrop NFH. The dissolved oxygen levels at each infiltration gallery are 9 mg/l according to staff, which is 82% of the full saturation level of 10.9 mg/l. There have been instances of gas bubble disease when the aquifer is drawn down too far and pumps begin to cavitate. Simple packed column aeration would increase the dissolved oxygen levels to near saturation, increase the carrying capacity of the supply, and would protect fish from gas bubble disease by equalizing the total dissolved gas pressures in the water supply if pumps are cavitating. A central degassing headbox could be added to the groundwater supply system in the vicinity of the valve chamber to provide this treatment. Detailed hydraulic analysis would be needed to determine what the impact of additional pump head would be on overall well production.

The cone of aquifer depression at Gallery #3 interferes with Gallery #1 water production so Gallery #3 is mostly used as a standby, redundant supply and does not have a back-up power supply. There is a valve needed on the spring branch pipe upstream of the tee from Gallery #3 to prevent groundwater from surcharging into the surface water screen chamber overflow. The back-up power and valve costs are included in the piping and power categories below.

6.4.3 Supply and Drain Piping

Much of the buried piping at Winthrop NFH is original steel piping, some of which is known to be severely corroded and in need of replacement. Leaks in the 36-inch surface water supply pipe have been repaired in multiple locations according to hatchery staff. A major leak occurred in a supply main near the west end of “C Bank” in September of 2014 which resulted in emergency relocation of fish while repairs were made. There are hydraulic restrictions in the supply piping to “C Bank” that contribute to poor turnover rates in those units. The drain/fish transfer pipe from the “A Bank” of Foster Lucas ponds is rusted out and is non-functional. There are also problems with undersized groundwater supply piping to “D and E Banks”.

It is recommended that the original piping be scheduled for replacement and upsizing of certain segments over the next few years. A video survey of the interiors of the pipelines is recommended to prioritize pipe replacements as they may need to be phased due to funding limitations. The sizing of the new piping will need to take into consideration the supply and drain flows associated with the recommended new rearing units described in Section 6.4.6 below. Table 6-4 summarizes the estimated lengths of piping and associated valves that will need to be investigated and replaced as needed.

Table 6-4. Summary of Potential Pipe Replacements - Winthrop NFH

Description	Pipe Length (LF)
36-inch RW Pipe	565
22" "Spring Line" to Valve Chamber	560
16" IG #3 to "Spring Line"	480
24" IG #2 to "Spring Line"	615
10" IG #1 to Valve Chamber	115
12" IG #1 to Valve Vault	90
10" Valve Vault Misc Piping	125
10" GW - Head Box to Rearing Units	290
36" SW - Valve Chamber to 8x80s D Bank	350
24" SW to Raceways	150
18" SW to Adult Holding	250
18" Reuse from Adult Holding	325
12" Reuse Pumpback Pipe	405
36" Main Drain from Raceways	245
39" Main Drain	125
12" Cleaning Waste Drain	125
18" Cleaning Waste Drain	580

There are two valve chambers on the supply piping, both of which are do not comply with confined space safety regulations and need to be modified. Since piping improvements were installed over the years, somewhat piecemeal, there would be opportunities to simplify piping and valve configurations for improved operational flexibility.

6.4.4 Adult Holding

The adult holding facility was rebuilt in 2011 and does not require any further improvements at this time.

6.4.5 Incubation and Early Rearing

There are no issues with the incubation and early rearing infrastructure in the hatchery building.

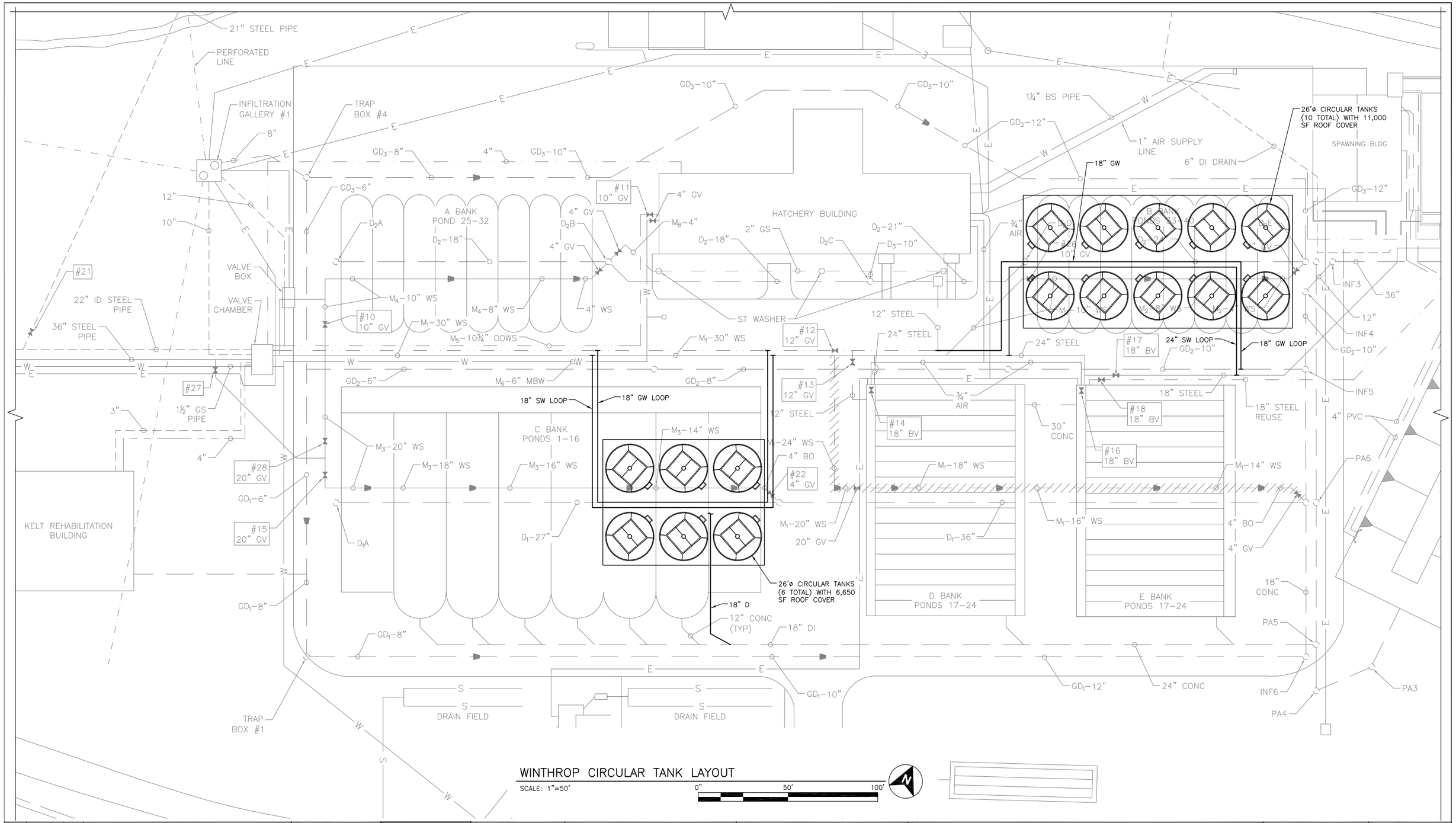
6.4.6 Juvenile Rearing and Release

The original and modified Foster-Lucas juvenile rearing ponds (Banks “A, B and C”), are in poor condition. The C bank (Fig. 6-14) has been converted into (16) 12 x 100 ft raceways, that have severe leakage problems and poor hydraulics. Demolition or abandonment of all three banks of the Foster-Lucas units is recommended.

The two banks of (15) 8 x 80 ft covered rearing raceways ("D and E Banks"),were added to Winthrop NFH in the mid-70's and now require some relatively minor repairs and maintenance to concrete and asphalt surfaces in the near term. In the long term, the rough concrete walls and floors (Fig 6-15) would need to be rehabilitated with an epoxy coating system, (similar to the Entiat NFH raceway treatment), to extend service life. The rearing volume summary in Section 3 indicates that approximately 85,500 cubic feet of total outdoor rearing volume is recommended to meet FWS density index targets for all three production programs. The "D and E Banks" provide 44,000 cubic feet of volume. This leaves a balance of 41,500 cubic feet of replacement capacity needed. The recommended alternative for providing this replacement volume is to construct 16 new 26-ft diameter circular tanks. A 17,650 square foot roof cover over the new rearing units is also recommended. Figure 6-16 illustrates one potential layout of the new tanks and associated supply and drain piping which would be installed in phases to avoid interrupting fish production. The first phase would include demolition of the "B Bank" of the small Foster Lucas ponds, and construction of 10 new 26-foot diameter within the B Bank footprint. A second phase would demolish a portion of the C Bank raceways and installation of at least 6 more new 26-foot circular tanks.

Figure 6-14. Crumbling Concrete at "C Bank" Raceways

Figure 6-15. Rough Walls at "D Bank" of 8 x 80 Raceways



WINTHROP CIRCULAR TANK LAYOUT

SCALE: 1"=50'

0" 50' 100'

REV	DATE	BY	DESCRIPTION
0	...	...	...

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN, LLC

1401 SHORELINE DRIVE
SUITE 100
BOISE, ID 83702

OFFICE: 208.342.4214
FAX: 208.342.4216

U.S. FISH & WILDLIFE SERVICE

UNITED STATES FISH AND WILDLIFE SERVICE

REPLACEMENT REARING UNITS (10) 26'ø CIRCULAR TANKS

DESIGNED J. HARPER

DRAWN D. LITA

CHECKED

ISSUED DATE 12/09/14

FIGURE

6-16

SCALE: AS NOTED

6.4.7 Alternative Rearing Technologies

6.4.7.1 Alternatives for Existing Rearing Units

Water reuse technology could be incorporated at Winthrop NFH to reduce groundwater demand. The reduced demand would create redundant supply during peak flow periods and increased operational flexibility utilizing the existing supply systems. The least costly method of reducing water demand is to use LHO units in conjunction with serial reuse. Similar to the recommendation for Entiat raceways, it would be relatively simple to retro-fit the lower bank of (15) 8 x 80 raceways ("E Bank") with LHO's to re-oxygenate serial reuse overflow water from "D Bank" in order to reduce water demand by 50%. Aeroboost units are not included as an alternative since they are not recommended for vessels with water depths of less than 38 inches.

6.4.7.2 Alternatives for New Rearing Units

As noted above, approximately 16 new outdoor rearing units are proposed to replace existing Foster Lucas ponds. These new tanks could be configured with LHO's (one per tank), or Aeroboost units, (three per tank), to reduce water demand by 50%. A small blower or oxygen shed with control panel and air or oxygen distribution piping would be included.

6.4.8 Effluent Treatment

Outdoor rearing units are typically cleaned by vacuuming, with the cleaning waste routed to a single cell settling pond, except for "A Bank" which is not connected to the drain or cleaning waste piping. The Winthrop NFH monitors effluent water quality in accordance to an NPDES discharge permit and no violations have occurred. We have included cleaning waste piping to connect the hatchery and all rearing units to the pollution abatement pond as a high priority item for the new rearing units.

6.4.9 Support Facilities

Recommended upgrades to support infrastructure include seismic upgrades to the hatchery building and residences, a 400 sf hatchery office addition, storage racks for fish transfer hoses in the shop building, and comfort station repairs.

6.4.10 Power, Lighting, Controls, and Alarms

6.4.10.1 Add Engine-Generator at Well #3

The existing diesel engine in the generator room is rated to have a maximum output of 300 amps. A cursory tabulation of the existing hatchery loads including the Main Hatchery Building, the two infiltration galleries and other miscellaneous loads indicate that the generator is loaded to at least 75% (225 amps). Well #3 is located approximate ¼ mile away from the existing generator and it is a 75 hp motor. Factors such as distance (i.e.-voltage drop problems) and load (a 75 hp motor draws 96 amps) indicate that the existing generator does not have the capacity to add Well #3. If Well 3 is critical to the operation of the Hatchery, then other standby power options should be considered. Possible options include the use of a portable generator or the provision of a dedicated unit at Well #3.

6.4.10.2 Provide Updated/Consolidated Electrical 'Present Condition' Drawings

Due to the many changes to the electrical system over the life of the facility, it would be greatly beneficial to have current site and building electrical drawings. This would aid in the daily O& M of the facility plus assist in future planning and may improve worker safety. As a minimum, preparation of an accurate one-line diagram is recommended.

6.4.10.3 Other Miscellaneous Items

Several other electrical items have been identified as beneficial additions to the facility. They include the following:

a. Repair several instances of broken PVC conduits and/or junction boxes at the surface water intake structure and the screenings area.
b. Modify the VFD starter cabinet for the pump control at Infiltration Gallery #1 to allow for better air circulation.

6.5 Alternatives Summaries and Costs

A list of alternatives for modernization of each Complex hatchery has been prepared, with items group according to functional area. Preliminary budgets for each line item are also included.

6.5.1 Alternatives Costs

Capital construction costs have been prepared to assist with budget planning for each of the alternatives described above. Capital construction costs are conservative estimates based on a conceptual design. Due to the level of uncertainty, a contingency of 20 percent is applied to each construction cost line. Such a contingency is largely dependent on the number of uncertainties associated with the project and the amount of pre-investigation work completed. Estimated construction costs represent a maximum range and likely cost reductions would be identified in future planning stages through analysis of alternatives and elimination of many uncertainties.

FWS provided the following cost factors which are included in the preliminary estimates for medium to large capital projects (See Appendix E), that are complex enough to require bid documents or are likely to require a general contractor and multiple subcontractors.

General Contract Requirements (15%): This factor includes mobilization/de-mobilization, temporary facilities, erosion control, special testing and other Division 1 contract requirements. It is applied to the construction cost subtotal including contingency.

Overhead (10%) and Profit (10%): These factors covers general contractor overhead and profit. They are applied to the construction cost subtotal including contingency.

State Sales Tax (8.2%): This factor covers the State of Washington sales tax for construction projects. On government projects retail sales tax is to be paid on materials and equipment and is included in unit costs.

Design, Permitting and Construction Management (20%): This factor includes site surveys, geotechnical investigations, preliminary design, final design, permitting, and construction management, and FWS management costs through project implementation. It is applied to the subtotal of the factors above. These cost factors are not split out for smaller deferred maintenance or capital projects that may be accomplished by a single contractor or that may not require permits, survey, a geotechnical report, preparation of bid documents, or contracted construction management.

Tables 6-2, 6-3 and 6-4 provide a summary of the recommended alternative modernization improvements at the respective Complex hatcheries. These summary tables include conceptual level costs for each item. Remaining line items carried over from the 2011 Special Inspection and FWS lists have been included and escalated to 2014 dollars. It should be noted that FWS and Reclamation have provided input to the prioritization of projects, and that recommended alternatives have not been selected for some high cost items such as alternative rearing technologies. Therefore the costs shown are not additive, since some alternatives would be eliminated or modified based on the implementation of other alternatives.

Table 6-5. Leavenworth NFH Alternatives Summary

Item Number	Description	RPI #	Benefit	Concept Cost	Priority	Comments
6.2.1 Surface Water Supply System						
6.2.1a	Intake Screens - Allowance	35500200	NMFS Compliance - Better for ESA Fish	TBD	High	By BOR
6.2.1b	Surface Water Transmission Pipe - Allowance	40710400	Operational Reliability - Extend Service Life of Facility	TBD	High	By BOR
6.2.1c	Structure #2 - Bridge Repairs	40760700	Operational Reliability - Extend Service Life of Facility	$ 100,000	Low	
6.2.1d	Repairs to Sand Settling Basin	40710300	Worker Safety - Extend Service Life of Facility	$ 30,000	Medium	
6.2.1e	Replace Upper Snow Lake Outlet Valves and Automate	40161200	Operational Reliability - Extend Service Life of Facility	$ 893,000	High	Could Reduce This Item by not automating control valve
6.2.2f	Upper and Lower Snow Lake Dam Repairs	40161900	Operational Reliability - Extend Service Life of Facility	$ 651,000	Medium	
6.2.2.g	Filter and Disinfect 12 cfs Surface Water	New	Allows Reuse of Surface Water - Reduces Pathogen Risks	$ 1,347,192	High	
6.2.2 Ground Water Supply System						
6.2.2a	Well Development - 8 CFS additional Capacity	New	Increase GW Supply/Redundancy	$ 2,955,000	High	Could Reduce This Item by Using Water Reuse
6.2.2b	Modify Aeration/Gas Stabilization Systems	40710300	Improve Water Quality, Protect Fish From Gas Bubble Disease	$ 395,000	High	Allowance - depends on new water vs. reuse
6.2.2c	Add Remote Controls for all 7 Production Wells	Multiple	Improve Operational Reliability and Efficiency	$ 159,000	Medium	Reduce Manpower costs
6.2.2d	28 cfs Pump Back System for Well Recharge	New	Increase GW Supply/Redundancy	$ 719,000	High	Cost Per Nov. 19 2014 Memo from Anchor QEA
6.2.3 Distribution Piping						
6.2.3a	Video Survey of Piping Systems	Multiple	Prioritize Pipe Replacements	$ 30,000	High	
6.2.3b	Pipe Replacement Allowance	Multiple	Improved Operational Reliability- Extend Service Life of Facility	$ 2,441,000	Medium	
6.2.3c	Valve Replacements	Multiple	Improved Operational Reliability- Extend Service Life of Facility	$ 200,000	Medium	Perform in Conjunction with Pipe Replacements
6.2.3d	Groundwater Supply Pipe to Lower bank of 8 x 80's	New	Improved Fish Health and Operational Flexibility	$ 60,000	Medium	Depends on Rearing Alternative Selected
6.2.3e	Replace Reuse Pump #1 with New Duplex Pumps and Piping	35500200	Increase Reliability - Reduced Groundwater Demand During Freeze Up	$ 338,000	High	Low cost compared to new source development
6.2.4 Adult Holding/Fish Ladder						
6.2.4a	Repair Fish Ladder		Extend Service Life of Facility	$ 125,000	Medium	Sack and patch with Epoxy Coating
6.2.4b	Replace Spawning Facility/Upgrade Electrical		Worker Safety, Improved Fish Condition & Handling Efficiency	$ 3,402,000	High	Similair to new WNFH facility
6.2.4c	Additional Holding Pond	New	Increased holding capacity and aid in maintaining already sorted fish	$ 800,000	Low	Combine with 6.2.4b
6.2.5 Incubation and Indoor Rearing						
6.2.5a	Additional Troughs and Building	New	Meet FWS Fish Culture Guidelines	$ 2,430,000	Low	Increasing flow and changing DI to 0.24 achieves the goals
6.2.5b	Groundwater Reuse	New	Provide Increased GW Flows and Better Temperatures	$ 239,000	Medium	Utilize pumping station from 6.2.3e.
6.2.6 Juvenile Rearing and Release						**Line items this section not Additive**
6.2.6a	Cover for 8 x 80 Raceways(350x140)	40500200	Predator Barrier and Shade to Reduce Sunburn and Algal Growth	$ 2,544,000	Medium	
6.2.6b	Existing 8 x 80 Raceways - Conc. Sealing & Asphalt Repair	40500200	Extend Service Life of Facility	$ 50,000	Medium	
6.2.6c	Repair Joints on 10 x 100 Raceways	40500400	Extend Service Life of Facility	$ 30,000	Medium	
6.2.6d	Alternative to Refurbish Existing 8 x 80 Raceways	40500200	Improve Fish Condition, Extend Service Life of Facility	$ 1,435,000	TBD	Alt. 6.4.6d,e and f are not additive
6.2.6e	Alternative to Construct 14 new 10 x 100 Raceways	New	Replaces Aging Production Units	$ 4,570,000	High	Alt. 6.4.6d,e and f are not additive
6.2.6f	Alternative to Construct 18 new 26' Circulars	New	Replaces Aging Production Units, Improves Fish Quality?	$ 4,543,000	TBD	Alt. 6.4.6d,e and f are not additive
6.2.7 Alternative Rearing Technologies						**Line items this section not Additive**
6.2.7a	Add Low Head Oxygenators to 30 Existing 8 x 80 Raceways	40500200	Reduced GW and SW Supply Demand, Save Energy	$ 550,000	TBD	50% to 67% Water Use Reduction (Depends on 6.4.6 Decisions)
6.2.7b	Add Low Head Oxygenators to 7 Existing 10 x 100 Raceways	40500400	Reduced GW and SW Supply Demand, Save Energy	$ 362,000	TBD	50% Water Use Reduction
6.2.7c	Alternative to Add AeroBoost Units to 45- 8 x 80 Raceways	40500200	Reduced GW and SW Supply Demand, Save Energy	-	NA	Inadequate water depth - Deleted Pending Further Research
6.2.7d	Alternative to Add AeroBoost Units to 14- 10 x 100 Raceways	40500400	Reduced GW and SW Supply Demand, Save Energy	$ 1,211,000	TBD	50% Water Use Reduction
6.2.7e	Alternative to Add PRAS to 18 new Circular Tanks	New	Reduced GW and SW Supply Demand, Save Energy	$ 4,666,000	TBD	50% Water Use Reduction
6.2.7f	Alternative to Add Aeroboosts to 18 new Circular Tanks	New	Reduced GW and SW Supply Demand, Save Energy	$ 810,000	TBD	50% Water Use Reduction
6.2.7g	High Density Alternative -14 new Circular Tanks on PRAS	New	Reduced GW and SW Supply Demand, Save Energy	$ 6,405,000	TBD	50% - 75% Water Use Reduction - Includes Tank Cost
6.2.8 Drains, Effluent Pond, and Outfall						
6.2.8a	Phosphorous Treatment System	New	Environmental Compliance	$ 4,222,000	Medium	See Appendix C for Details - May become high priority
6.2.8b	Cover Settling Ponds	Multiple	Reduce Algal Growth and Thermal Gain in Effluent	$ 100,000	Low	
6.2.8c	Early Rearing CWE Standpipe to PAP	New	Reduces Discharge of Untreated Waste to Icicle Creek	$ 50,000	Medium	
6.2.8d	Vacuum Pumps for Cleaning Raceways	New	Long Term Phosphorous Management Measure	$ 30,000	Medium	Increases Staff Time for Cleaning Operations
6.2.9 Support Facilities						
6.2.9a	Hatchery Building Seismic Upgrades	35500100	Worker Safety - Extends Service Life of Facility	$ 700,000	High	
6.2.9b	Shop/Garage - Seismic Retrofits	35600100	Improve Worker Productivity	$ 600,000	High	
6.2.9c	Shop/Garage - Enclose Office Space	35600100	Improve Worker Safety and Productivity	$ 213,000	Medium	
6.2.9d	FRO Covered Walkway	35100000	Worker Safety - Extends Service Life of Facility	$ 100,000	Medium	
6.2.9e	FRO CWT Processing Station	New	Worker Comfort and Efficiency	$ 50,000	High	
6.2.9f	Fishing Platform Accessibility and Repairs	40800900	ADA Compliance - Extend Service Life of Facility	$ 56,000	High	
6.2.9g	Spillway Bridge Repairs	40760500	Worker Safety - Extends Service Life of Facility	$ 300,000	Medium	
6.2.10 Power, Lighting, Controls, and Alarms						
6.2.10a	Provide Back-up Power to Wells 1,2,3, and 7	New	Increased Water Supply Reliability/Prevents Potential Fish Losses	$ 100,000	High	
6.2.10b	Electrical 'Present Condition Drawings'	NA	Worker Safety and Operational Reliability	$ 30,000	Medium	
6.2.10c	Load Verification Study	NA	Needed to Inform Design of Upgrade Options	$ 20,000	Medium	
6.2.10d	Misc Small Items	NA	Modernization	$ 30,000	Low	

Table 6-6. Entiat NFH Alternatives Summary

Item Number	Description	RPI #	Benefit	Concept Cost	Priority	Comments
Surface Water Supply System						
6.3.1a	Intake/Fish Screen Modifications	40500100	Improved Worker Safety - Reduces ESA Impacts	$ 1,213,000	High	
6.3.1b	Surface Water Flow Meter Transmitter	40710400	Increases Operational Efficiency	$ 10,000	Low	
6.3.1c	10 cfs Surface Water Disinfection	New	Improved Water Quality, Reduces Dependence on Groundwater	$ 1,139,000	High	Primarily for July-Nov Rearing Period
6.3.1d	10 CFS Effluent Pumpback System	New	Allows Higher SW Diversion Rates During Low River Flow Periods	$ 871,000	High	Cost Effective Method to Increase Water Supply
6.3.1e	Re-purpose Limekiln Spring to Fishing Pond Supply	40801100	Improved Water Quality	$ 20,000	Medium	Verify WQ Data
6.3.1f	Sediment Basin Weir Raise	40710300	Improved Flow to Upper Raceway Bank	$ 10,000	Medium	May Eliminate with Alt Rearing Technology
Ground Water Supply System						
6.3.2a	Groundwater Infiltration Gallery - 2015 BOR Project	New	Increase GW Supply Flow. Provides Flexibility/Redundancy	By FWS	High	
Distribution Piping						
6.3.3a	Video Survey of Piping Systems	Multiple	Prioritizes Pipe Replacement Projects. May Avoid Emergency Situations	$ 15,000	High	
6.3.3b	Pipe Replacement Allowance	Multiple	Extends Service Life of Facility by 75 years	$ 1,506,000	Varies	Depends on video survey results
6.3.3c	Flow Meters on SW and GW Supply to Each Raceway Bank	Multiple	Improved Rearing Conditions,Simplify Flow Balancing, Reduced Labor	$ 142,000	Medium	
Adult Holding and Fish Ladder						
6.3.4	Ladder Entrance Modifications	NA	Improves Trapping Efficiency	NA		Deleted by FWS
Incubation						
6.3.5a	Add Surface Water Supply to Inc. Room for Lamprey	New	Allows Culture of New Species	$ 25,000	Medium	
6.3.5b	Cap Off Limekiln Spring Supply to Hatchery	40710400	Improved Water Quality, Reduces Chemical Use	$ 1,000	Medium	
Juvenile Rearing and Release						
6.3.6a	Replace 3 CWE Vacuum Pumps	New	Extends Service Life of Facility. Improved Work Environment	$ 15,000	Medium	Reduce if Two Banks of Raceways are Used
6.3.6b	Replace Grating	40500400	Improves Worker Safety- Reduces CWE Hose Costs	$ 180,000	High	Reduce if Two Banks of Raceways are Used
6.3.6c	Replace Predator Barriers with Metal Roof Over Raceways	40500400	Improved Predator Barrier and Shade to Reduce Algal Growth	$ 1,439,000	Medium	Reduce if Two Banks of Raceways are Used
Alternative Rearing Technologies						
6.3.7	Low Head Oxygenators - Middle Bank	40500400	Reduced GW and SW Supply Demand, Saves Energy	$ 300,000	Medium	Depends on Results of Items 6.3.1 and 6.3.2
Drains, Effluent Pond, and Outfall						
	None					
Hatchery and Shop Buildings						
	None					
Support Buildings						
6.3.9.a	Replace Plumbing in FRO and Residence #3	Multiple	Reduce Energy Costs	$ 30,000	Medium	
6.3.9.b	Replace 2 Residences	Multiple	Extends Service Life of Facility Housing by 75 Years	$ 650,000	Medium	
Power, Lighting, Controls, and Alarms						
6.3.10.a-i	Existing Generator Modifications	40710100	Increases Operational Efficiency	$ 21,500	Medium	Either 6.3.10a-i or 6.3.10-ii
6.3.10.a-ii	Replacement Generator	40710100	Increases Operational Efficiency and Reliability	$ 47,500	Medium	Either 6.3.10a-i or 6.3.10-ii
6.3.10b	Electrical As-builts	NA	Worker Safety and Operational Reliability	$ 20,000	Medium	
6.3.10c	Existing Flowmeter Replacement	Multiple	Increases Operational Efficiency and Reliability	$ 67,000	Medium	
6.3.10d	Code Clearances	40710100	Worker Safety	$ 25,000	High	
6.3.10e	Wellfield Monitoring and Alarm System	Multiple	Improved Pump Protection and Fish Health Management	$ 100,000	Medium	

Table 6-7 Winthrop NFH Alternatives Summary

Item Number	Description	RPI #	Benefit	Concept Cost	Priority	Comments
Surface Water Supply System						
6.4.1a	Recoat Sluice Gates	40161200	Extend Service Life	$ 5,000	Medium	
6.4.1b	Surface Water Disinfection	New	Pathogen Control, Improved Water Quality	$ 1,128,000	Low	Verify Need with FWS
Ground Water Supply System						
6.4.2a	Add Well for Redundancy at Peak Flow Periods	New	Increase GW Supply/Redundancy	$ 399,000	Medium	Could Eliminate This Item by Using Water Reuse
6.4.2b	Add Central Aeration/Gas Stabilization Headbox	New	Improve Water Quality, Protect Fish From Gas Bubble Disease	$ 395,000	Medium	Potentail to Reduce Water Demand Due to Higher DO
Distribution Piping						
6.4.3a	Video Survey of Piping Systems	40710400	Prioritize Pipe Replacements	$ 15,000	High	
6.4.3b	Pipe Replacement Allowance	40710400	Extend Service Life of Facility	$ 1,843,000	Medium	
6.4.3c	Upgrade Valve Chambers to Meet Confined Space Regs.	40710400	Operational Reliability, Improved Worker Safety	$ 10,000	High	
6.4.3d	Add valve to prevent GW overflow at Screen Chamber	40710400	Elimates Waste of Groundwater - Energy Efficiency	$ 5,000	Medium	
Adult Holding						
	None					
Incubation and Indoor Rearing						
	None					
Juvenile Rearing and Release						
6.4.6a	Replace 41,000 CF of Rearing Volume - (16) 26 ft Dia Circulars	New	Replace Obsolete Foster Lucas Units	$ 2,728,000	High	Failing Rearing Units
6.4.6b	17,650 sf Roof Cover for New Rearing Units	New	Predator Barrier and Shade to Reduce Sunburn and Algal Growth	$ 1,038,000	High	
6.4.6c	Existing 8 x80 Raceways - Conc. Sealing & Asphalt Repair	40500400	Extend Service Life of Facility	$ 50,000	Medium	
6.4.6d	Refurbish Existing 8 x 80 Raceways	40500400	Improve Fish Condition, Extend Service Life of Facility	$ 797,000	Medium	
Alternative Rearing Technologies						
6.4.7a	Add Low Head Oxygenators to 15 Existing E Bank Raceways	40500400	Reduced Groundwater and Surface Water Supply Demand, Save Energy	$ 374,000	Medium	50% Water Use Reduction
6.4.7b	Incorporate LHO/Serial Reuse into New Rearing Units	New	Reduced Groundwater and Surface Water Supply Demand, Save Energy	$ 300,000	Medium	50% Water Use Reduction
6.4.7c	Incorporate Aeroboost Units at New Circular Tanks	New	Reduced Groundwater and Surface Water Supply Demand, Save Energy	$ 468,000	Medium	50% Water Use Reduction
Drains, Effluent Pond, and Outfall						
6.4.8a	Connect New Rearing Units To Pollution Abatement Pond	New	Environmental Compliance		High	Covered in 6.4.6.a Above
Support Facilities						
6.4.9a	Hatchery Building Seismic Upgrades	35500100	Worker Safety - Extends Service Life of Facility	$ 150,000	High	From Reclamation Report
6.4.9b	Hatchery Building - Add 400 sf Office Space	35500100	Improve Worker Productivity	$ 60,000	Low	From Reclamation Report
6.4.9c	Shop - Fish Transfer Hose Storage Racks	35410300	Improve Worker Safety and Productivity	$ 3,000	Medium	
6.4.9d	Residence - Seismic Upgrades	Multiple	Worker Safety - Extends Service Life of Facility	$ 60,000	Medium	
6.4.9e	Comfort Station Accessibility and Repairs	35240100	ADA Compliance - Extend Service Life of Facility	$ 12,000	Medium	
Power, Lighting, Controls, and Alarms						
6.4.10a	Gen-Set For Gallery #3	New	Increased Water Supply Reliability/Prevents Potential Fish Kil	$ 92,000	Medium	
6.4.10b	Electrical As-builts	NA	Worker Safety and Operational Reliability	$ 20,000	High	
6.4.10c	Other Misc. - Broken J Boxes, Modify VFD Cabinent	NA	Maintenance	$ 10,000	Medium	

SECTION 7
CONCLUSIONS AND IMPLEMENTATION RECOMMENDATIONS

7.0 Introduction

This section briefly summarizes the alternatives analysis conclusions and provides descriptions of the highest ranked implementation priorities and preliminary 20-year implementation schedules for selected alternatives.

7.1 Conclusions

The alternatives analysis concludes that the Complex is currently meeting its core mission with regards to the GCFMP and US v. Oregon mitigation commitments. Aging and failing infrastructure and declining water supplies at the existing hatcheries threatens their ability to continue meeting these legal obligations while also meeting FWS fish health criteria.

A high level review of geographically separate alternatives was conducted to evaluate the feasibility of relocating all or part of Complex fish production. This review identified several potential fatal flaws that tend to preclude further study of a new or expanded hatchery at a different site. Therefore, this section focuses on implementation recommendations for improvements at each of the three existing Complex hatcheries.

Hatchery water supplies are of primary importance. In consideration of climate change and its impact on water supplies, improvements that allow FWS to more fully utilize existing water rights at Complex facilities will become increasingly critical. Groundwater supply improvements are underway at Leavenworth and Entiat NFH, and surface water improvements are highly recommended at both facilities. Winthrop NFH has an adequate water supply that would benefit from aeration treatment of groundwater and disinfection of surface water. The major issue at Winthrop is replacement of failing outdoor rearing units.

The Complex is providing cost effective interim support for the YN Mid-Columbia coho program. The YN program would benefit from water supply and rearing unit improvements at Leavenworth and Winthrop NFH, however, permanent improvements may be difficult to justify since the approved master plan for the coho program indicates drastically reduced production at both hatcheries within the next five to ten years. Many of the small to medium sized projects identified in the 2011 Special Inspection have already been accomplished out of annual O and M and replacement budgets. Significant investment in modernization of Complex facilities is recommended and will require a sustained higher level of funding. Since annual funding is subject to Congressional and Bonneville Power Administration budget processes, actual funding levels in future years are difficult to predict with any certainty. Recommended infrastructure improvements have been prioritized to assist in the planning and budgeting process.

7.2 Alternatives Prioritization

The highest priority ratings for alternatives implementation have been assigned to life/worker safety items and water supply improvements which are critical to achieving fish production and fish health goals. Medium priority ratings are assigned to important infrastructure improvements that should be planned and budgeted for in order to increase service life, comply with regulatory and best management practices, and

avoid failures that could impact fish production commitments. This includes items such as pipe or rearing vessel replacements that will eventually become high priority or even emergency items if they are not accomplished prior to further degradation or failure. Alternative rearing technologies that address water availability issues also fall into the medium priority category. There are a few low priority items that have been included in this analysis, most of which involve deferred maintenance of support infrastructure.

The tables at the end of this section, (Tables 7-1, 7-2 and 7-3), utilize the list of infrastructure alternatives identified in Section 6 and illustrate an expenditure schedule for alternatives implementation, in consideration of the assigned priority. An overall implementation timeline of 20 years is shown with costs in 2014 dollars escalated at 3% per year. These implementation schedules are loosely based on a guideline provided by Reclamation that the Complex may receive replacement project funding in the range of $5 to $10M per year over the next 15 to 20 years. Several of the smaller deferred maintenance type projects are shown being implemented early on in the 20-year cycle since funding for these projects is routinely available.

7.2.1 Leavenworth NFH Implementation Priorities

The implementation schedule for capital spending at Leavenworth NFH is front loaded with $2.5 to $5M per year in spending over the next ten years due the number of high priority mission critical projects that have been identified. The spending then tapers off significantly to less than $1M per year for the second ten years. The highest priority projects include:

Phosphorous Management: Implement short-term phosphorous management measures. Once NPDES permit conditions are updated, implementation of the long term phosphorous management plan may become a priority.

Surface Water Intake Screens: Modify or replace the existing Icicle Creek intake screens and building to provide NOAA compliant screening at the point of diversion to eliminate entrainment of ESA fish. Improvements will reduce impingement of adult spawned out salmonids at the intake trash rack and provide better worker safety and ice management as well.

Surface Water Transmission Pipe Upgrade: Repair or replace the failing surface water transmission piping from the intake to the sand settling basin.

Surface Water Filtration and Disinfection: Construct a new microstrainer filtration and UV disinfection facility to treat a portion of the incoming surface water supply. The most critical period for treatment is late summer/early fall when fish may be stressed by elevated water temperatures and higher pathogen loading. Typical surface water supply flows at this time of years are 20 to 25 cfs, however implementing water reuse technology may reduce these flow rates by 50%. A disinfected surface water source would make water reuse alternatives more feasible from a disease risk standpoint.

Groundwater Supply Development: The facility is in deficit on groundwater supply for much of the year. The groundwater rights are for 14.9 cfs, yet present peak capacity of the well field is 7 to 8 cfs which is not sustainable year-round due to aquifer depletion. Geophysical modeling and test pumping conducted as part of this analysis indicates development of an infiltration gallery system on the hatchery island appears to a cost effective and feasible approach to obtaining additional groundwater supplies with seasonal yields of 2 to 5.5 cfs. Implementation of water reuse technologies, either in the hatchery building or at outdoor rearing units would help the facility make better use of limited groundwater supplies.

Replace Spawning Facility: The present facility is outdated, difficult to use and electrical components including the wall they are mounted on, require replacement. A new roof cover and improved crowders, fish lifts and sorting facilities are included.

Construct New Rearing Vessels with Roof Cover: The 8 x 80 ft concrete raceways are nearing the end of service life and will require refurbishment or replacement. Hatchery staff prefers the alternative to construct new 10 x 100 ft raceways similar to the double bank of 7 raceways that were constructed in the mid-1990s. Fish health and FWS regional managers may prefer FRP circular tanks which offer advantages in terms of effluent management, controllable water velocities, and reduced water demands. Total costs are similar for either type of rearing unit.

Provide back-up power to Wells No. 1, 2, 3, and 7: These wells provide the coldest groundwater which is most suitable for incubation and early rearing and it is important to maintain this supply continuously.

Pipe Replacements: Original steel piping is known to be near failure and some of it is being replaced this year. A sustained program to investigate pipelines and replace them over a period of time is recommended. These costs are shown spread out over the 20-year plan period.

Effluent Pump-back System: FWS has been conducting studies on the feasibility of pumping hatchery overflow water into the dewatered Hatchery Channel to recharge the well field aquifer. A potential added benefit would be a reduction in the total phosphorous discharged at outfall #1.

7.2.2 Entiat NFH Implementation Priorities

The implementation schedule for capital investments at Entiat NFH shows costs averaging $0.5 to 1.0M per year over the 20-year cycle. Top priority projects include:

Groundwater Supply Development: The six existing vertical wells at Entiat NFH have lost at least 50% of production capacity over the years and produce less than 3 cfs total flow on average out of a combined water right of 22.5 cfs. FWS has an infiltration gallery project scheduled for 2015 construction. Depending on the results of this project, additional groundwater development may be recommended.

Surface Water Intake and Fish Screen Modifications: The surface water intake has a long history of problems and flow interruptions due to clogging of trash racks and fish screens with ice. A project to move the fish screens to the point of diversion and include more robust ice management is recommended.

Surface Water Disinfection: The hatchery is not able to use surface water April-October due to the presence of a neural myxobolid salmon pathogen in the Entiat River. A 10-cfs surface water filtration and disinfection system is recommended to allow increased use of surface water with reduced risk of disease. A disinfected surface water source would make water reuse alternatives more feasible.

Replace Gratings at Raceways: This is a relatively small project to solve a worker safety problem due to gaps in raceway grip-strut grating and increase the service life of vacuum hoses by replacing the grating with a smoother walking surface.

Effluent Pumpback System: Surface water diversion by the hatchery is limited to 5 to 10 cfs during low flow periods in the Entiat River to maintain in-stream flows per an operating agreement with NOAA. Compliance is time consuming and requires daily monitoring of an off-site stream gage followed by complex adjustments to a dozen flow control valves in the hatchery. A pump back system to collect hatchery overflow water at the fish ladder and pump it through a conveyance pipeline to discharge a short distance downstream of the surface water intake would avoid hatchery impacts on streamflow and may allow the in-stream flow agreement to be modified such that daily adjustments would no longer be required.

Electrical Items: These are relatively low cost items to improve worker safety and water supply reliability. They include code clearances at a 480v panel, accurate electrical diagrams, well field monitoring and alarms, and remote indication of surface water flow to the intake.

7.2.3 Winthrop NFH Implementation Priorities

At Winthrop NFH, a single large high priority project, the replacement of obsolete rearing units, dominates the implementation schedule with a concept cost of nearly $4M. For the remainder of the 20-year cycle spending is in the $200,000 to $1.0M per year range. Unlike the other two Complex hatcheries, the water supplies at this hatchery are generally adequate. The following is a list of the highest priority projects:

Replace 41,000 Cubic Feet of Rearing Volume: The facility has three banks of obsolete Foster Lucas ponds, one of which was converted to 12 x 100 raceways (C Bank). All three banks are in poor condition and do not function well for fish production. 14 to 16 circular tanks, 26 feet in diameter are recommended to provide the needed replacement volume to meet fish production targets using FWS density index criteria. This project should be implemented as soon as possible. The work will probably need to be phased in order to minimize disruptions to fish production.

Connect Rearing Units to Pollution Abatement Pond: This item is solved by abandoning or demolition of the Foster Lucas Ponds and providing pipe connections from the new rearing units and the hatchery building to the existing cleaning waste piping system that flows to the pollution abatement pond.

Pipe Replacements: There have been failures and leaks in the original steel piping and in some previously replaced piping. A sustained program to investigate the condition of pipelines and replace them as needed over a period of time is recommended. There are some hydraulic restrictions (undersized segments), in the groundwater supply piping that need to be addressed as part of the replacement projects as well. These costs are shown spread out over the 20-year plan period.

Gas Stabilization Headbox: The groundwater supply is not presently aerated or gas stabilized prior to use. The shallow aquifer provides groundwater with relatively high DO and acceptable total gas pressures. DO is approximately 20% below full saturation and there have been infrequent problems with gas bubble disease when the aquifer is drawn down and pump cavitation occurs. Construction of a gas stabilization head box is recommended to fully oxygenate the groundwater and provide control of total gas pressures.

Refurbish Existing 8 x 80 ft Raceways: The D and E banks of raceways require some minor concrete repairs and have rough wall and floor surfaces. They will eventually need to be replaced or refurbished. Since these units already have roof covers, it is recommended that the interior concrete surfaces be

refurbished similar to the project that was completed at Entiat NFH at some point later in the 20-year implementation period.

Table 7-1. LNFH Implementation Schedule

Item Number	Description	RPI #	Cost Range	Priority	Ranking	FY 2015 -2018				FY 2019-2023				FY 2024-2027				FY 2028-2031				FY 2032-2035				
6.2.1 Surface Water Supply System																										
6.2.1a	Intake Screens - Allowance	35500200	**5,500,000**	High	**1**	$ 500,000	$ 5,000,000																			
6.2.1b	Surface Water Transmission Pipe - Allowance	40710400	**1,800,000**	High	**2**			$ 360,000	$ 1,440,000																	
6.2.1c	Structure #2 - Bridge Repairs	40760700	**$ 100,000**	Low																						
6.2.1d	Repairs to Sand Settling Basin	40710300	**$ 30,000**	Medium				$ 30,000																		
6.2.1e	Replace Upper Snow Lake Outlet Valves and Automate	40161200	**$ 893,000**	High	**5**								$ 150,000	$ 804,000												
6.2.2f	Upper and Lower Snow Lake Dam Repairs	40161900	**$ 651,000**	Medium												$ 651,000										
6.2.2g	Filter and Disinfect 12 cfs Surface Water	New	**$ 1,347,192**	High	**1**		$ 170,000	$ 1,177,192																		
6.2.2 Ground Water Supply System																										
6.2.2a	Well Development - 8 CFS additional Capacity	New	**$ 2,955,000**	High	**5**	$ 155,000	$ 400,000	$ 400,000	$ 400,000		$ 400,000		$ 400,000		$ 400,000		$ 400,000									
6.2.2b	Modify Aeration/Gas Stabilization Systems	40710300	**$ 395,000**	High	**5**						$ 65,000	$ 355,000														
6.2.2c	Add Remote Controls for all 7 Production Wells	Multiple	**$ 159,000**	Medium				$ 159,000																		
6.2.2d	28 cfs Pump Back System for Well Recharge	New	**$ 719,000**	High	**7**			$ 719,000																		
6.2.3 Distribution Piping																										
6.2.3a	Video Survey of Piping Systems	Multiple	**$ 30,000**	High	**7**	$ 30,000																				
6.2.3b	Pipe Replacement Allowance	Multiple	**$ 2,441,000**	Medium	**8**		$ 40,000		$ 300,000		$ 300,000		$ 300,000		$ 300,000		$ 300,000		$ 300,000		$ 300,000		$ 300,000			
6.2.3c	Valve Replacements	Multiple	**$ 200,000**	Medium	**8**																					
6.2.3d	Groundwater Supply Pipe to Lower bank of 8 x 80's	New	**$ 60,000**	Low	**TBD**																					
6.2.4 Ad	Fish Ladder																									
6.2.4a	Repair Fish Ladder		**$ 125,000**	Medium	**10**																					
6.2.4b	Replace Spawning Facility/Upgrade Electrical		**$ 3,402,000**	High	**3**			$ 200,000	$ 200,000	$ 3,000,000																
6.2.4c	Additional Holding Pond	New	**$ 800,000**	Low																						
6.2.5 Incubation and Indoor Rearing																										
6.2.5a	Additional Troughs and Building	New	**$ 2,430,000**	Low																						
6.2.5b	Groundwater Reuse	New	**$ 239,000**	Medium	**11**																					
6.2.6 Juvenile Rearing and Release																										
6.2.6a	Cover for 8 x 80 Raceways(350x140)	40500200	**$ 2,544,000**	Low																						
6.2.6b	Existing 8 x 80 Raceways - Conc. Sealing & Asphalt Repair	40500200	**$ 50,000**	Low																						
6.2.6c	Repair Joints on 10 x 100 Raceways	40500400	**$ 30,000**	Medium				$ 30,000																		
6.2.6d	Alternative to Refurbish Existing 8 x 80 Raceways	40500200	**$ 1,435,000**	Low																						
6.2.6e	Alternative to Construct 14 new 10 x 100 Raceways	New	**$ 4,570,000**	TBD	**4**						$ 500,000	$ 4,000,000														
6.2.6f	Alternative to Construct 18 new 26' Circulars	New	**$ 4,543,000**	TBD																						
6.2.7 Alternative Rearing Technologies																										
6.2.7a	Add Low Head Oxygenators to 30 Existing 8 x 80 Raceways	New	**$ 550,000**	TBD																						
6.2.7b	Add Low Head Oxygenators to 7 Existing 10 x 100 Raceways	New	**$ 362,000**	TBD																						
6.2.7c	Alternative to Add AeroBoost Units to 45- 8 x 80 Raceways	New	-	NA																						
6.2.7d	Alternative to Add AeroBoost Units to 14- 10 x 100 Raceways	New	**$ 1,211,000**	TBD																						
6.2.7e	Alternative to Add CPRAS to 18 new Circular Tanks	New	**$ 4,666,000**	TBD																						
6.2.7f	Alternative to Add AeroBoost Units to 18 New Circular Tanks	New	**$ 810,000**	TBD																						
6.2.7g	High Density Alternative -14 new Circular Tanks on PRAS	New	**$ 6,405,000**	TBD																						
6.2.8 Drains, Effluent Pond, and Outfall																										
6.2.8a	Long Term Phosphorpous Management Treatment System	New	**$ 4,222,000**	Medium	**12**								$ 600,000	$ 3,622,000												
6.2.8b	Cover Settling Ponds	Multiple	**$ 100,000**	Low																						
6.2.8c	Early Rearing CWE Standpipe to PAP	New	**$ 50,000**	Medium	**7**			$ 50,000																		
6.2.8d	Vacuum Pumps for Cleaning Raceways	New	**$ 30,000**	Medium	**8**								$ 30,000													
6.2.9 Support Facilities																										
6.2.9a	Hatchery Building Seismic Upgrades	35500100	**$ 700,000**	High	**7**						$ 700,000															
6.2.9b	Shop/Garage - Seismic Retrofits	35600100	**$ 600,000**	High	**8**						$ 600,000															
6.2.9c	Shop/Garage - Enclose Office Space	35600100	**$ 213,000**	Medium											$ 213,000											
6.2.9d	FRO Covered Walkway	35100000	**$ 100,000**	Medium	**13**								$ 100,000													
6.2.9e	FRO CWT Processing Station	New	**$ 50,000**	High	**7**			$ 50,000																		
6.2.9f	Fishing Platform Accessibility and Repairs	40800900	**$ 56,000**	High	**7**			$ 56,000																		
6.2.9g	Spillway Bridge Repairs	40760500	**$ 300,000**	Medium	**14**											$ 300,000										
6.2.10 Power, Lighting, Controls, and Alarms																										
6.2.10a	Provide Back-up Power to Wells 1,2,3, and 7	New	**$ 100,000**	High	**6**			$ 100,000																		
6.2.10b	Electrical 'Present Condition Drawings'	NA	**$ 30,000**	Medium	**6**			$ 30,000																		
6.2.10c	Load Verification Study	NA	**$ 20,000**	Medium	**6**			$ 20,000																		
6.2.10d	Misc Small Items	NA	**$ 30,000**	Low												$ 30,000										
TOTAL						***$ 685,000***	***$ 5,610,000***	***$ 3,381,192***	***$ 2,340,000***	***$ 3,000,000***	***$ 2,565,000***	***$ 4,355,000***	***$ 1,580,000***	***$ 4,426,000***	***$ 913,000***	***$ 981,000***	***$ 700,000***	***$ -***	***$ 300,000***	***$ -***	***$ 300,000***	***$ -***	***$ 300,000***	***$ -***	***$ -***	***$ 31,436,192***
ESCALATION / INFLATION - ANNUALLY @ 3%						***$ 20,550***	***$ 336,600***	***$ 304,307***	***$ 280,800***	***$ 450,000***	***$ 461,700***	***$ 914,550***	***$ 379,200***	***$ 1,195,020***	***$ 273,900***	***$ 323,730***	***$ 252,000***	***$ -***	***$ 126,000***	***$ -***	***$ 144,000***	***$ -***	***$ 162,000***	***$ -***	***$ -***	***$ 5,624,357***
ANNUAL TOTAL						***$ 705,550***	***$ 5,946,600***	***$ 3,685,499***	***$ 2,620,800***	***$ 3,450,000***	***$ 3,026,700***	***$ 5,269,550***	***$ 1,959,200***	***$ 5,621,020***	***$ 1,186,900***	***$ 1,304,730***	***$ 952,000***	***$ -***	***$ 426,000***	***$ -***	***$ 444,000***	***$ -***	***$ 462,000***	***$ -***	***$ -***	***$ 37,060,549***

Table 7-2. ENFH Implementation Schedule

Item Number	Description	RPI #	Cost Range	Priority	Ranking	FY 2015 -2018				FY 2019-2023				FY 2024-2027				FY 2028-2031				FY 2032-2035				
Surface Water Supply System																										
6.3.1a	Intake/Fish Screen Modifications	40500100	**$ 1,213,000**	High	**2**		$ 200,000	$ 1,000,000																		
6.3.1b	Surface Water Flow Meter Transmitter	40710400	**$ 10,000**	Low	**11**				$ 10,000																	
6.3.1c	10 cfs Surface Water Disinfection	New	**$ 1,139,000**	High	**4**				$ 150,000	$ 989,000																
6.3.1d	10 CFS Effluent Pumpback System	New	**$ 871,000**	High	**5**						$ 142,000	$ 771,000														
6.3.1e	Re-purpose Limekiln Spring	40801100	**$ 20,000**	Medium	**10**									$ 20,000												
6.3.1e	Sediment Basin Weir Raise	40710300	**$ 10,000**	Low	**14**																					
Ground Water Supply System																										
6.3.2a	Groundwater Infiltration Gallery - 2015 BOR Project	New	**TBD**	High	**1**	$ 500,000																				
Distribution Piping																										
6.3.3a	Video Survey of Piping Systems	Multiple	**$ 15,000**	High	**8**								$ 15,000													
6.3.3b	Pipe Replacement Allowance	Multiple	**$ 1,506,000**	Varies	**8**									$ 70,000	$ 432,000		$ 70,000	$ 432,000			$ 70,000	$ 432,000				
6.3.3c	Flow Meters on SW and GW Supply to Each Raceway Bank	Multiple	**$ 142,000**	High	**6**			$ 23,000	$ 128,000																	
Adult Holding and Fish Ladder																										
	None	NA																								
Incubation																										
6.3.5a	Add Surface Water Supply Capability to Inc. Room	New	**$ 25,000**	Low	**15**														$ 25,000							
6.3.5b	Control Valve for Limekiln Spring Supply to Aeration Chamber	40710400	**$ 3,000**	Medium	**9**								$ 3,000													
Juvenile Rearing and Release																										
6.3.6a	Replace 3 CWE Vacuum Pumps	New	**$ 15,000**	Low	**7**								$ 15,000													
6.3.6b	Replace Grating	40500400	**$ 180,000**	High	**3**		$ 180,000																			
6.3.6c	Replace Predator Barriers with Metal Roof Over Raceways	40500400	**$ 1,439,000**	Medium	**12**																	$ 240,000	$ 1,298,000			
Alternative Rearing Technologies																										
6.3.7	Low Head Oxygenators	40500400	**$ 300,000**	Medium	**13**														$ 52,000	$ 280,000						
Drains, Effluent Pond, and Outfall																										
	None																									
Hatchery and Shop Buildings																										
	None																									
Support Buildings																										
6.3.9.a	Replace Plumbing in FRO and Residence #3	Multiple	**$ 30,000**	Medium	**17**																			$ 30,000		
6.3.9.b	Replace 2 Residences	Multiple	**$ 650,000**	Medium	**18**																				$ 650,000	
Power, Lighting, Controls, and Alarms																										
6.3.10.a-i	Existing Generator Modifications	40710100	**$ 21,500**	Medium	**6**						$ 21,000															
6.3.10.a-ii	Replacement Generator	40710100	**$ 47,500**	Medium	**-**																					
6.3.10b	Electrical As-builts	NA	**$ 20,000**	Medium	**2**		$ 20,000																			
6.3.10d	Code Clearances	Multiple	**$ 67,000**	Medium	**2**		$ 67,000																			
6.3.10e	Wellfield Monitoring and Alarm System	40710100	**$ 25,000**	High	**2**	$ 25,000																				
6.4.10c	Other Misc.	Multiple	**$ 100,000**	Medium	**16**											$ 50,000			$ 50,000							
	TOTAL - 2014 Dollars					***$ 525,000***	***$ 467,000***	***$ 1,023,000***	***$ 288,000***	***$ 989,000***	***$ 163,000***	***$ 771,000***	***$ 33,000***	***$ 90,000***	***$ 432,000***	***$ 50,000***	***$ 70,000***	***$ 432,000***	***$ 127,000***	***$ 280,000***	***$ 70,000***	***$ 672,000***	***$ 1,298,000***	***$ 30,000***	***$ 650,000***	***$ 8,460,000***
	ESCALATION / INFLATION - ANNUALLY @ 3%					***$ 15,750***	***$ 28,020***	***$ 92,070***	***$ 34,560***	***$ 148,350***	***$ 29,340***	***$ 161,910***	***$ 7,920***	***$ 24,300***	***$ 129,600***	***$ 16,500***	***$ 25,200***	***$ 168,480***	***$ 53,340***	***$ 126,000***	***$ 33,600***	***$ 342,720***	***$ 700,920***	***$ 17,100***	***$ 390,000***	***$ 2,545,680***
	ANNUAL TOTAL					***$ 540,750***	***$ 495,020***	***$ 1,115,070***	***$ 322,560***	***$ 1,137,350***	***$ 192,340***	***$ 932,910***	***$ 40,920***	***$ 114,300***	***$ 561,600***	***$ 66,500***	***$ 95,200***	***$ 600,480***	***$ 180,340***	***$ 406,000***	***$ 103,600***	***$ 1,014,720***	***$ 1,998,920***	***$ 47,100***	***$ 1,040,000***	***$ 11,005,680***

Table ES-5. Winthrop Implementation Schedule

Item Number	Description	RPI #	Cost Range	Priority	Ranking	FY 2015 -2018				FY 2019-2023				FY 2024-2027				FY 2028-2031				FY 2032-2035				
Surface Water Supply System																										
6.4.1a	Recoat Sluice Gates	40161200	$ 5,000	Medium	10	$ 5,000																				
6.4.1b	Surface Water Disinfection	New	$ 1,128,000	Low	9								$ 150,000	$ 978,000												
Ground Water Supply System																										
6.4.2a	Add Well for Redundancy at Peak Flow Periods	New	$ 399,000	Medium	8											$ 50,000	$ 348,000									
6.4.2b	Add Aeration/Gas Stabilization Headbox	New	$ 395,000	Low	7							$ 50,000	$ 345,000													
Distribution Piping																										
6.4.3a	Video Survey of Piping Systems	40710400	$ 15,000	High	3				$ 15,000																	
6.4.3b	Pipe Replacement Allowance	40710400	$ 1,843,000	Medium	3					$ 80,000	$ 432,000			$ 80,000	$ 432,000							$ 80,000	$ 432,000			
6.4.3c	Upgrade Valve Chambers to Meet Confined Space Regs.	40710400	$ 10,000	High	6	$ 10,000																				
6.4.3d	Add Valve to prevent GW overflow at Screen Chamber	40710400	$ 5,000	Medium	11	$ 5,000																				
Adult Holding			$ -																							
	None		$ -																							
Incubation and Indoor Rearing			$ -																							
	None		$ -																							
Juvenile Rearing and Release																										
6.4.6a	Replace 41,000 CF of Rearing Volume - (16) 26 ft Circulars	New	$ 2,728,000	High	1		$ 400,000	$ 2,328,000																		
6.4.6b	17,650 sf Roof Cover for New Rearing Units	New	$ 1,038,000	High	1		$ 150,000	$ 988,000																		
6.4.6c	Existing 8 x80 Raceways - Conc. Sealing & Asphalt Repair	40500400	$ 50,000	Medium	12				50,000																	
6.4.6d	Refurbish Existing 8 x 80 Raceways	40500400	$ 797,000	Medium	12															$ 797,000						
Alternative Rearing Technologies																										
6.4.7a	Add Low Head Oxygenators to 15 Existing E Bank Raceways	40500400	$ 374,000	Medium	12				$ 50,000	$ 324,000																
6.4.7b	Incorporate LHO/Serial Reuse into New Rearing Units	New	$ 300,000	Medium	12													$ 40,000	$ 240,000							
6.4.7c	Incorporate Aeroboost Units at New Circular Tanks	New	$ 468,000	Medium	-																					
Drains, Effluent Pond, and Outfall			$ -																							
6.4.8a	Connect New Rearing Units To PAP (Included Above)	New	$ -	High	2																					
Support Facilities																										
6.4.9a	Hatchery Building Seismic Upgrades	35500100	$ 150,000	High	5	$ 150,000																				
6.4.9b	Hatchery Building - Add 400 sf Office Space	35500100	$ 60,000	Low	13											$ 60,000										
6.4.9c	Shop - Fish Transfer Hose Storage Racks	35410300	$ 3,000	Medium	5	$ 5,000																				
6.4.9d	Residence - Siesmic Upgrades	Multiple	$ 60,000	Medium	5				$ 60,000																	
6.4.9e	Comfort Station Accessibility and Repairs	35240100	$ 12,000	Medium	4				$ 12,000																	
Power, Lighting, Controls, and Alarms																										
6.4.10a	Gen-Set For Gallery #3	New	$ 92,000	Medium	8							$ 92,000														
6.4.10b	Electrical As-builts	NA	$ 20,000	High	4	$ 20,000																				
6.4.10c	Other Misc.	NA	$ 10,000	Medium	15												$ 10,000									
TOTAL - 2014 Dollars						***$ 195,000***	***$ 550,000***	***$ 3,316,000***	***$ 187,000***	***$ 404,000***	***$ 432,000***	***$ 142,000***	***$ 495,000***	***$ 1,058,000***	***$ 432,000***	***$ 110,000***	***$ 358,000***	***$ 40,000***	***$ 240,000***	***$ -***	***$ 797,000***	***$ 80,000***	***$ 432,000***	***$ -***	***$ -***	***$ 9,268,000***
ESCALATION / INFLATION - ANNUALLY @ 3%						***$ 5,850***	***$ 33,000***	***$ 298,440***	***$ 22,440***	***$ 60,600***	***$ 77,760***	***$ 29,820***	***$ 118,800***	***$ 285,660***	***$ 129,600***	***$ 36,300***	***$ 128,880***	***$ 15,600***	***$ 100,800***	***$ -***	***$ 382,560***	***$ 40,800***	***$ 233,280***	***$ -***	***$ -***	***$ 2,000,190***
ANNUAL TOTAL						***$ 200,850***	***$ 583,000***	***$ 3,614,440***	***$ 209,440***	***$ 464,600***	***$ 509,760***	***$ 171,820***	***$ 613,800***	***$ 1,343,660***	***$ 561,600***	***$ 146,300***	***$ 486,880***	***$ 55,600***	***$ 340,800***	***$ -***	***$ 1,179,560***	***$ 120,800***	***$ 665,280***	***$ -***	***$ -***	***$ 11,268,190***

SECTION 8
REFERENCES

Bonneville Power Administration. (2012). Mid-Columbia Coho Restoration Program, Final Environmental Impact Statement, DOE/EIS-0425. Okanogan County, The Confederated Tribes and Bands of the Yakama Nation.

Chisam, C. (2014). Information Memorandum. Entiat NFH Original Land Deed & Roaring Creek Diversion Relocation Project. Entiat National Fish Hatchery, U.S. Fish and Wildlife Service.

Cooper, M. (2006). Fish Production Review of the Leavenworth National Fish Hatchery Complex, 2005. U.S. Fish and Wildlife Service, Mid-Columbia River Fishery Resource Office, Leavenworth, WA.

Department of Ecology, State of Washington. (2014). Water Resources Program, Certified Water Right Examiner (CWRE), Proof Report of Examination and Recommendations, Water Right No: CS4-SWC848.

Entiat National Fish Hatchery. (2004). Comprehensive Hatchery Management Plan – June 2004.

Geocal, Inc, & Short Elliott Hendrickson, Inc. (2012). Bridge Inspection and Appraisal Report. Bridge Number: 13225-00099. Leavenworth NFH, Region 1, U.S. Fish & Wildlife Service.

Geocal, Inc, & Short Elliott Hendrickson, Inc. (2012). Bridge Inspection and Appraisal Report. Bridge Number: 13225-00038. Leavenworth NFH, Region 1, U.S. Fish & Wildlife Service.

Geocal, Inc, & Short Elliott Hendrickson, Inc. (2012). Bridge Inspection and Appraisal Report. Bridge Number: 13225-00100. Leavenworth NFH, Region 1, U.S. Fish & Wildlife Service.

Goodwin, A., Bayer, M., Christiansen, J., Cook-Tabor, C., Cooper, M., Eaton, C., Yundt, S. (2014). Recirculating Aquaculture Systems Evaluation Group.

National Oceanic and Atmospheric Administration. (2012). Project 1993-056-00 Annual Report (Performance Period: 1 June 2011 Through 31 May 2012).

National Testing Laboratories Ltd. (2004). Water Analysis Results. Winthrop National Fish.

Rice, D., & Montgomery, B. (2014). Technical Memorandum, Leavenworth National Fish Hatchery Pump Back – Preliminary Assessment. Anchor QEA, LLC.

Scribner, T., Murdoch, K., Dunnigan, J., Ferguson, G., Pasley, C., Ahrens, M., ...Weintraub, N. (2002). Hatchery and Genetics Management Plan, Mid-Columbia Coho Reintroduction Feasibility Project. Yakama Nation. Washington Department of Fish & Wildlife. Bonneville Power Administration.

Sneddon, M., Beckner, C., & Miller, H. (2014). Leavenworth National Fish Hatchery Preservation Plan, Contract No. GS10F0194S, U.S. Fish and Wildlife Service. Historical Research Associates, Inc.

United States Court of Appeals for the Ninth Circuit. (2013). Wild Fish Conservancy v. Jewell. No. 10-35303, D.C. No. 2:09-cv-00206-LRS, Opinion.

U.S. Fish and Wildlife Service. (2009). Entiat National Fish Hatchery (ENFH), Leavenworth Hatchery Complex. Hatchery and Genetic Management Plan (HGMP). Entiat River, tributary to the Columbia River, Washington State.

U.S. Fish and Wildlife Service. (2012). Leavenworth National Fish Hatchery. Annual Flow Monitoring Report, Water Year 2011. State of Washington, Department of Ecology, Water Quality Program.

U.S. Fish and Wildlife Service. (2013). Leavenworth National Fish Hatchery. Annual Flow Monitoring Report, Water Year 2012. State of Washington, Department of Ecology, Water Quality Program.

U.S. Fish and Wildlife Service. (2008). Leavenworth National Fish Hatchery Tier II Water Quality Analysis.

U.S. Fish and Wildlife Service. (2002). Leavenworth National Fish Hatchery (LNFH), Leavenworth Hatchery Complex. Hatchery and Genetic Management Plan (HGMP). Icicle Creek, tributary to Wenatchee River, Columbia River Basin, Washington State.

U.S. Fish and Wildlife Service. (2013). National Pollutant Discharge Elimination System, Discharge Monitoring Report. Leavenworth National Fish Hatchery.

U.S. Fish and Wildlife Service. (2009). Winthrop National Fish Hatchery (WNFH), Leavenworth Fisheries Complex. Hatchery and Genetic Management Plan (HGMP). Methow River, tributary to the Columbia River, Washington State.

U.S. Fish and Wildlife Service. (2013). Winthrop National Fish Hatchery: Climate Change Vulnerability Assessment, December 2013. Climate Change Assessment Team for National Fish Hatcheries, Pacific Region. U.S. Fish and Wildlife Service, Portland, Oregon.

U.S. Fish and Wildlife Service. (2009). Winthrop National Fish Hatchery (LNFH), Leavenworth Hatchery Complex. Hatchery and Genetic Management Plan (HGMP). Methow River, tributary to the Columbia River, Washington State.

U.S. Fish and Wildlife Service – Pacific Region, & Columbia Basin Hatchery Review Team. (2007). Leavenworth, Entiat and Winthrop National Fish Hatcheries Assessments and Recommendations. Final Report.

U.S. Fish and Wildlife Service. (2014). Pacific Region, Office of the ARD-Fishery Resources, Leavenworth Fisheries Complex.

U.S. Fish and Wildlife Service. Unpublished Data provided by U.S. Fish and Wildlife Service.

United States v. Oregon. (2008). 2008-2017 United States v. Oregon Management Agreement.