U.S. Fish & Wildlife Service

Wapato Lake

National Wildlife Refuge

Environmental Assessment

Washington and Yamhill Counties, Oregon

Finding of No Significant Impact for the

Wapato Lake National Wildlife Refuge Environmental Assessment

Washington and Yamhill Counties, Oregon

The U.S. Fish and Wildlife Service (Service) has completed an Environmental Assessment (EA) for Wapato Lake National Wildlife Refuge (Refuge). The proposed action aims to restore as feasible, the composition and structure of functioning ecosystems that historically occurred in and around Wapato Lake, thus improving the biological integrity, diversity, and environmental health (BIDEH) of Wapato Lake NWR and the surrounding landscape. The EA describes our proposal for achieving the ecological restoration of 1,000+ acres of the Refuge and their effects on the human environment under three alternatives, including the no action alternative.

Alternatives Considered

Alternative 1: No Action (Maintain cooperative farming program)

Under the No Action Alternative, the Service would not restore 800 acres of freshwater wetlands within the lakebed and 206 acres of wetlands and uplands on non-lakebed properties at Wapato Lake NWR. This portion of the Refuge would remain as converted wetlands and uplands and continue to be used for agricultural purposes.

Alternative 2: Lakebed–Restoration of lacustrine and palustrine wetlands (Remove pumping infrastructure and reconnect lake to Wapato Creek).

Under Alternative 2, 800 acres of freshwater wetlands comprised of lacustrine and multiple palustrine systems (Cowardin et al. 1979), would be restored by reconnecting Wapato Lake to the greater Tualatin River system. The reconnection would allow natural physical processes, chiefly the water levels in Wapato Creek (which is influenced by Tualatin River levels), to shape the ecological character of the lake. Water levels in Wapato Lake would be driven by intra- and inter-annual variability of Tualatin River flows, and in turn, drive aquatic plant community response which would ultimately influence wildlife response. Reconnection would be achieved by excavating a single breach at the north end of the lakebed where the current pumping infrastructure exists.

Alternative 3 (Preferred Alternative): Lakebed–Restoration of palustrine wetlands (Manage lakebed water levels with pumping infrastructure).

Under Alternative 3, the Preferred Alternative, 800 acres of freshwater wetlands, consisting of multiple palustrine systems (Cowardin et al. 1979), would be restored by seasonally managing water levels with pumping infrastructure. The extensive levee system that surrounds the lake, a pump station, and a bridge that provide access to Wapato Lake would be required to manage the site. Seasonal hydrology would be a primary driver of Wapato Lake's ecological character; however, lakebed water levels would be controlled primarily by pumping infrastructure, and the lakebed would remain disconnected from the greater Tualatin River system. Pumps are proposed to manage water levels rather than a head gate structure, because the water surface elevation of

the creeks that surround Wapato Lake are typically higher than the water surface elevation of Wapato Lake.

Comparison of Effects and Decision

The No Action Alternative would result in continuing the cooperative farming operations at the Refuge, thus maintaining the agricultural use of the site that has occurred for over a century. With the exception of wintering and migrating waterfowl, other native wildlife and their habitats have largely been displaced as a result of these practices. Therefore, it was determined that the No Action Alternative would not improve the Service's ability to meet its legally mandated mission to protect trust resources, and protect and enhance wildlife habitat**.**

The action alternatives would result in lakebed restoration; however, they would result in different hydrologic outcomes within the lakebed, which governs the plant community types that could be restored and the wildlife that would use the lakebed. While both action alternatives would improve the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat, the magnitude of effects, particularly associated with the ecology of the restored lakebed, would differ.

Alternative 2 would better assist the Service to meet its legally mandated mission to protect trust resources, and preserve and enhance wildlife habitat compared to the No Action Alternative, it was not selected as the Preferred Alternative due to concerns that high water levels during the growing season would limit the re-establishment of palustrine wetland plant communities and result in more open water, compared to Alternative 3. In addition, Alternative 2 presented water quality risks associated with potential algal blooms due to the open connection that was proposed between Wapato Lake and the Tualatin River.

Alternative 3 was selected as the Preferred Alternative, because it would provide marked ecological improvement to Refuge lands compared to the No Action Alternative, and as a result of maintaining pumping infrastructure for water-level control, provided greater certainty that ecological restoration and water quality goals within the lakebed would be achieved compared to Alternative 2. For example, Under Alternative 3, the pumping infrastructure would give the Service the ability maintain shallow water depths during the growing season and support more diverse and structurally complex plant communities compared to the deeper, more open water system expected under Alternative 2. While some similarities exist with respect to expected wildlife use under both Alternatives 2 and 3, the abundance and diversity of wildlife throughout the year would be greater under Alternative 3 where habitat heterogeneity is greater.

Summary of the Actions to be Implemented

Under the Preferred Alternative, 800 acres of freshwater wetlands, consisting of multiple palustrine wetland types would be restored by seasonally managing water levels with pumping infrastructure. Because the Preferred Alternative aims to achieve an outcome dependent upon water level control, the aging pumps, which have required multiple repairs in recent years, and associated piping infrastructure would need to be replaced. In addition, the 5.5 miles of levees that surround the lake would have to be regularly inspected and maintained to ensure that ecological goals associated with the Preferred Alternative could be achieved in the long-term, as

well as separate the Tualatin Valley Irrigation Districts irrigation infrastructure (i.e. the canals that surround the lakebed) from the lakebed.

Considering that the lakebed has been intensively manipulated and degraded as a result of agricultural practices over the last century and is largely void of native flora, the Preferred Alternative would also require the re-establishment of native herbaceous and woody plant communities. Re-establishment of native flora would occur subsequent to site preparation actions aimed at eliminating or suppressing non-native plant cover. Therefore, Integrated Pest Management Strategies (e.g. mowing, soil tilling, brush clearing, spraying with Refuge approved herbicides, etc…) would first be employed to establish site conditions that would favor newly installed native vegetation. Upon adequately preparing the site for native plant re-establishment, native woody and herbaceous plant species would be installed (e.g. seeding, plug, bulb, and tuber installation, and bare-root and live stake planting) based on planned growing season water depths in the lakebed and according to the depth gradients that particular species' are known to occupy. The additional 200+ acres of Service lands on the periphery of the lakebed (located outside of the lakebed), would be restored to a diversity of wetland and upland plant communities ranging from palustrine forested, scrub-shrub, and emergent wetlands, as well as upland prairie. Plant community re-establishment would be conducted by employing similar strategies described for the lakebed wetlands above, but be informed by soil moisture and soil type rather than inundation patterns since only small portions of those sites are flooded and rarely during the growing season.

Impacts to the human environment are described in Chapter 4 of the EA and are incorporated by reference. Impacts to all resources do not rise to the level of significance because while the effects would be detectable, they would be localized, small, and of minor consequence to fish and wildlife populations, plant communities, recreational opportunities, visitor experience, or to any cultural resource. Mitigation measures are not required to reduce impacts below the threshold of significance.

Public Involvement and Changes Made to the Selected Alternative Based on Comments

The draft EA for the Wapato Lake NWR was released on May 5, 2017 and made available for review during a 30-day public comment period that extended from May 5 – June 3, 2017. In addition, the Service held a public meeting on May 15, 2017 to describe the alternatives that were considered and provide rationale for selecting the preferred alternative.

Copies of the planning document were available at local libraries, refuge headquarters, and online. English and Spanish versions of the planning update announcing the availability of the EA and the public meeting were posted in multiple businesses in Gaston, Forest Grove and Cornelius, included as an insert to Forest Grove Pacific Gas and Electric customers, sent via e-mail to all Gaston School District families, written about in a Forest Grove News Times story, and sent via e-mail to 40 individuals representing local, state and federal government agencies, as well as non-governmental organizations.

A total of 11 responses were received from individuals and organizations, either as a letter to the Service or on the Public Comment Form that was distributed at the Public Meeting or found online with the EA. No changes were made to the selected alternative based on comments

received from the public. Additional information about public comments received are found in Appendix A.

In addition to review of the Draft EA during May/June 2017, numerous planning, informational, and consultation meetings were held between November 2014 and May 2017 with various stakeholders (see table 5 of the EA).

Conclusions

As described in detail in this EA, implementation of the Preferred Alternative, in concert with other Service, Clean Water Services, Metro, and other partner conservation efforts, would have long-term cumulative benefits for wildlife and their habitats throughout the northern Willamette Valley.

The Preferred Alternative for the Wapato Lake NWR was found to have less-than-significant impacts to all the evaluated resources. Where adverse impacts were found, they were found to be localized and of a minor consequence to the human environment and would be of too short a duration to be considered significant. Mitigation measures are not required to reduce impacts below the threshold of significance. Overall, implementation of the Preferred Alternative is expected to have beneficial impacts to natural resources, mainly native plant communities and wildlife resources. However, in the context of historic losses of native habitats in the northern Willamette Valley and continuing habitat loss and degradation resulting from human activities in the area, the beneficial effects associated with the Preferred Alternative are not considered to be significant.

Based on review and evaluation of the information contained in the supporting references, I have determined that implementing the Preferred Alternative of the EA for Wapato Lake National Wildlife Refuge is not a major Federal action that would significantly affect the quality of the human environment within the meaning of section 102(2)(c) of the National Environmental Policy Act of 1969. The proposed action is not without precedent and is not similar to actions that would normally require preparation of an Environmental Impact Statement. Accordingly, we are not required to prepare an environmental impact statement. Interested and affected parties are being notified of our decision.

Robyn Thorson

Regional Director, Region 1
Portland, Oregon

September 12, 2019

Date

Supporting References

U.S. Fish and Wildlife Service. 2017. *Wapato Lake National Wildlife Refuge, Draft Environmental Assessment.* Sherwood, OR: Tualatin River National Wildlife Refuge.

Note: This Finding of No Significant Impact and supporting references are available for public review at Tualatin River National Wildlife Refuge, 19255 SW Pacific Highway, Sherwood,

Oregon, 97140 and U.S. Fish and Wildlife Service, Division of Planning, Visitor Services, and Transportation, 911 NE 11th Avenue, Portland, Oregon, 97232.

WAPATO LAKE

NATIONAL WILDLIFE REFUGE

ENVIRONMENTAL ASSESSMENT

Washington and Yamhill Counties, Oregon

Prepared by

U.S. Fish and Wildlife Service

Tualatin River National Wildlife Refuge Complex

19255 SW Pacific Highway

Sherwood, OR 97140

PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

Chapter 1 Purpose and Need for Action 1
1.1 Introduction 1
1.2 Purpose and Need for Action 1
1.3 Proposed Action 2
1.4 Decision to be Made 3
1.5 Development of the Alternatives 3
1.6 Background of Area 4
1.7 Proposed Action Study Area 7
Chapter 2 Alternatives 10
2.1 Introduction and Definitions 10
2.2 Alternative 1: No Action 11
2.3 Alternative 2: Restoration (open connection) 14
2.4 Alternative 3 (Preferred Alternative): Restoration (pumping) 20
2.5 Alternatives Considered But Not Forwarded for Detailed Analysis 22
Chapter 3 Existing Environment 24
3.1 Soils 24
3.2 Hydrology and Vegetation 25
3.3 Wildlife and Fish 26
3.4 Threatened and Endangered Species 28
3.5 Water Quality – Harmful Algal Blooms 29
3.6 Air Quality 30
3.7 Cultural Resources 30
3.8 Mosquitoes 34
3.9 Neighboring Lands 34
3.10 Water Rights 36
3.11 Economics 36
3.12 Land Use 37
3.13 Transportation, Rights-of-Way, and Easements 39
3.14 Soundscape 39
Chapter 4 Environmental Effects 40
4.1 Introduction 40
4.2 Soils 47

4.3 Hydrology and Vegetation 48
4.4 Wildlife and Fish 55
4.5 Threatened and Endangered Species 60
4.6 Water Quality – Harmful Algal Blooms 61
4.7 Air Quality 63
4.8 Cultural Resources 63
4.9 Mosquitoes 65
4.10 Neighboring Lands 67
4.11 Water Rights 68
4.12 Economics 69
4.13 Land Use 69
4.14 Transportation, Rights of Way, and Easements 70
4.15 Soundscape 70
Chapter 5 Cumulative Effects 71
5.1 Introduction 71
5.2 Cumulative Effects Associated with the Preferred Alternative 71
5.3 Potential Effects from Climate Change 74
Chapter 6 Communication, Consultation, and Coordination 76
6.1 Public Involvement 76
6.2 Individuals Involved with EA Preparation 78
6.3 Tribal Coordination 80
Chapter 7 References 80

FIGURES

Figure 1. Study area showing Refuge acquisition boundary and Service real property interests 8
Figure 2. Service real property interests inside and outside of the lakebed at Wapato Lake NWR 9
Figure 3. Map depicting location of water control structures and flow of water within and around the lakebed at Wapato Lake 13
Figure 4. Hydric soil status of lakebed and non-lakebed properties at Wapato Lake NWR 17
Figure 5. Soils associated with lakebed and non-lakebed properties at Wapato Lake NWR 18
Figure 6. Pre-settlement (1851) composition of plant communities associated with lakebed and non-lakebed properties at Wapato Lake NWR 19
Figure 7. Annual hydrograph for Wapato Lake under Alternative 2 where a breach is used to connect Wapato Lake to the greater Tualatin River system 50

Figure 8. Water depth gradient of Alternative 2 during the growing season (April - September).....51

Figure 9. Annual hydrograph for Wapato Lake under the Preferred Alternative where pumping infrastructure is used to manage water levels in Wapato Lake.....52

Figure 10. Water depth gradient of the Preferred Alternative (Alt 3) during the growing season (April -September). 53

Figure 11. Map of the Tualatin River Watershed.....73

TABLES

Table 1. Comparison of costs associated with each of the three proposed alternatives (lakebed only) 22

Table 2. Agricultural acreage in Washington and Yamhill Counties, Oregon (1997-2012) 38

Table 3. Summary of Environmental Effects..... 41

Table 4. Palustrine and lacustrine wetland type and plant community associations expected to occupy the range of growing season water depths under Alternative 2 and the Preferred Alternative (negative values represent feet above the water line. For example, -2 – (-1) is equivalent to 1 to 2 feet above the water line).....54

Table 5. Summary of public involvement and meetings.....76

Table 6. List of preparers and reviewers.....78

APPENDICES

Appendix A. Summary of Comments Received on Draft EA 87

Appendix B. Environmental Compliance.....92

Appendix C. Wapato Lake Water Quality Monitoring Plan 95

Appendix D. Section 6 of the NHPA..... 109

Appendix E. Section 7 Biological Evaluation..... 121

PAGE INTENTIONALLY LEFT BLANK

Chapter 1

Purpose and Need for Action

1.1 Introduction

The U.S. Fish and Wildlife Service (Service, USFWS) is the primary Federal agency responsible for conserving and enhancing the nation's fish and wildlife populations and their habitats. Although the Service shares this responsibility with other Federal, state, tribal, local, and private entities, the Service has specific trust responsibilities for migratory birds, Federally listed threatened and endangered species, and certain anadromous fish and marine mammals. Service efforts over the last 100 years to protect wildlife and their habitats have resulted in a network of protected areas that form the National Wildlife Refuge System (Refuge System). This network of protected areas is the largest and most diverse in the world. Refuge System lands provide essential habitat for numerous wildlife species, wildlife-dependent recreational opportunities for the public, and a variety of benefits to local communities.

Wapato Lake National Wildlife Refuge (NWR, Refuge), located in Gaston, Oregon, was first established in 2007 as a Unit of the Tualatin River NWR under the intents stated in the National Wildlife Refuge System Administration Act (Administration Act), as amended by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act), to restore the historic lakebed and surrounding lands for the purpose of improving habitat conditions for a number of native species. In 2013, this Unit was re-designated as Wapato Lake National Wildlife Refuge. With a total acquisition boundary of 4,370 acres, the Service currently owns and manages 958 acres.

1.2 Purpose and Need for Action

The purpose of the proposed action is to meet the Service's overarching goals set forth in the 2007 Land Conservation Plan and Environmental Assessment for the establishment of the Wapato Lake Unit of the Tualatin River National Wildlife Refuge (USFWS 2007) and the Tualatin River National Wildlife Refuge Comprehensive Conservation Plan (CCP) (USFWS 2013), which include:

- Protecting, restoring, and managing rare and native habitats for a diversity of migratory birds, fish, and other native wildlife of the Willamette Valley
- Contributing to efforts across the Tualatin River Basin to improve watershed health and function

More specifically, the proposed action aims to restore as feasible, the composition and structure of functioning ecosystems that historically occurred in and around Wapato Lake (described further in section 1.6), thus improving the biological integrity, diversity, and environmental health (BIDEH) of Wapato Lake NWR and the surrounding landscape. This would include restoration of Wapato Lake in a manner that complies with Total Maximum Daily Load standards established by the Oregon Department of Environmental Quality (DEQ) for the Tualatin River (USFWS 2014). The proposed action is needed because for over a century, Wapato Lake has been diked and annually drained to facilitate farming. As a result, the site's hydrology has been impaired, its historic plant communities have been lost, and its unique peat soils degraded. With the exception of wintering and migrating waterfowl benefiting from agricultural crops grown in the lakebed, other native wildlife have largely been displaced. Further, restoration of Wapato Lake augments larger landscape-scale conservation efforts aimed at addressing fish and wildlife habitat loss throughout the Willamette

Valley (ODFW 2016 and The Intertwine Alliance 2012), where nearly 60 percent of the Willamette Valley's original wetlands have been lost over the past century (Morlan 2010).

The Administration Act directs the Service to ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained for the benefit of present and future generations of Americans. To meet this mandate, the Service developed their Biological Integrity, Diversity, and Environmental Health Policy to provide refuges with implementation guidance. BIDEH policy provides guidance for consideration and protection of the broad spectrum of native fish, wildlife, and habitat resources that represent BIDEH on refuges and in associated ecosystems. This policy provides refuges with a process for evaluating the best management direction to prevent the additional degradation of environmental conditions and to restore lost or severely degraded environmental components.

In evaluating these factors, the Service looks at historic conditions and compares them to the current ones. This provides a benchmark of comparison for the relative intactness of ecosystems' functions and processes, as well as an assessment of the opportunities and limitations to restoring biological integrity, diversity, and environmental health.

1.3 Proposed Action

The Service has completed the EA for the restoration of 1000+ acres comprised of wetlands and uplands associated with Wapato Lake at the Wapato Lake NWR by developing and examining three alternatives. The Service discloses anticipated effects for each alternative, pursuant to the National Environmental Policy Act of 1969 (NEPA), as amended. The action proposed in this EA is the implementation of the Preferred Alternative.

The Service has selected Alternative 3 as the Preferred Alternative, which would restore 800 acres of palustrine wetlands within the lakebed and restore of 200+ acres of palustrine wetlands and associated uplands on non-lakebed Service lands. Restoration actions associated with the Preferred Alternative would be accomplished by re-establishing native wetland plant communities and managing site hydrology (water levels) within the 800-acre lakebed with pumping infrastructure. The additional 200+ acres of Service lands on the periphery of the lakebed (separated by levee infrastructure) would be restored to palustrine wetlands (e.g., wet prairie and riparian forest) and uplands by re-establishing native plant communities.

Alternative 3 was selected as the Preferred Alternative because it would provide marked ecological improvement to Refuge lands compared to the No Action Alternative, and greater certainty that wetland restoration goals within the lakebed would be achieved compared to Alternative 2 as a result of maintaining pumping infrastructure for water-level control.

Summarized below are the reasons why the No Action Alternative and Alternative 2 were not identified as the Preferred Alternative.

The No Action Alternative would result in continuing the cooperative farming operations at the Refuge, thus maintaining the agricultural use of the site that has occurred for over a century. As discussed in 1.2 above, with the exception of wintering and migrating waterfowl, other native wildlife and their habitats have largely been displaced as a result of these practices. Therefore, it was determined that the No Action Alternative would not improve the Service's ability to meet its legally mandated mission to protect trust resources, protect and enhance wildlife habitat, and provide opportunities for wildlife-dependent public uses.

Alternative 2 would better assist the Service to meet its legally mandated mission to protect trust resources, preserve and enhance wildlife habitat, and potentially provide opportunities for future wildlife-dependent public uses; however, it was not selected as the Preferred Alternative due to concerns regarding biological response to growing-season water levels and potential effects to water quality downstream of Wapato Lake. Because Alternative 2 would be accomplished by creating a breach in the existing levee infrastructure and reconnecting Wapato Lake to the Tualatin River, Wapato Lake water levels would be driven by the Tualatin River and Wapato Creek, and the ability to control water levels in the lakebed would be eliminated. The reconnection would restore natural floodplain processes and result in ecological uplift associated with palustrine and lacustrine wetland restoration. However, the water depth predicted during the growing season raised concern that the system would be dominated by deeper, open water, and as a result, limit plant community diversity and structure, and in turn wildlife use, compared to Alternative 3. For example, based on hydrologic modeling (Rounds et al. 2016), 500 acres (or more than 60 percent) of the lakebed would be under 3–5 feet of water between April and August under Alternative 2. Further, once water control infrastructure is removed, the Service's ability to reverse any undesirable results would be limited (e.g., low plant productivity due to large expanses of deeper water, establishment of plant monocultures or invasive plants, invasive carp establishment, etc…).

Modeling also indicates that under Alternative 2, water levels would be 2–4 feet deeper during November–January compared to the Preferred and No Action Alternatives. This is important to note because this time frame corresponds with peak waterfowl use in the lakebed, and greater water depths would limit accessibility to foraging resources, particularly for dabbling ducks and tundra swans. In addition, of the three alternatives, Alternative 2 poses the greatest risk to water quality in the Tualatin River (Kasch and Dupuis 2016). An algal bloom originating in Wapato Lake could reach the Tualatin River through the breach proposed in Alternative 2, thereby negatively affecting aquatic resources, drinking water for some 500,000 people, as well as recreational uses associated with the River, as it did in 2008 (Rounds et al. 2015).

The Preferred Alternative was not modified between the draft and the final EA based on comments received from the public and other agencies and organizations. The Service's Regional Director for Region 1, the Pacific Region, will decide which alternative will be implemented. For details on the specific components and actions constituting the range of alternatives, see Chapter 2.

1.4 Decision to be Made

Based on the analysis documented in this EA, the Service's Regional Director for Region 1 will decide whether or not to restore the historic lakebed and surrounding lands at Wapato Lake NWR to a more natural condition. Should the Service decide to restore the lakebed, the Service would then choose how to implement that decision by selecting one of the two proposed action alternatives.

Should the Service decide to restore the lakebed and surrounding lands, the analysis in this EA will inform the decision of whether a Finding of No Significant Impact (FONSI) can be reached. The FONSI would identify the alternative selected for implementation and the rationale behind the decision. If a FONSI cannot be reached, an Environmental Impact Statement would be prepared.

1.5 Development of the Alternatives

In developing the alternatives for this EA, the Service considered a variety of natural and cultural resource, social, economic, and organizational information, ideas, and concerns important for restoring and managing the Refuge. Much of this information is more fully described in Chapters 3

and 4. As is appropriate for a national wildlife refuge, biological resource considerations were paramount in designing the alternatives. A U.S. House of Representatives report accompanying the Refuge System Improvement Act stated, "the fundamental mission of our [Refuge] System is wildlife conservation: wildlife and wildlife conservation must come first."

The Refuge planning team reviewed available scientific reports and studies to better understand ecosystem trends and the latest scientific recommendations for species and habitats, including environmental and social effects of those uses, as well as records describing the historical conditions of Wapato Lake. Central to the planning effort was the Service's coordination with the U.S. Geological Survey's (USGS) Oregon Water Science Center, Clean Water Services, and the Joint Water Commission to study the hydrology of Wapato Lake. Results from this work produced what is referred to as the Water Management Scenario Tool (WMST) (Rounds et al. 2016) which allowed the planning team to better define and evaluate alternatives.

The WMST allows users to compute the effects of hypothetical water-management scenarios, including imposing a range of hydrologic conditions (dry, wet, or normal years), specifying initial storage conditions, re-routing tributary streams into the lakebed, adding an outlet weir with a time-variable crest elevation, scheduling the use of pumps based on time of year and lake level, and creating an open connection between Wapato Lake and Wapato Creek. To allow the imposition of different hydrologic conditions, the WMST draws upon streamflow and meteorological data from water years 1992 through 2014. These years encompass a wide range of normal and unusual climatic conditions (wet, dry, wet summer, dry winter) that may be tested in combination with other user-selected management/restoration strategies.

Refuge staff met with representatives from local, state, and Federal agencies, local non-governmental organizations, and initiated contact with elected officials and the Confederated Tribes of Grand Ronde (Tribes) to ascertain issues, priorities, problems, and recommendations as perceived by others. Refuge staff provided multiple opportunities for these groups to provide comment as alternatives were being developed. Refuge staff also conducted a scoping meeting with the general public to ensure that comments and ideas were considered from all interested parties during development of this EA.

The Refuge planning team considered all of the above information and input, and identified and described a range of reasonable alternatives. A reasonable alternative is one that is technically and economically practical or feasible, would fulfill the purpose and need for action without violating minimum environmental standards, and could be implemented. Each alternative was then evaluated for environmental and social effects. The Refuge then identified Alternative 3 as its Preferred Alternative for the Proposed Action. Following public review and comment, the Service will select an alternative for implementation. This selected alternative may include elements from any of the alternatives evaluated herein.

1.6 Background of Area

Wapato Lake NWR is located between the Coast Range and the Chehalem Mountains at approximately river mile 62 of the Tualatin River near the city of Gaston in northwestern Oregon.

Historical records describing the hydrology and vegetation of Wapato Lake are scant; however, historical observations from Wapato Lake and other Labish soil wetlands in the Willamette Valley provide some insight about the ecological character of Wapato Lake prior to its conversion to agriculture. For example, Christy (2015) reports that prior to artificial drainage, sites with Labish and Semiahmoo soils were perennially saturated, although portions of some sites evidently drained

to mudflats in late summer, and that these sites were described as "saturated with water," or where "large tracts...covered with water so large a proportion of each year that they are either absolutely worthless to the owner or are used only for pasture during a brief period in the summer." Christy (2015) also reports that the earliest description of Wapato Lake is from the journal of John Work, a Hudson's Bay Company employee, who traveled along the west side of the lake in May 1834. He described it as "a kind of swamp or lake" with a surrounding prairie ("plain") "subject to be partially inundated."

Surveyors under contract with the General Land Office (GLO) working around Wapato Lake in 1852 and 1853 provide the earliest consistent descriptions of the area's topography and vegetation (Christy 2015). The report describes the lake as "swampy & low & covered by water in the wet season," and "all overflowed in winter. After surveying meander lines around the perimeter of the lake the general course of Lake Wapatu is NW & SE. It heads in a sloo about a mile SW of cor to secs 12 & 13. It extends about half a mile north of the township line, where it has an outlet into the S fork of the Tualatin River & its depth depends on the amount of water running in this stream. In the lowest stages of water it is little more than a very mirey sloo toward its head & in the winter & for part of summer a beautiful sheet of water." Areas flooded in winter produced "a coarse grass and rushes in summer." Christy (2015) also describes the area around the southern part of the lake as "very smooth & beautiful, with fern grass. That portion of it liable to overflow from Wappatoo Lake has a black sandy loam, soil very rich...the Lake Marsh is a great range for hogs & very valuable on this account, being filled with wappatoos (wild potatoes) & hogs get very fat on them in the fall of the year."

Stand of Wapato (*Sagittaria latifolia*) at Sauvie Island WMA. Curt Mykut/USFWS.

Wapato Lake was reportedly the only large natural lake in the Tualatin River Basin (Rounds 2016). Whether it existed as a true lake system (lacustrine), shallow marsh (palustrine), or some combination of the two systems is unknown. Both Rounds (2016) and Christy (2015) provide evidence based on soil sampling that Wapato Lake existed as a lacustrine rather than palustrine system; however, historical accounts of vegetation documented in Christy (2015) and knowledge of

Atfalati' wapato harvesting (pers. comm.) suggest that portions of the site were shallow enough to support emergent vegetation, which is more indicative of a marsh or palustrine system.

Based on GLO survey notes from 1852, Christy (2015) describes the immediate areas surrounding Wapato Lake as being comprised largely of upland and wet prairie interspersed with shrub and forested wetlands, particularly where creeks and sloughs intersected with Wapato Lake.

In 1882, a portion of the Tualatin River was channelized between Gaston and the river's confluence with Scoggins Creek, bypassing the section of river that originally flowed closer to the outlet of Wapato Lake (Washington County 1883). By 1895, Wapato Lake had been drained by the installation of canals. The Wapato Improvement District (WID), a state-sponsored irrigation and drainage district, was formed in the 1930s to manage the lake. The WID installed 5.5 miles of levees and exterior canals around the lake, a lift pump station at the northern end of the lake, and interior ditches to facilitate drainage of the lake to the pump station. Creeks that historically flowed into the lake (Ayers, Goodin, Hill, Olsen, and Wapato Creeks) were diverted around the outside of the levees to allow the pumps to more easily empty the lake in spring so that the lakebed could be farmed in summer. Prior to construction of the levees, seasonal high water likely flowed into Wapato Lake from the Tualatin River, providing additional storage of floodwaters and causing the lake to expand and contract in response to river conditions.

Today, canals on the outside of the levees are used in summer to deliver water for irrigation. In 1975, the WID entered into agreement with the Tualatin Valley Irrigation District (TVID) and the Bureau of Reclamation (BOR) allowing the use of these canals for water delivery to TVID customers on the periphery of the lake. A diversion canal from the Tualatin River at river mile 61.9 to the Wapato canal system is still in use to deliver water to TVID customers outside the lakebed, as well as any farmed areas within the lakebed.

Acquiring lands within the lakebed from willing landowners was the primary focus when the Refuge was established. After the Service became a majority landowner, the WID dissolved and donated all assets to the Service. With this dissolution, the Service became the primary owners of lakebed dewatering infrastructure. While continuing to acquire lands and develop this EA, interim management of the lakebed has consisted of maintaining a cooperative farming program on an as needed basis, as well as conducting general weed abatement. The Service works with farmers under cooperative agreements to farm the lakebed primarily as a management tool to limit the establishment of invasive weeds, as well as provide a food source for wintering waterfowl. The Service has continued to dewater the lakebed following the dissolution of the WID on a temporary basis in order to facilitate farming and construction projects.

The Service has also acquired 210 acres outside of the levee system that surrounds the lakebed. These non-lakebed areas historically supported a diversity of land cover types, ranging from scrub-shrub wetlands to forested wetlands to upland prairie. Like the lakebed properties, non-lakebed properties have been used for agriculture purposes over the past century, and have been managed under Service cooperative farming agreements.

The potential for restoring these Service-owned properties to a mosaic of wetland and upland ecosystems that would benefit a wide range of native flora and fauna is extremely high. Of the 958 acres owned and managed by the Refuge, 748 acres comprise the lakebed and associated levees, while 210 acres comprise the non-lakebed areas. Two privately owned tracts are included in the project (the Service is currently discussing options with these landowners), the potential exists to restore the 800 acre lakebed to a diversity of wetland types. An additional 200 plus acres of non-

lakebed properties present an opportunity to restore a mosaic of forested, emergent wetland, scrub-shrub wetlands, and upland prairie.

1.7 Proposed Action Study Area

The current approved acquisition boundary for the Wapato Lake National Wildlife Refuge, located immediately south of the city of Forest Grove and adjacent to the town of Gaston, encompasses approximately 4,370 acres spanning both Washington and Yamhill Counties. The Service's real property interests currently include 958 acres of fee- simple and conservation easement lands (Figs. 1 and 2). The Refuge is bounded on the west by State Highway 47, on the east by Spring Hill Road, and south by Flett Road. The Refuge includes the historic Wapato Lake lakebed and portions of Wapato Creek, Ayers Creek, Goodin Creek, and Hill Creek, and non-lakebed properties largely consisting of agricultural lands. The proposed EA action area includes all Service fee-simple and conservation easement properties and two privately owned properties, all within Wapato Lake NWR acquisition boundary.

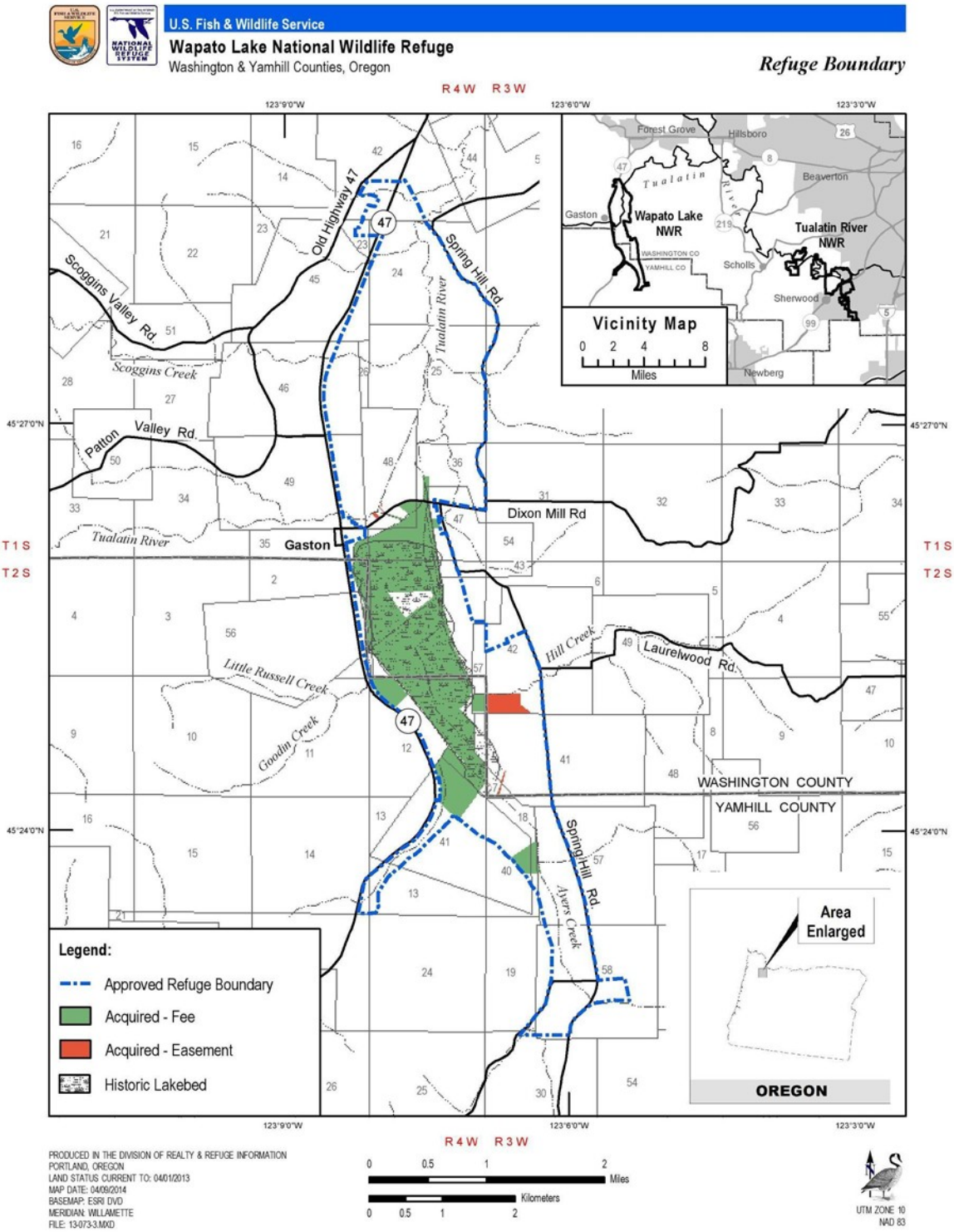

Figure 1. Proposed action area showing Refuge acquisition boundary and Service real property interests.

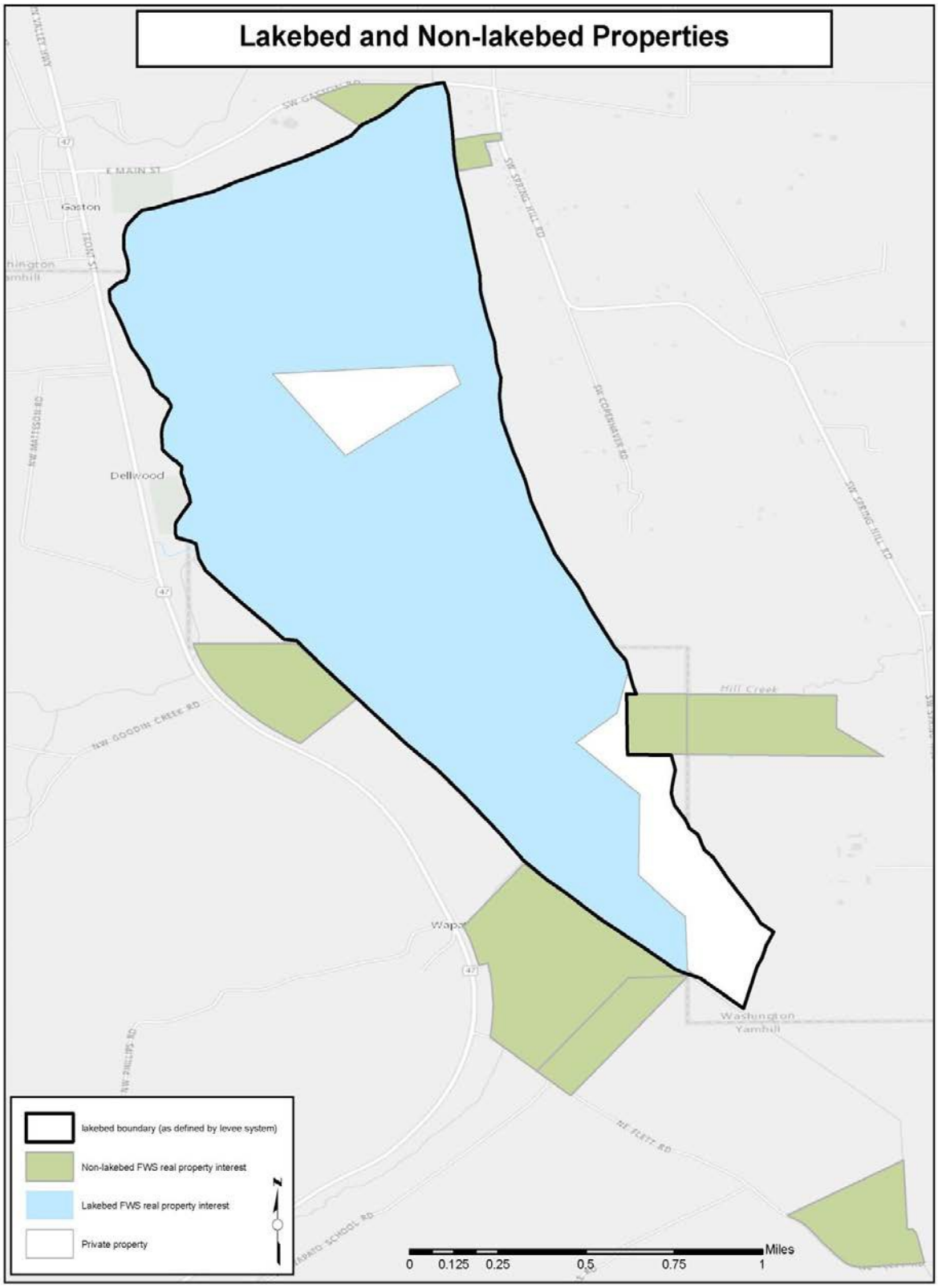

Figure 2. Service real property interests inside and outside of the lakebed at Wapato Lake NWR.

Chapter 2

Alternatives

2.1 Introduction and Definitions

This chapter describes the alternatives considered for the EA; these include the No Action Alternative, two restoration alternatives, and alternatives considered but not forwarded for detailed analysis. The No Action and restoration alternatives are carried forward for further analysis in Chapters 3 and 4. NEPA requires analysis of the No Action Alternative to provide the reader an understanding of baseline conditions without the proposed action and how these compare to the effects resulting from the proposed action. Section 2.4 describes other alternatives that were considered to meet the need and purpose described in Chapter 1 and the reasons they were not carried forward for further detailed analysis in Chapter 3.

Definitions:

Lacustrine:

The lacustrine system includes wetlands and deep water habitats situated in a topographic depression or a dammed river channel; lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30 percent areal coverage; with a total area exceeding 20 acres (Cowardin et al. 1979). Similar wetland and deep-water habitats totaling less than 20 acres are also included in the lacustrine system if an active wave-formed or bedrock shoreline feature makes up all or part of the boundary, or if the water depth in the deepest part of the basin exceeds 6.6 feet at low water. Typically, there are extensive areas of deep water and there is considerable wave action. Islands of palustrine wetland may lie within the boundaries of the lacustrine system.

Palustrine:

The palustrine system includes all non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 percent. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: area less than 20 acres (Cowardin et al. 1979); active wave-formed or bedrock shoreline features lacking; water depth in the deepest part of basin less than 6.6 feet at low water; and salinity due to ocean-derived salts less than 0.5 percent. The palustrine system was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers. The erosive forces of wind and water are of minor importance except during severe floods.

Lakebed and Non-lakebed properties:

Throughout the EA, reference is made to lakebed and non-lakebed properties. Lakebed properties include all lands lying within the existing levee infrastructure that surround Wapato Lake, while non-lakebed properties include all lands outside of, and separated from, the lakebed by the levee infrastructure (Figs. 2 and 3). A distinction is made between the two because lakebed properties represent approximately 800 acres of contiguous land (comprised of both Service fee-simple and

private property) that generally corresponds to the low-lying area that historically made up Wapato Lake. Under all three alternatives, the lakebed properties would comprise the area directly affected hydrologically by the levee breach or water management with the pump system.

2.2 Alternative 1: No Action (Maintain cooperative farming program)

Under the No Action Alternative, the Service would not restore 800 acres of freshwater wetlands within the lakebed and 206 acres of wetlands and uplands on non-lakebed properties at Wapato Lake NWR. This portion of the Refuge would remain as converted wetlands and uplands and continue to be used for agricultural purposes.

Lakebed:

Under the No Action Alternative, the extensive levee system that surrounds the 800-acre lakebed, the internal ditch system, the pump station, and three bridges that provide access to Wapato Lake would all remain in place to maintain maintenance of cooperative farming operations on this portion of the Refuge.

To maintain cooperative farming operations, the Service would continue to use both existing pumps (a large 75 hp 10K gpm pump and a small 30 hp 3K gpm pump) to drain the lakebed of 2,500+ acre-feet of water that accumulates as a result of wet season precipitation. Pumping would occur from February through April at an annual cost of $15,000 to prepare the site for summer farming. In addition, the 5.5 miles of levees (Fig. 3) that surround the lake would have to be inspected and maintained on a periodic basis to not only ensure the viability of a cooperative farming program long-term, but also prevent water quality degradation downstream in the Tualatin River. For example, in 2008, aging lakebed levees breached during a high-water event and delayed drainage of the lake until June and July when water temperatures begin to increase in the Tualatin River. After river levels receded and the levee damage was repaired, pumping resumed which released warm, stagnant, and algae-laden waters into the Tualatin River, resulting in a toxic algae bloom (Rounds et al. 2015). As a result, Oregon Department of Environmental Quality (DEQ) imposed a regulatory framework restricting the use of the larger capacity pump beyond May.

Inspection and maintenance of levees has not been occurring annually. Every few years, blackberry and reed canarygrass are mowed on about half of the levee system at a cost of $15,000. Additional maintenance actions would likely include removal of larger trees from the levee to prevent levee degradation resulting from woody plant roots (e.g., piping or tree toppling from wind events). To prevent a repeat of the 2008 levee failure, more regular inspection would be necessary, and the potential exists that portions of the levee would require repair in the future. It should also be noted that in 2010, and again in 2016, the large pump failed. To reduce the risk of sending algae- laden water into the Tualatin River again during summer, significant financial investments were made on both occasions by Clean Water Services, the Joint Water Commission, and the Service to operate portable, diesel-driven pumps to drain the lake between March and June. Therefore, pump maintenance or replacement would have to be considered under the No Action Alternative.

Other long-term infrastructure considerations under the No Action Alternative include:

- **Pumps**—Replacement of the pumps and associated piping infrastructure. The large pump has experienced multiple mechanical failures in the past 10 years. Complete replacement of the pumps and associated infrastructure would be required to ensure that the lake could be dewatered to support cooperative farming operations. The current estimate for design and replacement of the pumping infrastructure is approximately $1.4 million.

- **Electricity**—Assessment and maintenance of pump house power. Electrical issues have been encountered in the past, and more recently it was determined that the system is out of code. The system was brought up to code in summer 2016; however, future repairs or changes to the pumps may require more work.
- **Bridges**—The pump house bridge, which serves as the primary point of entry for pump operations and maintenance, cooperative farming and refuge management will be replaced in 2019. This bridge will provide vehicle and equipment access. The Gaston Feed Store bridge will also be replaced in 2019 with a pedestrian bridge. This bridge will provide the primary access point for the public.

Existing pump station infrastructure at the north end of Wapato Lake. USFWS.

Non-lakebed:

Under the No Action Alternative, 206 acres of land associated with six tracts of Service real property interests located outside of the lakebed (Fig. 2) would not be restored to a diversity of wetland and upland plant communities. Based on site soil characteristics (Figs. 3 and 4) and historic, pre- settlement vegetation types that existed in and around the vicinity of Wapato Lake (Fig. 5), these sites could support a mosaic of wetlands and uplands, ranging from palustrine forested, scrub-shrub, and emergent wetlands, as well as upland prairie. Rather, the Service would cooperatively farm these properties. A seventh, 4-acre property owned by the Service located just northeast of the lakebed, containing a residence and barn, would be maintained for temporary housing, meetings, and storage.

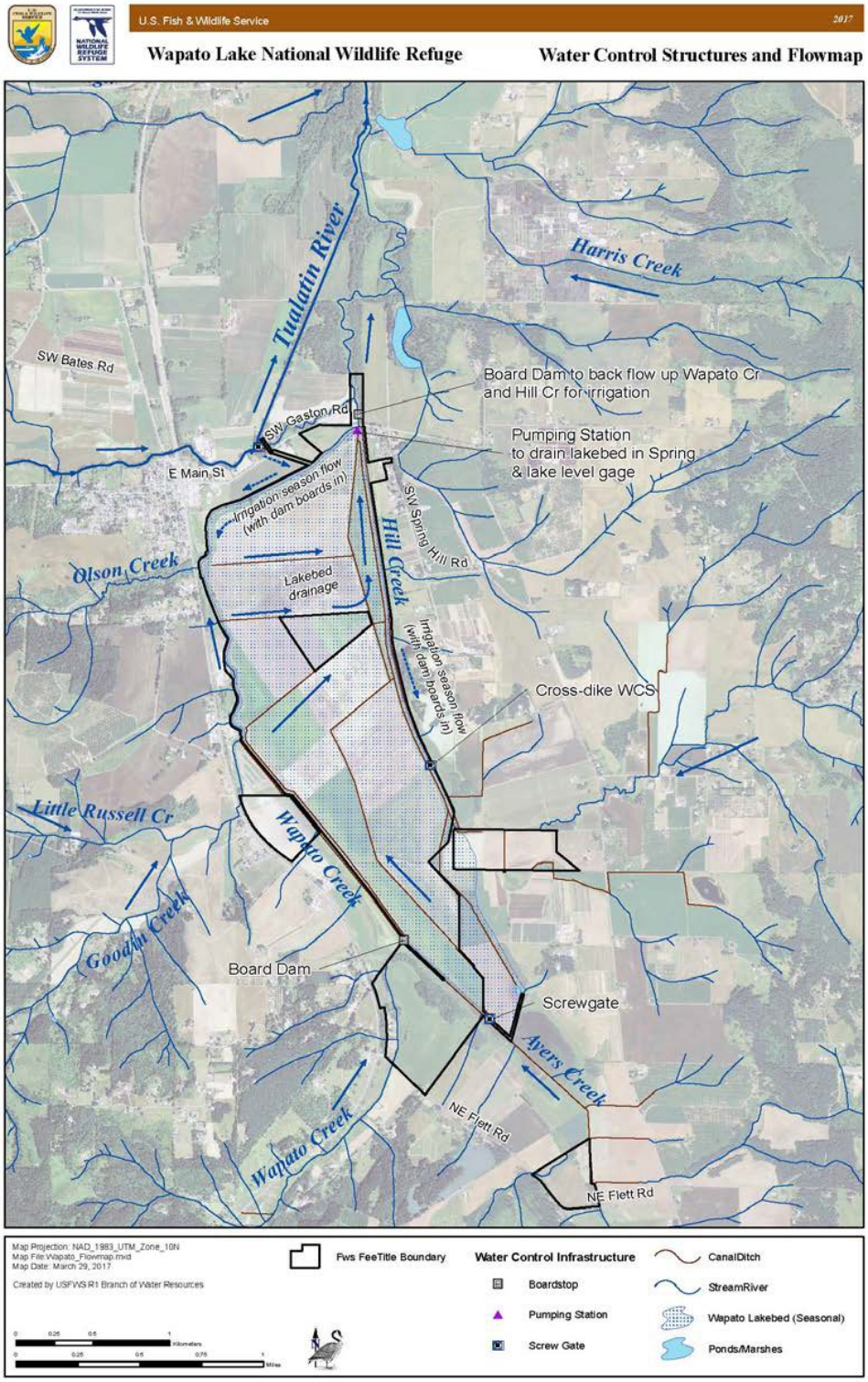

Figure 3. Map depicting location of water control structures and flow of water within and around the lakebed at Wapato Lake.

2.3 Alternative 2: Lakebed–Restoration of lacustrine and palustrine wetlands (Remove pumping infrastructure and reconnect lake to Wapato Creek).

Non-lakebed–Restoration of palustrine wetlands and uplands

Lakebed:

Under Alternative (2), 800 acres of freshwater wetlands comprised of lacustrine and multiple palustrine systems (Cowardin et al. 1979), would be restored by reconnecting Wapato Lake to the greater Tualatin River system. The reconnection would allow natural physical processes, chiefly the water levels in Wapato Creek (which is influenced by Tualatin River levels), to shape the ecological character of the lake. Water levels in Wapato Lake would be driven by intra- and inter-annual variability of Tualatin River flows, and in turn, drive aquatic plant community response which would ultimately influence wildlife response. Reconnection would be achieved by excavating a single breach at the north end of the lakebed where the current pumping infrastructure exists.

By creating a single breach, Wapato Lake would be reconnected to the Tualatin River through Wapato Creek and as a result, remain inundated to a varying degree throughout the year as the Tualatin River ebbed and flowed (Rounds et al. 2016). General patterns of hydrologic exchange between the Tualatin River system and Wapato Lake would result in backflow of the Tualatin River and Wapato Creek into Wapato Lake during wet season months and movement of water from Wapato Lake into Wapato Creek and the Tualatin River during the dry season. The amount of water leaving the lakebed during the dry season would depend on Wapato Creek's stage. For example, beaver dams and releases from Hagg Lake during the irrigation season raise water levels in Wapato Creek during this time of year.

Although a breach with precise dimensions has not been engineered to date, conceptually it would be created by removing the existing pumping infrastructure (described in 2.1) and leaving an opening for hydrologic exchange between Wapato Lake and Wapato Creek. The breach design would also need to account for the irrigation canal that exists on the outer perimeter of the lake.

Currently, the Tualatin Valley Irrigation District (TVID) diverts water from the Tualatin River immediately northwest of Wapato Lake. A small adjustable weir is used just north of the pump station in Wapato Creek to create hydraulic head that forces water back to the south in the irrigation canals around the lake for irrigation purposes. An engineered solution would be required to ensure that TVID's operations are separated from the Wapato Creek-Wapato Lake connection; otherwise the potential exists for irrigation water to flow into the lake during summer months, thus reducing the amount of water available in the exterior ditches for irrigation. While the cost of removing the existing pump infrastructure and creating a breach would be less than replacing the pumping infrastructure (as proposed with the Preferred Alternative), an added cost would be associated with separating the TVID irrigation infrastructure from the lakebed. A cost estimate has not yet been developed to design and implement this work.

Additionally, a bridge would be required for operations and maintenance associated with wetland management and the levee infrastructure. Therefore, like Alternatives 1 and 3, a new bridge will be built in 2019 to replace the existing bridge.

While the north-end breach would result in the removal of a small portion of the levee, the majority of the 5.5 miles of levees would remain in place to maintain separation between Wapato Lake and the TVID irrigation canals on the exterior of the lakebed; they would have to periodically be inspected and maintained. Inspection and maintenance of levees has not been occurring annually.

Every few years, blackberry and reed canary grass are mowed on about half of the levee system at a cost of $15,000. Additional maintenance actions would likely include removal of larger trees and shrubs from the levee to prevent levee degradation resulting from woody plant roots (e.g., piping or tree toppling from wind events) or other unforeseen repairs that arise. To date, cost estimates for any levee work have not been formulated. In addition the Service would aim to fill the network of interior drainage ditches to the degree practicable (i.e., would be dependent on available fill material) and eliminate the 1 mile of internal levee extending south from the pump house. A cost estimate for this work has not yet been developed.

Considering that the site has been intensively manipulated and degraded as a result of agricultural practices over the last century and is largely devoid of native flora, Alternative 2 would require re-establishing native herbaceous and woody plant communities. Because greater than 60 percent (or 500 acres) of the lakebed would be inundated with 3–5 foot water depths and greater during the growing season, installation of herbaceous and woody vegetation would be limited to depth zones < 3 feet on the outer fringes of the lakebed. Water depths >3 feet would likely exist as open water and support little to no vertical plant structure above water, but possibly a submerged aquatic plant community below the water surface.

Where native revegetation efforts would be planned, the process would entail first eliminating or significantly suppressing non-native plant cover. The cooperative farming program was implemented in part to abate non-native vegetation while restoration planning occurred, and has largely been successful. Additional efforts would be necessary; however, to ensure that native vegetation installations had a competitive advantage and successfully re-established. Therefore, Integrated Pest Management strategies (e.g., mowing, soil tilling, brush clearing, spraying with Refuge-approved herbicides) would be employed first to establish site conditions that would limit the cover of non-natives, thus favoring newly seeded and planted native vegetation.

Site preparation and plant re-establishment could span several years and be conducted prior to breaching the levee; therefore existing pumping infrastructure would need to be used to continue to dewater the lakebed while plant re-establishment occurs. Upon adequately preparing the site for native plant re-establishment, woody and herbaceous plant species would be installed (e.g. seeding, plug, bulb, and tuber installation, and bare-root and live stake planting) based on expected growing season water depths in the lakebed and according to the depth gradients that particular species are known to occupy. Although a cost estimate was not developed for conducting site preparation and re-establishment of native vegetation for Alternative 2, we assume these costs would be similar to those associated with the Preferred Alternative. Clean Water Services estimates that $1.5 million would be required to adequately conduct site preparation actions and begin the process of re-establishing native vegetation.

Prior to construction of the levee infrastructure in the 1930s, small tributary creeks from the east and west terminated in Wapato Lake (Ayers, Goodin, Hill, Olsen, and Wapato Creeks – Figs. 1 and 3). Today, those tributaries are intercepted by the large irrigation canals that now surround the lakebed and are further disconnected from Wapato Lake by the levee infrastructure. While an opportunity exists to restore the flow of these creeks directly back into Wapato Lake, the presence of the irrigation canal system and the levees would require an engineered solution with added infrastructure to achieve reconnection to the lakebed in order to separate the creeks from the irrigation system. To date, an engineered solution has not been developed, so if Alternative 2 were selected, additional NEPA analysis would need to be completed to further evaluate the stream reconnection.

Non-lakebed:

Under Alternative 2; 206 acres of land associated with six tracts of Service real property interests, located outside of the lakebed (Fig. 2), would be restored to a mosaic of wetlands and uplands. Based on site soil characteristics (Figs. 4 and 5) and historic pre-settlement vegetation types that existed in and around the vicinity of Wapato Lake (Fig. 6), these sites could support a diversity of plant communities ranging from palustrine forested, scrub-shrub, and emergent wetlands, as well as upland prairie. A seventh, 4-acre fee-simple property located just northeast of the lakebed, containing a residence and barn, would be maintained for temporary housing, meetings, and storage.

Similar to the lakebed wetlands, the non-lakebed sites have also been intensively manipulated and degraded as a result of agricultural practices for nearly a century and are largely devoid of native flora. Therefore, this alternative would require re-establishment of native herbaceous and woody plant communities on the non-lakebed tracts. Restoration of native plant communities would be conducted by employing similar strategies described for the lakebed wetlands above. The primary difference being that non-lakebed properties would not experience perennial ponding, so soil moisture and soil type, rather than water depth, would dictate where wetland and upland plant species would be re-established.

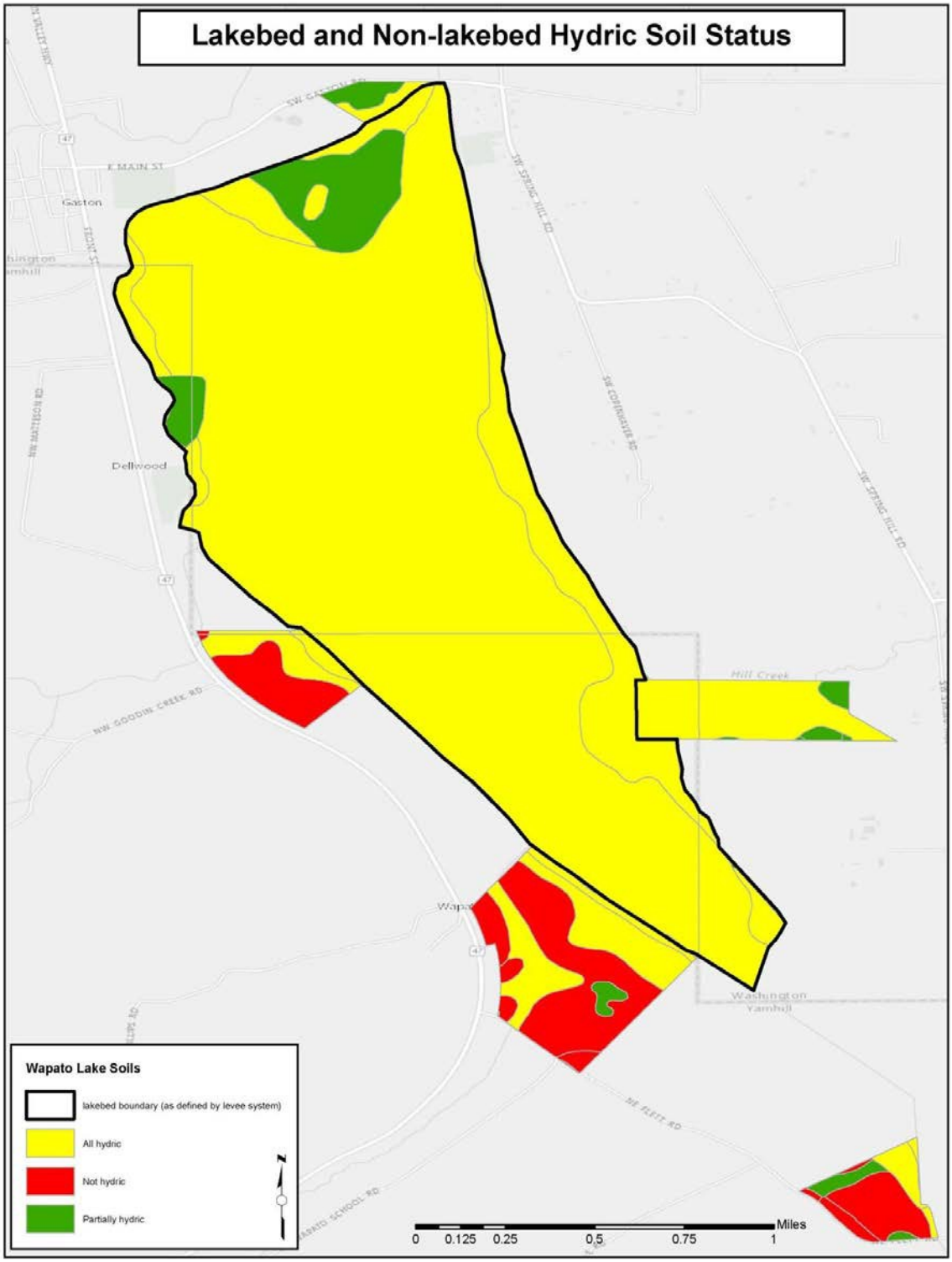

Figure 4. Hydric soil status of lakebed and non-lakebed properties at Wapato Lake NWR.

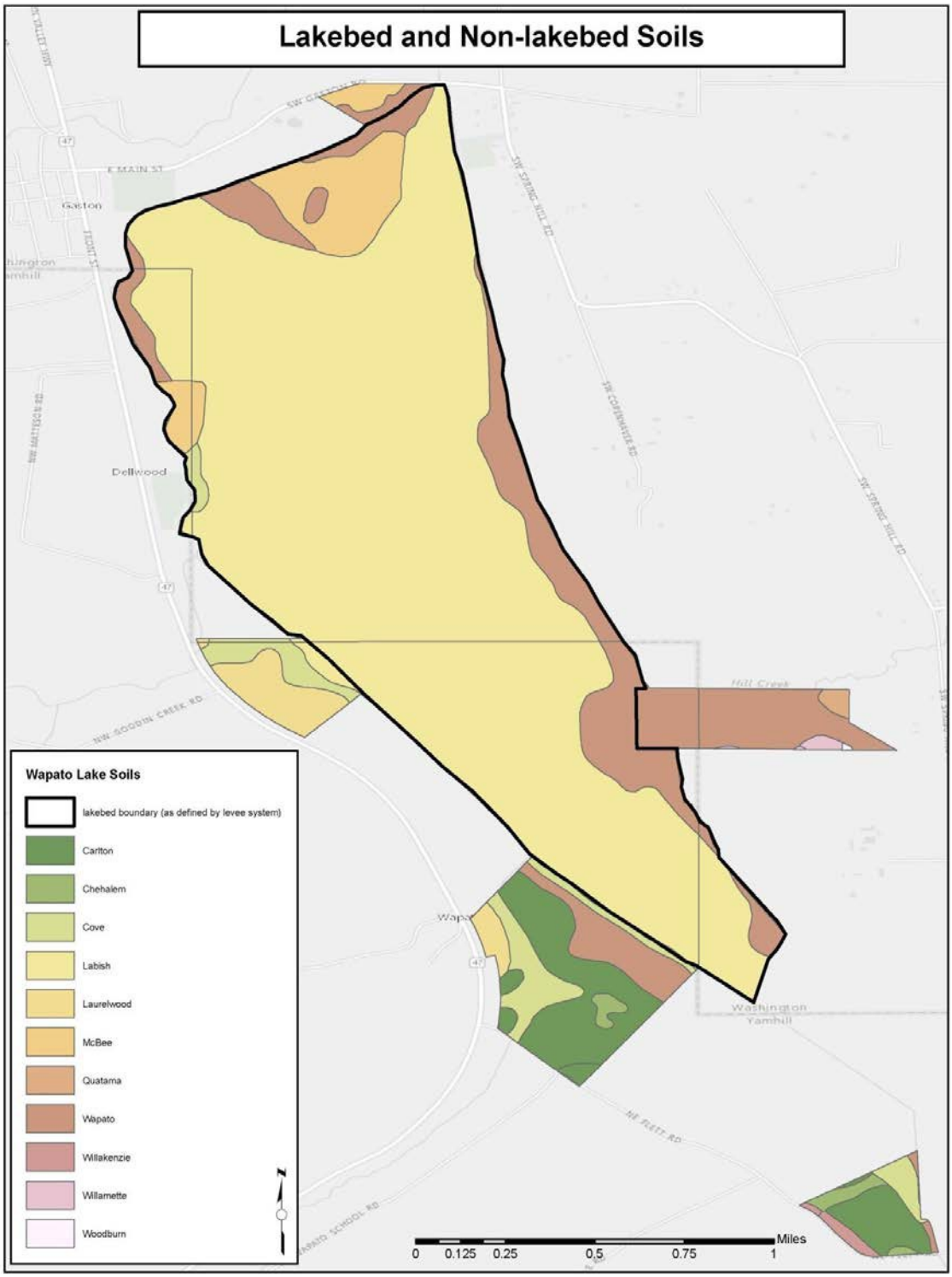

Figure 5. Soils associated with lakebed and non-lakebed properties at Wapato Lake NWR

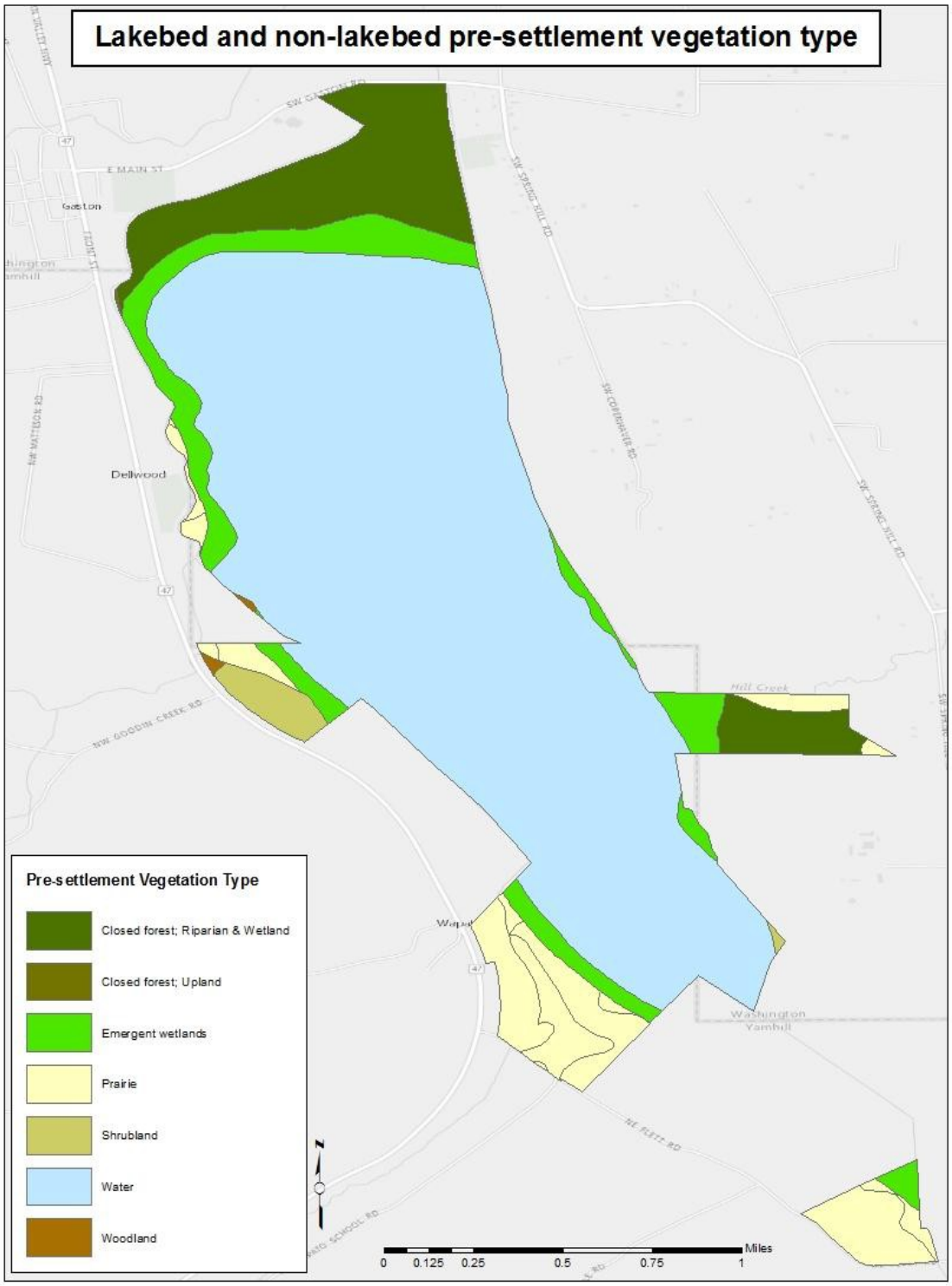

Figure 6. Pre-settlement (1851) composition of plant communities associated with lakebed and non-lakebed properties at Wapato Lake NWR (Christy et al. 2011).

2.4 Alternative 3 (Preferred Alternative): Lakebed–Restoration of palustrine wetlands (Manage lakebed water levels with pumping infrastructure).

Non-lakebed–Restoration of palustrine wetlands and uplands

Lakebed:

Under Alternative 3, the Preferred Alternative, 800 acres of freshwater wetlands, consisting of multiple palustrine systems (Cowardin et al. 1979), would be restored by seasonally managing water levels with pumping infrastructure. Similar to the No Action Alternative (Section 2.1), the extensive levee system (Fig 3) that surrounds the lake, a pump station, and a bridge that provide access to Wapato Lake would be required to manage the site. Like Alternative 2, seasonal hydrology would be a primary driver of Wapato Lake's ecological character; however, lakebed water levels would be controlled primarily by pumping infrastructure, and the lakebed would remain disconnected from the greater Tualatin River system. Pumps are proposed to manage water levels rather than a head gate structure, because the water surface elevation of the creeks that surround Wapato Lake are typically higher than the water surface elevation of Wapato Lake.

Generally, the pumps would be operated between March and April to lower rather than completely dewater the lake, targeting a gradient of water depths ranging from 0 to 3 feet across 70 percent (or 556 acres) of the lakebed during the growing season (Section 3.6 further details lakebed growing season conditions). The 0-to-3-feet depth range would provide optimal conditions for restoring above-ground plant community structure associated with a shallow water palustrine wetland, resulting in greater plant community diversity and wildlife use compared to conditions expected under Alternative 2 where deeper water would limit palustrine wetland plant community establishment (described further in Chapter 3). The need for additional, lower capacity pumping to further reduce water levels during the summer, or possibly introducing water to the system later in the summer by using the Service's Tualatin River water right, would be evaluated in future years subsequent to evaluating plant community response under a March–April pumping regime.

Between fall and spring, lakebed water levels would be influenced by precipitation as they currently are under existing conditions, rising slowly between November and January and reaching a maximum sometime during February–March.

Because the Preferred Alternative aims to achieve an outcome dependent upon water level control, the aging pumps, which have required multiple repairs in recent years, and associated piping infrastructure, would need to be replaced. In addition, the 5.5 miles of levees that surround the lake would have to be regularly inspected and maintained to ensure that ecological goals associated with the Preferred Alternative could be achieved long-term, as well as separate the Tualatin Valley Irrigation Districts irrigation infrastructure from the lakebed.

Inspection and maintenance of levees has not been occurring annually. Every few years, blackberry and reed-canary grass are mowed on about half of the levee system at a cost of $15,000. Additional maintenance actions would likely include removal of any large trees from the levee to prevent levee degradation resulting from woody plant roots (e.g., piping, or tree toppling from wind events) and a thorough inspection of the levee for other signs of degradation/failure. Cost estimates for tree removal and inspection have not been formulated to date. The pumping infrastructure upgrades will be completed in 2020. In addition, while the Service currently incurs a $15,000 annual electrical cost to operate the existing pumps for cooperative farming operations, these costs are

expected to drop with the installation of new and more efficient pumps, coupled with less water being pumped from the lakebed every spring.

The pumphouse bridge will be replaced in 2019. Until then, work is limited by the load rating of 7 tons. Two other bridges were evaluated in summer 2016. One of them was deemed safe for crossing at a load rating of 7 tons and the other one, near the Gaston Feed Store, was closed. A new pedestrian bridge will be built in 2019 to replace the closed bridge.

Finally, considering that the site has been intensively manipulated and degraded as a result of agricultural practices for nearly a century and is largely devoid of native flora, the Preferred Alternative would require the restoration of native herbaceous and woody plant communities. Re-establishment of native flora would occur subsequent to site preparation actions aimed at eliminating or significantly suppressing non-native plant cover. The cooperative farming program was implemented in part to abate non-native vegetation while restoration planning occurred, and has largely been successful. Additional efforts would be necessary; however, to ensure that native vegetation installations had a competitive advantage and successfully re-established. Therefore, Integrated Pest Management strategies (e.g., mowing, soil tilling, brush clearing, spraying with Refuge-approved herbicides) would be employed first to establish site conditions that would favor newly installed native vegetation.

Site preparation could span several years and would be conducted concurrently with infrastructure upgrades and other earth moving actions occurring in the lakebed. Upon adequately preparing the site for native plant re-establishment, woody and herbaceous plant species would be installed (e.g. seeding, plug, bulb, and tuber installation, and bare-root and live stake planting)based on expected growing season water depths in the lakebed and according to the depth gradients that particular species are known to occupy. While a detailed budget itemizing the costs associated with native plant re-establishment and long-term maintenance have not been fully developed, it is estimated that at minimum, a $1.5 million investment would be needed to conduct initial site prep work and revegetation efforts. Clean Water Services has committed to contributing $1 million, as well as 20 years of assistance with site maintenance associated with non-native/invasive plant abatement. Otherwise, all long-term costs associated with additional plant establishment, as well as general operations and maintenance of the site, would be the Service's responsibility.

<u>Non-lakebed:</u>

Under the Preferred Alternative; 206 acres of land associated with six tracts of Service real property interests, located outside of the lakebed (Fig. 2), would be restored to a mosaic of wetlands and uplands. Based on site soil characteristics (Figs. 4 and 5) and historic pre-settlement vegetation types that existed in and around the vicinity of Wapato Lake (Fig. 6), these sites could support a diversity of plant communties ranging from palustrine forested, scrub-shrub, and emergent wetlands, as well as upland prairie. A seventh, 4-acre fee-simple property located just northeast of the lakebed, containing a residence and barn, would be maintained for temporary housing, meetings, and storage.

Similar to the lakebed wetlands, the non-lakebed sites have also been intensively manipulated and degraded as a result of agricultural practices for nearly a century and are largely devoid of native flora. Therefore, this alternative would require re-establishment of native herbaceous and woody plant communities on the non-lakebed tracts. Restoration of native plant communties would be conducted by employing similar strategies described for the lakebed wetlands above. The primary difference being that non-lakebed properties would not experience perennial ponding, so soil

moisture and soil type, rather than water depth, would dictate where wetland and upland plant species would be re-established.

Table 1. Comparison of some of the estimated costs associated with each of the three proposed alternatives (lakebed only).

	Alt 1: No Action (Cooperative farming)	**Alt 2: (Open connection/remove pump station)**	**Alt 3: Preferred Alt (Manage wetland with pumps)**
Pumping infrastructure replacement	$1.4 million	NA	$1.4 million
Annual pumping cost (electricity)/yr	$15,000	NA	$7,500
Pump infrastructure and partial levee removal	NA	$500,000	NA
Isolation of Wapato Lake from TVID infrastructure	NA	No cost estimate to date	NA
Pump-house bridge replacement	$1.1 million	$1.1 million	$1.1 million
Levee maintenance/year	$5,000	$5,000	$5,000
Chemical fallow of lakebed, levee clean-up, and 1st round of native vegetation reestablishment	NA	$1.5 million	$1.5 million
Supplemental water right (TVID assessment)	$17,000	NA	$17,000
Staffing needs associated with long-term management of the lakebed	.25 FTE	1 FTE	1 FTE

2.5 Alternatives Considered But Not Forwarded for Detailed Analysis

Two additional restoration options associated with the lakebed were considered during the development of the proposed project. The discussion below summarizes alternatives that were considered but dismissed.

2.5.1 Lakebed: Restoration of lacustrine and palustrine wetlands – option 2 (complete removal of site infrastructure including filling of external (TVID) ditches)

Lakebed:

This alternative was similar in many respects to Alternative 2, where lacustrine and palustrine wetlands would be restored by reconnecting the lakebed to Wapato Creek and the greater Tualatin River system; however, this alternative differed with respect to the level of infrastructure removal that would occur. Under this alternative all of the infrastructure onsite would be eliminated, including the pump house, the entire 5+ miles of levee infrastructure surrounding the lakebed, as well as filling of the exterior irrigation canals that surround the lakebed. This alternative was not analyzed further because it would result in similar ecological outcomes to Alternative 2, and dismissed because it would eliminate the exterior canals which are used by TVID for delivering irrigation water to customers on the exterior of the lakebed. While a conceptual solution to replacing the irrigation infrastructure under this alternative has been explored, additional deliberation would be required to determine how the replacement would be funded. A preliminary report prepared by CWS estimates the cost of upgrading to a pressurized line irrigation system would exceed $18 million (Dummer 2009).

2.5.2 Lakebed: Restoration of palustrine wetlands – option 2 (construction of independently managed wetland cells within the lakebed)

Lakebed:

Like the Preferred Alternative, this alternative aimed to enhance palustrine wetlands by using levee and pump infrastructure; however, rather than managing water levels across one contiguous 800-acre wetland, the lakebed would be divided into multiple independently managed wetland cells. Conceptually, this would have been accomplished by constructing new levees within the lakebed to separate each wetland cell. Depending upon the configuration, additional pumps and/or water control structures would be required to manage water levels within each of the cells. The primary advantage of this approach is providing a mechanism to focus wetland management efforts within smaller management units and have more control over water levels and plant community response within those smaller units.

This approach is most commonly associated with food production for wintering waterfowl. Referred to as moist soil management (Strader and Stinson 2005, Nelms 2007), this practice results in the production of plant and animal foods that are a critical part of the diet of wintering and migrating waterfowl. Moist soil management has become a significant part of management efforts on many refuges and private lands wetland projects. Preferred moist-soil plants provide seeds and other plant parts (e.g., leaves, roots, and tubers) that generally have low deterioration rates after flooding and provide substantial energy and essential nutrients less available to wintering waterfowl in common agricultural grains (e.g., corn, milo, and soybeans). Moist-soil impoundments also support diverse populations of invertebrates, an important protein source for waterfowl. The plants and invertebrates available in moist-soil impoundments provide food resources necessary for wintering and migrating waterfowl to complete critical aspects of the annual cycle, such as molt and reproduction.

While this approach has biological merit and has been used successfully throughout the Refuge System, particularly where wintering and migrating waterfowl are the primary conservation emphasis, it was eliminated from further consideration at Wapato Lake NWR primarily because it did not support the project purpose of "protecting, restoring, and managing rare and native plant communities for a diversity of migratory birds and other native wildlife of the Willamette Valley." Rather, it would have shifted the emphasis from an ecosystem approach to managing for a single wildlife taxon.

Further, considering the size of Wapato Lake and its underlying porous peat soils, design and construction of new levee infrastructure would require a significant financial investment. For example, it is estimated that pumping-infrastructure upgrades and existing levee improvements associated with the Preferred Alternative will require, at minimum, a $1.75 million, plus investment. The wetland cell alternative would require these same upgrades plus an additional financial investment to construct new levees and install new water control structures for each wetland cell. While multiple options would exist regarding the number of cells to be constructed within the lakebed, we estimate that at minimum, an additional $1 million would be required to implement this alternative based on a preliminary engineering cost provided to us by Ducks Unlimited during 2015.

Given that the peat soils onsite may not be suitable for levee construction, which would require mobilizing offsite material, an additional $1 million may be a low estimate. While these costs are not exorbitant in the realm of restoration ecology, few sources of funds exist to support water management infrastructure for habitat work, particularly multi-million dollar projects. In addition, the added infrastructure cost would arguably not result in significantly greater biological gains, if any, compared to the proposed action alternatives. It would likely result in added operations and maintenance costs associated with a network of new interior levees and associated water control structures.

Finally, constructing a network of new levee infrastructure in a historic wetland basin, that also has significant cultural resource values, would face regulatory challenges related to section 404 of the Clean Water Act and section 106 of the National Historic Preservation Act.

Chapter 3

Existing Environment

This chapter describes the existing environment of the proposed action area.

3.1 Soils

Lakebed:

Wapato Lake is located in a depression along Wapato Creek near its confluence with the Tualatin River. The lake formed in a valley that was scoured by the catastrophic Missoula Floods and contains about 740 acres of Labish soils, which along with the related Semiahmoo soils, are rare in the Willamette Valley (Christy 2015).

Labish and Semiahmoo soils have a high organic content, now much decomposed because of a century or more of artificial drainage, tilling, oxidation, compaction, and erosion. These processes cause the soil to subside, lowering the elevation of the lakebed. As a result, the Wapato lakebed is reportedly 5 to 7 feet lower than the Tualatin River. Prior to artificial drainage, sites with Labish and Semiahmoo soils were perennially saturated.

In addition to the Labish soils found across much of Wapato Lake, higher elevation, well-drained areas at the north end of the lakebed are made up of McBee soils, which would have historically supported a woody riparian zone. Seasonally saturated Wapato soils are found along the northern and eastern edges of the lakebed and would have historically supported a shallow emergent and shrub-scrub marsh (Figs. 4–6).

Non-lakebed:

Service properties on the periphery of the lakebed and separated by the levee system contain soil types ranging from hydric McBee and Wapato soils—identical to what is found within the lakebed —to well-drained upland areas predominantly Carlton and Laurelwood soils (Figs. 4 and 5). The latter two soil types have historically supported Oregon white oak and Douglas-fir/Big-leaf maple forest communities, respectively.

3.2 Hydrology and Vegetation

Lakebed

Despite the construction of levees, the channelization of the Tualatin River, and the diversion of tributary streams, Wapato Lake forms and inundates its lakebed each winter through a combination of precipitation, runoff, and subsurface seepage (Rounds et al. 2016). The lakebed has experienced a relatively consistent hydrologic pattern since the 1930s, where the lake is dewatered every spring in preparation for summer farming followed by recharge of the lake during the fall/winter wet season. On average, 2,500 acre feet of water accumulate in lakebed. The Service has continued to manage the lake similar to its previous owners by maintaining agricultural operations in the lakebed. The Service dewaters the lakebed in early spring and uses a cooperative farming program to control invasive vegetation and provide winter forage for waterfowl. Drainage of the lake is accomplished through the use of two pumps that lift water from the lakebed and discharge it to Wapato Creek near Gaston Road on the north end of the lake.

As a result of past and current land use, the lakebed and surrounding area are a patchwork of agricultural and ruderal lands and in-tact, remnant wetland and uplands. Current conditions in the lakebed are the result of annually draining the site for cultivation of agricultural crops for nearly a century. Crops grown on the majority of the lakebed acreage include corn, oats, winter wheat, and reed-canarygrass hay. The lakebed does support small patches of native wetland vegetation, primarily along the western toe ditch that runs along the interior of the levee and in the internal drainage ditches, both of which retain some level of saturation or ponding throughout the summer. While systematic vegetation surveys have not been conducted in these areas, common herbaceous species such as Wapato, water plantain, rice-cutgrass, spike-rush, bur-reed, smartweed, pondweed, and duckweed have been observed. Common non-native, herbaceous wetland vegetation associated with these drainage features includes reed-canarygrass, Eurasian water-milfoil, and water purslane.

Outside these drainage features, scattered patches of native woody vegetation exist in the lakebed along levee toes. For example, a few mature black cottonwood trees exist at the northern and northwestern edge of the lakebed, while willow, Nootka rose, and Douglas spirea are common along the entire levee system. But overall, the levee system is dominated by reed- canarygrass, Himalayan blackberry, common teasel, and poison hemlock.

The banks of the canal system on the northern half of the lakebed's exterior support a similar plant community composition to the interior portions of the levee as described above, while the canal banks in the southern half are generally more wooded and with narrow bands of closed canopy forest dominated by Oregon ash and black cottonwood and an associated slough sedge understory.

The exterior canals themselves are perennially inundated; however, their ecological value is generally limited. The canals are steep-banked and flow is representative of a low-gradient creek.

The canal bottom is comprised of soft, mucky substrate, and woody vegetative is absent from most of the banks.

Non-lakebed

The landscape that immediately surrounds the lakebed today can generally be described as agriculturally dominated with pockets and bands of remnant upland forest, riparian forest, and forested and scrub-shrub wetlands. The Refuge holds fee-simple ownership to six tracts of land outside the lakebed and holds one conservation easement collectively totaling 210 total acres. Similar to the larger surrounding landscape, five of the six properties are currently used for agricultural or fallow purposes, while one fee-simple property contains a homesite and a small lot. Two of the fee-simple properties and the conservation easement possess narrow bands and patches of remnant, forested wetland, largely dominated by Oregon ash, big-leaf maple, and black cottonwood, similar to what is observed on the larger surrounding landscape.

3.3 Wildlife and Fish

Birds

Despite being an intensively farmed and degraded wetland basin, the action area and Wapato Lake in particular, supports a wide range of avian taxa, including wintering and staging waterfowl, staging shorebirds, wading birds, raptors, and neotropical migrants.

The most abundant avian taxon observed at Wapato Lake is waterfowl. Beginning in late September, flocks of resident western Canada geese and wintering cackling geese begin arriving at Wapato Lake to take advantage of waste grains associated with harvested crops prior to inundation of the lakebed with fall and winter rains. As rains slowly fill the lakebed, large influxes of Northern pintail arrive. Waterfowl numbers (both geese and ducks) peak between mid-November to mid-December, when weekly counts document an average 21,000 birds utilizing the lakebed (USFWS unpublished data). Notable waterfowl surveys where numbers far exceeded the mid-winter average include counts during December 2006 and November 2016 where an estimated 66,000 and 40,000 pintail, respectively, were observed on the lakebed (USFWS unpublished data). In addition, during January 2017, over 8,000 ring-necked ducks and 400 canvasbacks were observed at Wapato Lake (USFWS unpublished data). Finally, during January 2018, three-hundred plus tundra swans were observed on the lakebed. Large numbers of green-winged teal, northern shoveler, American wigeon, ruddy ducks, and bufflehead also winter at Wapato Lake. While not observed in large numbers, dusky Canada geese, which is a species of management concern in the Pacific Flyway, also use Wapato Lake and the surrounding landscape during fall and winter. In addition to wintering waterfowl, the exterior and interior canal system associated with the lakebed also supports small breeding populations of mallards, gadwall, wood ducks, and cinnamon teal. In addition, wood duck and mallard broods have been observed using both the interior and exterior ditches during the summer.

While systematic shorebird surveys have not been conducted at Wapato Lake, species such as black-bellied plover, long-billed dowitcher, semi-palmated plover, and black-necked stilt have been observed in small numbers during fall and spring migrations. Shorebird use is most common when the lakebed is shallowly inundated or contains mudflats. Species such as killdeer and spotted sandpiper are present year-round and nest along the outer edge of the lakebed.

Although riparian forest and scrub-shrub and forested wetland habitat are limited, the Wapato Lake area does support a number of breeding neotropical migrants. Olive-sided flycatcher, willow

flycatcher, purple martin, and yellow-breasted chat have all been observed in remnant forest patches associated with the lakebed. Raptors such as red-tailed hawk, northern harrier, and red-shouldered hawk are commonly observed in and around Wapato Lake. One known active bald eagle nest is located just outside the southern end of the lakebed in an Oregon ash-dominated forest and one active osprey nest exists on a man-made platform that sits atop a power pole in the northwestern portion of the lakebed. In total, 191 species of birds from 45 families have been documented using the Wapato Lake area.

65,000+ Northern pintails at Wapato Lake, December 2010. Pete Schmidt/USFWS.

Mammals

Systematic mammal surveys have not been conducted at Wapato Lake. Anecdotally, the area appears to provide limited value to mammals in its current state. Intensive agricultural use has eliminated vegetative structure and diversity that was likely important to support diverse and abundant mammal populations. While mammal abundance and diversity has declined in the area, it is not uncommon to observe black-tailed deer, coyote, and Roosevelt elk at Wapato Lake. Smaller rodents, such as western pocket gopher, vagrant shrew, and pacific jumping mouse, have been observed during summer in the farmed lakebed. Aquatic mammals observed include beaver, North American river otter, and invasive, non-native nutria.

Reptiles and Amphibians

Fourteen species of reptiles and amphibians have been documented in the Wapato Lake area (USFWS unpublished data); however, little is known regarding species abundance. They include Pacific chorus frog, invasive, non-native bullfrog, Northwestern salamander, rough-skinned newt, Northwestern garter snake, common garter snake, and two Oregon state sensitive species: Northern red-legged frog and Western pond turtle.

Non-listed Fish and Other Aquatic Fauna

The Wapato Lake area is on the southern boundary of the Upper Tualatin-Scoggins sub-watershed of the Tualatin River Watershed (Tualatin River Watershed Council). Mainstem and upper tributaries of the Tualatin River, including Wapato Lake, historically provided spawning, passage, and rearing habitat for native fish. Fourteen species of fish have been observed in the watershed, (Hawksworth 2000). Many native non-salmonid species are present in streams within the watershed, including sculpin, lamprey, dace, coarsescale sucker, and redside shiner. Introduced, non-native species include bluegill, common carp, and smallmouth and largemouth bass, yellow perch, and bullhead.

During summer 2015, Refuge staff and staff from the Pacific Northwest Native Freshwater Mussel Working Group documented the presence of native western floater mussels and non-native Asian clams in the canal system that surrounds the lakebed and in Wapato Creek just north of the lakebed.

3.4 Threatened and Endangered Species

Wildlife

No species listed as threatened or endangered under the ESA have been documented in or around the immediate vicinity of Wapato Lake, including on Service real property interests.

Fish

There are two ESA-listed threatened or endangered species under National Marine Fisheries Service (NMFS; NMFS 2016) and U.S. Fish and Wildlife Service (USFWS; USFWS 2018a) jurisdiction that may occur in the proposed action area (i.e. Wapato Creek); Threatened (Upper Willamette River ESU) Chinook salmon and Threatened (Upper Willamette River ESU) Steelhead. Threatened Lower Columbia River coho may be present; however, they are not ESA-listed in the Willamette Basin above Willamette Falls. Critical habitat has been designated for these species, but none occurs in the proposed action area.

According to NOAA Fisheries (personal communication Annie Bernie) Chinook are present downstream of the project area in the Tualatin River, however, they do not utilize any portion of the proposed action area. Adult and juvenile steelhead could be present in close proximity to, or within the proposed action area; however, given that Wapato Creek is a degraded, low-gradient, soft substrate stream channel unsuitable for spawning, only juveniles would be expected to occupy the proposed action area during implementation of the proposed action (July – October). Other steelhead life history stages, excluding spawning, could be supported by Wapato Creek outside of the implementation phase of the proposed project action.

Temporal Use of the Tualatin River by adult and juvenile steelhead (personal communication Annie Bernie NOAA Fisheries and ODFW https://nrimp.dfw.state.or.us/FHD_FPB_Viewer/index.html):

- Upstream adult migration occurs primarily from mid-January through April.
- Adult holding occurs primarily from mid-January through April.
- Adult spawning occurs primarily from mid-February through May.
- Juvenile rearing can occur year round.
- Juvenile downstream migration occurs primarily from March until mid-August.

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and the 1996 Sustainable Fisheries Act, potential adverse effects on Essential Fish Habitat (EFH) are also analyzed. Within the proposed action area, Pacific salmon EFH is designated for Chinook salmon and coho salmon.

Plants

No listed flora species have been documented in or around the immediate vicinity of Wapato Lake, including on Service real property interests.

3.5 Water Quality – Harmful Algal Blooms

At the heart of water supply and water quality issues in the watershed is the Tualatin River. The Tualatin River flows east out of the Coast Range, then turns north on the valley floor near Wapato Lake in order to skirt the northern edge of the Chehalem Mountains before continuing eastward toward its confluence with the Willamette River. Water discharged from the Wapato Lake area flows northward in Wapato Creek, exiting the low-lying areas of the lakebed at Gaston Road and joining the Tualatin River a couple of kilometers downstream near the river's confluence with Scoggins Creek. Summertime streamflow in the Tualatin River is augmented from two upstream reservoirs: Henry Hagg Lake on Scoggins Creek and Barney Reservoir in the adjacent Trask River Basin.

Wapato Lake is located upstream of an important municipal water intake at river mile 56.1; the drinking water treatment plant operated by the Joint Water Commission produces up to 75 million gallons of drinking water a day and serves more than 365,000 people in the basin. It has been estimated that when the Service releases water from the lakebed at the pumphouse, that water reaches the Joint Water Commission water treatment plant within 8 hours. The consequence of poor water quality is that the Joint Water Commission must then treat the water with various chemicals in order to improve the quality to an acceptable standard and then release it as drinking water for the customers they serve. In addition, Clean Water Services, a large water resources management utility organization, is tasked with the health of the Tualatin River watershed and relies on water quality and quantity to effectively accomplish their goals and service to over 500,000+ people in Washington County.

Despite the importance of the Tualatin River to the region, it does not meet several water quality criteria including temperature, bacteria, volatile solids, ammonia (dissolved oxygen), and total phosphorus (USFWS 2014). These water quality standards assure that beneficial uses such as clean drinking and irrigation water, swimming, fish consumption, and fish spawning and rearing are protected. When water quality standards are not met, the Federal Clean Water Act requires a Total Maximum Daily Load (TMDL) to be established. A TMDL determines how much pollution can be added to a river without exceeding water quality standards (USFWS 2014). Considering Wapato Lake's large size and proximity to the headwaters of the Tualatin River, lakebed management actions could have profound effects on water quality in the Tualatin River system. For example, in 2008, aging lakebed levees breached during a high-water event and delayed drainage of the lake until June and July when water temperatures begin to increase in the Tualatin River (Rounds et al. 2015, Kasch and Dupuis 2016).

After river levels receded and the levee damage was repaired, pumping resumed and released warm, stagnant and algae laden waters into the Tualatin River which resulted in a harmful algal bloom (HAB). This HAB event led to taste and odor problems in drinking water withdrawn at the JWC intake. A major blue-green algae bloom also occurred in the lower Tualatin River that

prompted a public health advisory to be posted by the State. As a result, DEQ imposed a regulatory framework requiring the Service to develop a TMDL implementation plan to ensure that Wapato Lake is managed in accordance with the Tualatin Sub-basin TMDL revision that the Environmental Protection Agency (EPA) approved on December 14, 2012. This includes actions to restrict large pump operations after April 30th, and if operations are necessary then a water monitoring plan must be implemented and corrective actions made as necessary.

A similar event would have likely occurred in summer 2010 due to failure of the main existing pump if not for significant withdrawals from the lake by a number of pumps brought to the site and used on an emergency basis. Another pump failure occurred in 2016 but was again mitigated with temporary pumps.

3.6 Air Quality

The EPA has lead responsibility for the quality of air in the United States. Through the 1990 Clean Air Act, the agency sets limits on the amount of pollutants that can be discharged into the air. More than 170 million tons of pollution is emitted annually into the air within the United States, through either stationary sources (such as industrial or power plants) or mobile sources (such as automobiles, airplanes, trucks, buses, and trains). There are also natural sources of air pollution such as fires, dust storms, volcanic activity, and other processes. The EPA has identified six principal pollutants that are the focus of its national regulatory program: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide.

The Oregon DEQ is responsible for protecting Oregon's air quality. DEQ monitors air pollution to ensure that communities meet national ambient air quality health standards (DEQ 2011c). There are three main pollutants that are of the greatest concerns in Oregon:

- Ground-level ozone, commonly known as smog
- Fine particulate matter (mostly from wood stoves, backyard burning, other combustion sources, cars, and dust) known as PM2.5 (2.5 micrometers and smaller in diameter)
- Hazardous air pollutants (also called air toxics)

Hillsboro, the closest city to the Wapato Lake area for which there is air quality data, is rated by DEQ as having good to moderate air quality. However, recent monitoring data has shown high particulate levels at the DEQ air monitor located in Hillsboro. While the region is not currently over the federal health standard for PM2.5, it is close and poor air quality could result in adverse health and economic impacts to the region (Oregon DEQ 2011c). As a result, Washington County, the city of Hillsboro, and other stakeholders have taken action to address air quality issues through education and outreach to the communities. Recent data shows that efforts have been working and PM2.5 levels have been kept below federal standards.

Likely sources of air pollution within the study area are wood stove smoke and backyard burning from private lands, vehicle traffic along Hwy 47 and SW Spring Hill Road, and particulate matter (dust) from farming operations within the lakebed and elsewhere.

3.7 Cultural Resources

Because of its abundant waterfowl, rich Labish soils, accessible water, and the lake's eponymous wapato root vegetable, Wapato Lake has been contributing resources to people and wildlife for thousands of years, including agricultural use of the lake during the 20th and 21st centuries. At the

time of contact with Euro-Americans, the watersheds of the Tualatin and Yamhill Rivers were home to the Atifalat'i or Tualatin Indians, sometimes referred to as the Wapato Lake Indians. The environment also made the area attractive to Euro-American settlement, including Joseph Gatson, who worked to bring a railroad to the area and developed Wapato Lake as an agricultural enterprise. The soils of the drained lakebed have been excellent for the production of onions (*Allium cepa* L.); these same conditions are found at Tualatin River NWR in the area commonly known as Onion Flats.

The FWS did a comprehensive cultural resources study of the Refuge lands affected by this project. This new information is in addition to what is presented below. As a result of this effort, five new archaeological resources were identified, including 3 precontact isolates, one precontact site, and one multicomponent site with primarily precontact components. Of these resources two are not eligible for listing and two were not evaluated because they are on private land. The final site, a multicomponent artifact scatter, was tested and artifacts were recovered from disturbed contexts, but it was determined to warrant further investigation to identify whether there are any intact deposits or features.

Pre-contact

The Oregon State Historic Preservation Office (SHPO) atlas identifies several archaeological sites around Wapato Lake. A few of these locations were derived from ethnographic accounts and not on field observation. One site found within the current lakebed (35WN19) was identified by a scatter of artifacts and corresponds with the ethnographic site Chachif, a place to gather wapato. Harvest of wapato by Atafalat'i and other Native Americans in the Pacific Northwest was typically undertaken by women. Wading barefoot into the frigid water, as much as waist deep, the women would root around with their bare toes to dislodge the tuber. Two nearby sites (35WN29 and 30) are in upland areas to the east of the lake. Neither has been subject to excavation, but the artifact assemblages and location are consistent with long-term occupation sites.

> "... at 3 oClock P. M. we arived at the Quath lah pah tle Village of 14 Houses on main Shore to the N E. Side of a large island. . .we purchased wappatoe and Some pashaquar roots. . . and at 5 oClock reembarked and proceeded up on the N E. of an Island to an inlet about 1 mile above the village and encamped on a butifull grassy plac, where the nativs make a portage of their Canoes and Wappato roots to and from a large pond at a Short distance. in this pond the nativs inform us they Collect great quantities of pappato, which the womin collect by getting into the water, Sometimes to their necks holding by a Small canoe and with their feet loosen the wappato or bulb of the root from the bottom from the Fibers, and it imedeately rises to the top of the water, they Collect & throw them into the Canoe, those deep roots are the largest and best roots. Great numbers of the whistling Swan, Gees and Ducks in the Ponds. . ." [Lewis and Clark 1806]

Petroglyphs

There are a small number of incised rock art panels about 2 miles west of Wapato Lake. These were observed by the linguist Albert Gatschet in 1878 and reported in the 10th Annual Report of the Bureau of Ethnography published in 1893. The petroglyphs purportedly commemorate an Atifalati'i woman's successful misdirection of a raiding party from the neighboring Tillamook tribe.

Ethnography

Atifalati'i were one of approximately 13 groups in the Willamette Valley sharing a common language, collectively known as the Kalapuya. During the spring and summer, Kalapuyans were widely dispersed as small mobile groups returning to major villages for the fall and winter. Winter houses were rectangular, partially sunk below ground, with siding and a roof of cedar planks or slabs of cedar bark attached to a wood frame. The winter villages were organized on a patrilineal

basis with females outside of the immediate social group creating an extended family group. These groups would occupy the winter period with tool making, basket weaving, storytelling and ceremonies, until the end of the season when they would break into smaller family groups and spread throughout the territory harvesting roots, seeds, berries, and whatever other produce the land could offer. What was not immediately used was preserved and stored for the winter. For the Atifalat'i, at least eight of these winter villages were located in the uplands around Wapato Lake.

Direct contact between Euro-American fur traders and the Kalapuyans started in the early 1800s, when the Kalapuyan population may have been as much as 10,000 or more. Though it occurred even before direct contact, the small pox epidemic of 1782–1783 and the later malaria epidemics of the 1830s devastated the Kalapuyan population. By the 1830s, the beaver had been trapped out. In the 1840s, Euro-Americans started to settle Oregon in large numbers. By the 1850s, numerous land claims had been made near Wapato Lake. In 1855, a treaty was established with the tribes and the following year all the Kalapuyans and several other Native American groups were removed to the Grand Ronde Reservation.

The Grand Ronde Reservation was terminated in 1956 and the various Native American tribes living there lost federal recognition. In 1974, the tribes reorganized and in 1983 were formally restored as the Confederated Tribes of the Grand Ronde Indian Reservation. A direct association can be made between the Atifalati'i that once occupied the Wapato Lake area and the Confederated Tribes of the Grand Ronde.

Kalapuya people ignited fires to manage habitat for their needs. USFWS.

History

Euro-American settlers began arriving in Oregon in the 1840s and turned the fertile Tualatin River Valley into an agricultural landscape through land clearing and building dikes, ditches, and transportation networks. The focal points of these activities became villages and towns often named for a prominent local citizens. Such is the case for the town of Gaston.

In 1862, Joseph P. Gaston arrived in Oregon to work as a newspaper editor. By 1866, he invested in the seemingly lucrative railroad development, partnering with others to create the Oregon Central Railroad. Eventually the competing Oregon and California (O&C) railroad was successfully established on the east side of the Willamette Valley and received federal land grants for building from Portland to California. Without the benefit of land grants, the Oregon Central Railroad could not compete and was sold to O&C. The O&C built a line in 1872 from Portland to St. Josephs with a stop at Gaston. Portions of that line south of Gaston were abandoned in the 1930s and by 1985 the rail line was terminated north of Gaston at Seghers. The abandoned railroad grade is still visible along the western edge of Wapato Lake.

In 1875, Gaston bought a farm near the town that was to bear his name. Within a few years, Gaston had started draining Wapato Lake for farming, which was continued by others until 1952 when the Wapato Improvement District was incorporated. Most of the existing infrastructure—the levees, ditches, tile drains, borrows, and pump houses—were constructed between 1928 and 1938. In 1936, Blain Browne and A.F. Hayes purchased 850 acres (600 acres of Wapato Lake bottom) and engaged two large excavators to construct about 5 ½ miles of a 13-foot high dike to reduce winter flooding by the Tualatin River. The borrow material in front of the dike acts as a moat, and borrow inside acts as a channel to carry irrigation water during the dry months. Reportedly 100 acres to the south would be allowed to flood as waterfowl habitat for use by local sportsmen. The regional newspaper noted the project was privately funded with no federal government assistance.

Key to reclaiming wetlands to be agriculturally productive is the rapid removal of excess water. To this end, underground drainage systems have been used. By the early 1800s "tile drains" were developed. This was a trench cut with the necessary depth and slope across the farm field. The bottom of the trench was lined to allow water flow, with a hollow construction of roofing tiles. Although principally used to render the land dry and workable, the tile drains may also be used for sub-irrigation during dry months.

Paleontological Resources

Much of the geology underlying the veneer of soils in the Wapato Lake area is Oligocene marine sediments. Two locations with fossils have been recorded near the lake. In the uplands east of the lake is a location that contains a variety of single cell organisms protected by a shell (foraminiferal assemblages). Near Hagg Lake is a younger layer of Oligocene sediments that contains multi-cellular marine organisms, such as crab and mollusks.

The lakebed is composed of Labish soils that were developed from soil deposited during the last of the Missoula floods. In downtown Tualatin, a similar wetland contained the remains of a mastodon. Radiocarbon dating indicated the mastodon died about 14,000 years ago, possibly trapped by rushing floodwaters. Given the documented history of locating remains of late Pleistocene megafauna throughout the Willamette Valley, including a mastodon in a nearby Tualatin wetland, there is potential for finding similar remains at Wapato Lake (Gilmour et al. 2014).

3.8 Mosquitoes

Wapato Lake National Wildlife Refuge supports diverse populations of mosquito species. Because mosquitoes have a requirement for low-flow conditions or still water, they are typically associated with water features such as drainage channels, slack-water areas of creeks, seasonal floodwaters and beaver ponds. These areas are used for oviposition and larval development. Mosquito production in these areas is most prevalent where aquatic vegetation is present, particularly along the shorelines.

During summer 2015, the Service and Washington County Environmental Health/Mosquito Control Program conducted a baseline inventory of adult mosquitoes occurring on or near the Refuge and monitored relative abundance of adult mosquitoes. Adult mosquito traps were set every 2 weeks from May to August at four locations along the perimeter of Wapato Lake and one location within Wapato Lake. The traps used dry ice ($C0^2$) as a bait to attract host-seeking (biting female) mosquitoes and collected live mosquitoes via a fan and net housing. A sample of mosquitoes collected at each location were tested to determine if they carried pathogens for diseases commonly vectored by mosquitoes, such as West Nile Virus, Western Equine Encephalitis, or Saint Louis Encephalitis.

Initial sampling found 12 species of mosquitoes present. Over 90 percent of the mosquitoes sampled on the Refuge were identified as the northern house mosquito (*Culex pipiens*). *Culex pipiens* have a limited flight range. Their primary blood meal hosts are considered to be birds, but they will feed on humans and other mammals. In particular, *Culex pipiens* is considered one of the most important vectors of WNV in the northern half of the United States (CDC 2013). However, there are no known recent or historical cases of West Nile Virus, Western Equine Encephalitis, or Saint Louis Encephalitis in Washington County or Yamhill County, Oregon (USGS 2016). Consequently, none of the mosquitoes collected on or adjacent to the Refuge tested positive for any disease pathogens.

3.9 Neighboring Lands

Within or adjacent to the study area for this EA are private lands ranging from single home lots to agricultural lands of varying size. In addition, Wapato Lake lies directly adjacent to irrigation infrastructure used by the TVID and is within a quarter of a mile of Gaston, OR.

<u>City of Gaston - small businesses, private homes, and farms</u>

With a population of 663 people, Gaston is the smallest town in Washington County and is close to some of the most popular tourist destinations in the area: Henry Hagg Lake, Scoggins Dam, and Stub-Stewart State Park. As of the census of 2010, there were 241 households and 160 families residing in the city. The population density was 2,275 inhabitants per square mile (878.4/km^2). The population of Gaston is mainly farmers, small business owners, and commuters to the Portland metropolitan area. The City of Gaston owns a local community park that is immediately adjacent to the northern end of Wapato Lake, outside the lakebed. Numerous tracts of private property also exist adjacent to, but outside, the lakebed (i.e., outside of the levee infrastructure). During periods of high winter- and spring-time flow in the Tualatin River, localized flooding occurs on low-lying private and city-owned property between Highway 47 and the lakebed, Gaston Road and the lakebed, Springhill Road and the lakebed, and Flett Road and the lakebed.

<u>Tualatin Valley Irrigation District</u>

The TVID was formed by Oregon statute in 1962 for the purpose of shepherding the Tualatin

Project through the Congress of the United States. The Tualatin Project, constructed by the Department of the Interior, Bureau of Reclamation (BOR), in 1978, provides water for the cities of Beaverton, Hillsboro, and Forest Grove. A principal feature of the project includes the Scoggins Dam and Henry Hagg Lake, constructed to store water to help meet the increasing water requirements of the area. Increasing water demands include irrigation, municipal and industrial, recreation, fish and wildlife, and maintenance of regulated in-stream flows for the Tualatin River.

Scoggins Dam, Henry Hagg Lake, and related recreation facilities were initially operated and maintained by BOR. However, by agreement of August 16, 1983, between TVID and BOR, responsibility for the operation and maintenance of Scoggins Dam was transferred to the district effective September 15, 1983. Operation and maintenance of the recreation facilities at Henry Hagg Lake were transferred to Washington County effective November 15, 1973.

In the vicinity of Wapato Lake, TVID operates and maintains a network of water delivery infrastructure serving the irrigation needs of the Service (i.e., cooperative farming operations), as well as neighboring landowners adjacent to the lakebed and Service property interests.

Historically, within Wapato Lake, the Wapato Improvement District (WID) operated under sanctioned by-laws governing land use within their legal boundary. Nearly all of the land within this boundary fell within the historic Wapato Lake basin. WID has traditionally allowed only cultivation practices which fostered and promoted agriculture and farming. To promote these practices, WID constructed, operated, and maintained infrastructure such as dikes, ditches, bridges, roads, and a small concrete dam. Some of these features were owned by WID and located on lands owned by TVID. Funds to maintain some of these facilities were derived from an annual assessment applied to all individual landowners within TVID's boundary. Given that WID already had water delivery infrastructure in place upon establishment of Scoggins Dam, it was mutually beneficial for TVID, BOR, and WID to enter into an agreement that authorized TVID use of WID infrastructure for delivery of water to TVID members located both inside and outside the WID boundary.

With the establishment of the Wapato Lake Unit in 2007 and subsequent acquisitions within WID and later designation as Wapato Lake NWR, the Service became the majority landowner within WID and held the majority vote that governed decision making within the TVID. With the majority vote, WID was dissolved in March 2013, necessitating a new agreement to address TVID's use of irrigation infrastructure that was formerly under the jurisdiction of TVID.

In June 2013, BOR, TVID, and the Service entered into a Memorandum of Understanding (MOU) for operation and maintenance of irrigation facilities on the Refuge that were required for TVID operations. The MOU outlines the duties of each entity for the operations and maintenance. TVID agreed to operate and maintain the water delivery system, including structures (flashboards, diversion valves, and crossover pipes), and regulate flow of water for delivery in the system to their customers. The Service agreed to operate and maintain the levee system in good working order and grant permission to TVID to enter Service lands for necessary repairs and operations of canals and head-gate structures.

<u>Lakebed inholdings</u>

There are 90 acres of privately owned land, associated with three tax lots, within the lakebed. These lands include an inholding located in the center (one tax lot) and at the southern end (two tax lots) of the lakebed (Figs. 7 and 9). Currently, these properties are inundated between October and May as a result of winter precipitation filling the lakebed, and are dry and farmable between May and October as a result of pumping by the Service to support cooperative farming operations and or

construction projects. The Refuge convened with both landowners to discuss the Service's conservation goals for the lakebed, and has articulated that both action alternatives would preclude dewatering/draining Wapato Lake. The Service has discussed a range of options with both landowners, if they want to consider them, that may include flowage easements, property acquisition, or land exchanges.

3.10 Water Rights

Water rights in the action area fall into two classes: the water right tied to the BOR Tualatin Project (Project), which is held by TVID and BOR; and the water rights owned by individual landowners. The TVID/BOR water right is Certificate 88102. The priority date of this right is 1963, the date of the Project, and the source of the right is the water stored in Hagg Lake behind Scoggins Dam. The TVID/BOR water right covers most of the irrigated lands within the action area, but it is the primary water right only for lands that held no other appurtenant water rights at the time the Project and TVID were established. If lands had water rights that pre- dated the Project, then these pre-existing rights are primary and the TVID/BOR water right is supplemental to these older rights.

Individual water rights are appurtenant to the lands they serve and held by the landowner. When the Service acquired lands within the Refuge acquisition boundary, it also acquired the appurtenant water rights. The source of water for the individual landowner water rights within the boundary is either the Tualatin River or the streams that are tributary to Wapato Lake. The main individual landowner water rights for the Refuge are Certificates 14092 and 14093, which are irrigation rights that cover 553.8 acres of the lakebed. These rights have a 1928 priority and are from the Tualatin River. They were originally in the name of A.F. Hayes and Elaine Brown, the landowners. As the current owner of the lands, the Service owns or 'holds' these rights. There are several other individual landowner water rights that cover small areas within the acquisition boundary that have been acquired by the Service. These are irrigation or livestock water rights, with various sources. Again, the Service owns or 'holds' these rights now.

While the state of Oregon recognizes wildlife and protection of aquatic life as beneficial uses, all of the water rights owned by the Service at Wapato Lake are currently for irrigation or livestock purposes, reflecting the original purposes of the rights. The purpose of these rights could be changed to a more appropriate beneficial use, like wildlife, in the future. This may not be true for the TVID/BOR water right since the purpose of that right is tied to the purpose of the Project, which is irrigation. However, the state of Oregon's definition of irrigation, "*the artificial application of water to crops or plants by controlled means to promote growth or nourish crops or plants*," is broad enough and commonly applied to include the application of water to grow wetland plants.

The season of use for irrigation water rights is May 1 to September 30 for live flow rights and March 1 to November 30 for rights using stored water. The Oregon Water Code requires that a water right must be used as provided in the water right at least once every 5 years, or it may be considered forfeited. There is no risk of forfeiture due to non-use for the supplemental water rights. However, non-use of a primary water right at least once every 5 years could result in forfeiture of both primary and supplemental water rights for the lands in question.

3.11 Economics

Wapato Lake is located in Washington and Yamhill Counties. The population in Washington County has been experiencing one of the most rapid growth rates in the country (Cox 2013). Between 1950 and 2015, Washington County's population has increased from 61,269 to 529,710, a rate faster than

both the state and national average. Yamhill County is also experiencing growth, but at a slower rate than neighboring Washington County, increasing from 33, 484 in 1950 to 99,193 in 2015.

In 2013, Washington County farm and ranch gross sales totaled nearly $292 million, placing the county seventh in the State in total farm sales; Yamhill County sales were over $269 million, placing ninth in the State (Oregon Agricultural Statistics Service 2012–2013). In nursery and greenhouse crops, Washington County ranked third with sales of nearly $147 million, while Yamhill County ranked fourth at nearly $86 million. Agriculture is still the main economic activity within the Wapato Lake basin. However, in Washington and Yamhill Counties, the growth and diversification of the non-farm economy has likely reduced the relative contribution agriculture makes to the counties' total economies. In 2013, the top five commodities in the state of Oregon were cattle, nursery and greenhouse crops, grass seed, dairy products, and hay (OSU Extension Service, Oregon Agricultural Information Network). The top five commodities in 2012 were the same for Washington and Yamhill Counties: (1) grains, oilseeds, dry beans, and dry peas, (2) vegetables, melons, potatoes, and sweet potatoes, (3) fruits, tree nuts, and berries, (4) nursery, greenhouse, floriculture, and sod, (5) cut Christmas trees and short-rotation woody crops (USDA 2012). In the study area of Wapato Lake NWR, lakebed farmers historically grew onions. Although onion production in western Oregon rose 120 percent from 1987 to 1997, the value of onions continued to decline, and many farmers have decided to plant other crops such as corn, clover, and wheat.

The expanding Portland metropolitan area has extended to the eastern boundaries of Yamhill County and brought an increase in property values and demand for greater services from the private sector and county government. Nearly one-fifth of the county's workforce commutes to the Portland metropolitan area. Yamhill County is meeting these demands by developing long-range plans for transportation, water, land use, criminal justice, and human services.

In Washington County, three technology-based industries are the cornerstone of the County's economy (USFWS 2007). They include machinery, including computing equipment and peripherals; electrical equipment and components, including semiconductors; and instruments, including electrical measuring devices, oscilloscopes, and industrial controls. Other technology- based manufacturers produce optical instruments and lenses, engineering instruments, and photographic equipment and supplies. Production in technology-based industries results in employment in the fabricated metals industry. The limited amount of mining activity in Washington and Yamhill Counties makes it a minor contributor to total county economy. Tourism and recreation are becoming more important economic factors. Area residents live within a 2-hour drive to either the Cascade Mountains or the Pacific Coast. Year-round, residents and tourists can enjoy the region's abundant natural resources to boat, water ski, fish, camp, climb, backpack, snow ski, raft, and many other outdoor activities.

3.12 Land Use

Wapato Lake NWR sits within the Tualatin River watershed in the northern third of the Willamette Valley, in both Washington and Yamhill Counties. Washington County contains approximately 465,280 acres (464,640 acres, 726 mi^2); Yamhill County is of comparable size at 459,520 acres (718 mi^2). Most of the higher elevation land in the watershed is forested, while lower elevation areas are used for agriculture, residential housing, and light industrial use. The top crop items by acres in Washington County in 2012 were (1) field and grass seed, (2) wheat for grain, (3) winter wheat for grain, (4) forage-land use for all hay and haylage, grass silage, and greenchop (5) nursery crop stocks. The top crop items by acres in Yamhill County in 2012 were (1) field and grass seed crops,

(2) forage-land use for all hay and haylage, grass silage, and greenchop, (3) wheat for grain, (4) winter wheat for grain, (5) hazelnuts (USDA 2012).

Within the Wapato lakebed farmers historically grew onions. Although onion production in western Oregon rose 120 percent from 1987 to 1997, the value of onions declined to a point that farmers moved to other crops such as corn, wheat, and oats. Today, the Service can farm the lakebed under cooperative farming agreements; crops include corn, wheat, oats, and reed-canarygrass hay.

Acreage in farms in both Washington and Yamhill Counties has generally decreased due to the pressures of urbanization (Table 2). In Washington County, farm acreage totaled 140,884 acres in 1997, and 135,733 acres in 2012, a decline of 3.7 percent. In Yamhill County, farmed acreage totaled 204,739 acres in 1997, and 177,365 acres in 2012, a decline of 13.4 percent (2012 Census of Agriculture County Data). During the same time, acreage of land in conservation reserve or wetlands reserve programs declined in Washington and Yamhill Counties by 25.6 percent and 24.2 percent, respectively.

Table 2. Agricultural acreage in Washington and Yamhill Counties, Oregon (1997-2012).

County	1997	2002	2007	2012
Washington	140,884	130,683	127,984	135,733
Yamhill	204,739	196,298	180,846	177,365

Washington County currently has federal land administered by Bureau of Land Management, BOR, and the Service; three state parks; and two county parks. The Tualatin Hills Parks and Recreation District is a special entity that owns or manages more than 200 parks and more than 35 miles of trails in Washington County. Yamhill County contains 4 state parks and 15 county parks. Both counties have several public golf courses. Many people enjoy Henry Hagg Lake in Washington County for boating and fishing. No designated wilderness areas and no wild and scenic river reaches exist in either county.

The Metropolitan Service District (Metro) is an elected regional government covering the urban and urbanizing areas of Clackamas, Multnomah, and Washington Counties, Oregon. Metro is responsible for land use, transportation, open space, and waste management in its area of jurisdiction. Wapato Lake NWR study area shares its north border with the Metro's urban growth boundary for the Forest Grove-Cornelius region. With two voter-approved natural areas bond measures, Metro works to acquire properties from willing sellers for natural resource and water quality management and, where appropriate, public access.

The Washington County Department of Land Use and Transportation regulates private land use outside the urban growth boundary. The Rural/Natural Resource Plan guides conservation and development according to the potential of the land and in accord with state and regional requirements. In Yamhill County, the Department of Planning and Development governs private land use. The Comprehensive Land Use Plan guides the county's growth and development. In both counties, land use plans must be in compliance with statewide planning regulations administered through the Oregon Department of Land Conservation and Development.

Taxes are assessed on all taxable property by the County Assessor's office. In addition to property taxes on private lands, the counties receive revenues from the Service land holdings in the form of payment in lieu of taxes.

A number of other agencies have recognized the biological and cultural values of wetlands and open spaces. The Oregon Department of Fish and Wildlife has numerous programs to promote wetland protection for fish and wildlife. The Oregon Department of State Lands, by virtue of its Wetland Fill and Removal Permit Program, has recognized the biological and economic values of Oregon wetlands. The Oregon Department of Water Resources has adopted statewide policies promoting protection of water-related functions of riparian areas on public lands and protection of instream flows. The Washington County Comprehensive Plan and the Yamhill County Comprehensive Land Use Plan recognize the ecological and social values that wetlands and riparian habitats provide. These habitats offer economic and environmental benefits other resources cannot provide, including water quality enhancement, recreation, fish and wildlife habitat, and aesthetic features.

3.13 Transportation, Rights-of-Way, and Easements

Roads

Wapato Lake NWR is bordered by Highway 47 to the west, Flett Road to the south, Springhill Road to the east, and Gaston Road to the north (Fig. 1). Highway 47 serves as a major transportation corridor between Forest Grove/Hillsboro and the Portland metropolitan area to Yamhill County towns such as Carlton and McMinnville. Highway 47 sees thousands of vehicles a day pass directly through Gaston and includes trucks, passenger vehicles, buses, and farm equipment. There are no stoplights, stop signs, or pedestrian crossings on Highway 47 as it passes through Gaston. Springhill Road, Flett Road, and Gaston Road are all busy two-lane rural roads and provide transportation north and south between Yamhill and Washington Counties.

Bridges

Gaston Road, a corridor between Springhill Road and Highway 47, has a two-lane bridge that crosses Wapato Creek, to which Wapato Lake is dewatered during the spring. There are also three bridges on Service lands in various stages of disrepair in need of replacement or repair. Two of these bridges as stated earlier are being replaced in 2019. The third bridge was repaired in 2019 and is used by Refuge staff to access the lakebed for management purposes only.

Easements

The Service possesses an approximately 35-acre, non-lakebed conservation easement on the eastside of the lakebed. Management of this easement will follow the prescription for restoration on non- lakebed properties, given that the property lies outside of the levee footprint. On the west side of the lakebed an access easement exists that provides ingress and egress across Refuge lands for the owner of the approximately 30-acre inholding located in the center of the lakebed.

3.14 Soundscape

The project area is rural in nature and located outside the urban growth boundary for the Portland metropolitan area. No large-scale industrial operations creating large-point sources of human-generated sound are located near or within the project area. Human sources of sound include traffic on State Hwy 47, farming operations, waterfowl hunting on adjacent private lands, and occasional planes landing at a nearby small airport. To assess the effects of sounds that are above ambient

levels, resources that would be disturbed by alternative-generated sounds are identified. These resources include wildlife and private residences in the relatively nearby vicinity of the project area.

Chapter 4

Environmental Effects

4.1 Introduction

Chapter 4 provides an analysis of the environmental effects of implementing each alternative described in Chapter 2. Effects are described for the main aspects of the environment presented in Chapter 3, including physical, biological, cultural, and socioeconomic resources. The alternatives are compared under each aspect, and both the adverse and beneficial effects of implementing each alternative are described.

For each environmental aspect, effects common to all alternatives, if any, are discussed first. This is followed by a discussion of effects specific to Alternative 1 (the No Action Alternative). Effects common to the two action alternatives—Alternatives 2 and 3 (the Service's Preferred Alternative) —are then provided, should there be common effects between the two alternatives. Effects specific to Alternatives 2 or 3 are then discussed. If an alternative is not discussed individually, then there are no effects specific to that alternative not already covered by the discussion of common effects.

The overall cumulative effects on the environment from implementing the Preferred Alternative are summarized in Chapter 5.

Table 4 below provides an overview of the effects under each alternative by indicator. Effects are described in terms of the change from current conditions. Although the analysis shows that none of the alternatives would be expected to result in significant effects, some positive (beneficial) or negative effects are expected. The terms intermediate and minor are used to describe the magnitude of the effect. To interpret these terms, intermediate is a higher magnitude than minor. The word neutral is used to describe a negligible or unnoticeable effect compared to the current conditions as described with Alternative 1 and in Chapter 3, sections 1–14.

The information used in this Environmental Assessment was obtained from relevant scientific literature, existing databases and inventories, consultations with other professionals, and personal knowledge of resources based on field visits and experience.

The terms identified below were used to describe the scope, scale, and intensity of effects on natural and cultural resources:

- Neutral. Resources would not be affected, or the effects to resources would be at or near the lowest level of detection.
- Minor. Effects would be detectable but localized, small, and of little consequence to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource. Mitigation, if needed to offset adverse effects, would be easily implemented and successful.
- Intermediate. Effects would be readily detectable and localized, with consequences to a population, wildlife or plant community, or cultural resource. Mitigation measures would

be needed to offset adverse effects, and would be extensive, moderately complicated to implement, and probably successful.

- Significant (major). Effects would be obvious and would result in substantial positive or negative consequences to a population, wildlife or plant community, or cultural resource within the local area and region. Extensive mitigating measures may be needed to offset adverse effects and would be large scale in nature, very complicated to implement, and may not have a guaranteed probability of success. In some instances, major effects would include the irretrievable loss of the resource.

Time and duration of effects have been defined as follows:

- Short-term or Temporary. An effect that generally would last less than one year or season and is typically related to restoration/construction activities.
- Long term. A change in a resource or its condition that would last longer than a single year or season. All effects described below are long-term unless otherwise indicated.

Alternative 1 (No Action)

The No Action Alternative would maintain the existing management regime and would not improve the Service's ability to meet its legally mandated mission to protect trust resources, preserve and enhance wildlife habitat, and provide opportunities for wildlife-oriented public uses.

Action Alternatives (Alternatives 2 and 3 [Preferred Alternative])

The action alternatives would result in lakebed restoration; however, they would result in different hydrologic outcomes within the lakebed, which governs the plant community types that could be restored and the wildlife that would use the lakebed. While both action alternatives would improve the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat, the magnitude of effects, particularly associated with the ecology of the restored lakebed, would differ.

Table 3. Summary of Environmental Effects

	Alternative 1 (No action) – Cooperative farming	**Alternative 2 – Restoration with a breach and open connection**	**Alternative 3 (Preferred Alternative) – Restoration with pumping infrastructure**
Soils	Lakebed – Significant long-term negative effects on the peat soils as a result of annually draining the lakebed and disturbing the ground Non-lakebed – Intermediate long-term negative effects as a result of annually disturbing the ground during farming	Lakebed - Minor temporary negative effect due to soil disturbance during restoration activities; minor long-term positive effect by restoring hydrology, facilitating sediment deposition, and ceasing oxidation of peat soils Non-lakebed – Minor temporary negative effect due to soil disturbance	Lakebed and Non-lakebed – Minor temporary negative effect due to disturbance associated with restoration activities; intermediate long-term positive effect on the natural processes associated with peat soil formation associated with emergent vegetation re- establishment and senescence. Non-lakebed – Minor

	Alternative 1 (No action) – Cooperative farming	Alternative 2 – Restoration with a breach and open connection	Alternative 3 (Preferred Alternative) – Restoration with pumping infrastructure
	operations	during restoration activities; minor long-term positive effect as a result of restoring native vegetation and ceasing farming operations	temporary negative effect due to soil disturbance during restoration activities; minor long-term positive effect as a result of restoring native vegetation and ceasing farming operations
Hydrology and Vegetation	Lakebed and Non-lakebed – Neutral effect. Little to no native vegetation exists under current conditions. Continuing farming operations would maintain these conditions	Lakebed – Minor long-term positive effect as a result of restoring native plant communities. Largely associated with a 285-acre palustrine fringe. The reconnection would favor deeper, open water (3–5.5 ft) across 64% of the lakebed. As a result, plant community diversity and structure would be low in this area Non-lakebed - Intermediate long-term positive effect as a result of restoring native plant communities	Lakebed – Intermediate long- term positive effect as a result of restoring native plant communities. Using a pump to manage water levels would provide a mechanism to maintain shallow water across the entire lakebed. As a result, plant community diversity and structure would be high across 800 acres Non-lakebed - Intermediate long-term positive effect as a result of restoring native plant communities
Wildlife and Fish	Lakebed and Non-lakebed – Neutral effect. Aside from wintering waterfowl and some migratory shorebird use, wildlife and fish use of the lakebed is limited and this would not change by implementing the No Action Alternative	Lakebed – Overall, a minor long-term positive effect to native fish and wildlife species as a result of implementing restoration actions. However, the potential for non-native carp to become established could reduce the overall beneficial effect. High winter water levels could also limit the site's value to waterfowl creating a minor long-term negative effect to this guild of wildlife Non-lakebed – Overall minor long-term positive effect to native wildlife	Lakebed and Non-lakebed – Intermediate long-term positive effect to a broad diversity of native wildlife species using the site throughout the year as a result of restoring 800 acres of palustrine wetlands where plant community diversity and structure would be high Non-lakebed – Overall minor long-term positive effect to native wildlife

	Alternative 1 (No action) – Cooperative farming	**Alternative 2 – Restoration with a breach and open connection**	**Alternative 3 (Preferred Alternative) – Restoration with pumping infrastructure**
Threatened and Endangered Species (Fish)	Lakebed – Minor short-term negative effect associated with pump station replacement work Non-lakebed - Minor long term negative effect associated with continuing	Lakebed – Minor long-term positive effect on listed fish as a result of restored access to Wapato Lake (e.g. off-channel refugia) Non-lakebed – Minor long-term positive effect	Lakebed - Minor short-term negative effect associated with pump station replacement work Lakebed and Non-lakebed- Minor long-term positive effect associated with
	to farm non-lakebed properties (i.e. pesticide, fertilizer, sediment inputs into Tualatin River tributaries)	associated with ceasing co-op farming and restoring non-lakebed properties (i.e. vegetated buffers, reduced pesticide, fertilizer, sediment inputs into Tualatin River tributaries)	ceasing co-op farming and restoring non-lakebed properties (i.e. vegetated buffers, reduced pesticide, fertilizer, sediment inputs into Tualatin River tributaries)
Water Quality	Lakebed – Minor long-term negative effect associated with annually dewatering the lakebed for farming (e.g. sediment, herbicide residue, nutrients) Non-lakebed – Minor long-term negative effect as a result of farming adjacent to water courses that flow into the Tualatin River	Lakebed – Difficult to predict the regularity of water quality deterioration; however, this alternative poses the greatest risk, namely associated with algal blooms and the open connection to the Tualatin River system. Non-lakebed – Minor long- term positive effects as a result of restoring native habitat adjacent to water courses that flow into the Tualatin River	Lakebed – Minor long-term positive effect associated with restoration of native plant communities in the lakebed and less pumping. Non-lakebed – Minor long- term positive effect as a result of restoring native habitat adjacent to water courses that flow into the Tualatin River
Air Quality	Lakebed and Non-lakebed – Minor long-term negative effect as a result of operating farming equipment (e.g., fuel emissions, dust from tillage and harvesting)	Lakebed and Non-lakebed - Minor temporary negative effect due to machinery operation during restoration activities; minor long-term positive effect from ceasing annual farming operations (e.g., fuel emissions, dust from tillage and harvesting)	Lakebed and Non-lakebed - Minor temporary negative effect due to machinery operation during restoration activities; minor long-term positive effect from ceasing annual farming operations (e.g., fuel emissions, dust from tillage and harvesting)

	Alternative 1 (No action) – Cooperative farming	Alternative 2 – Restoration with a breach and open connection	Alternative 3 (Preferred Alternative) – Restoration with pumping infrastructure
Cultural Resources	Lakebed and Non-lakebed – Minor long-term negative effect as a result of annual ground disturbance resulting from farming activities	Lakebed and Non-lakebed – Intermediate long-term positive effect as a result of ceasing ground disturbing actions and restoring native plant and animal communities important to indigenous people Lakebed - Minor temporary negative effect as a result of removing historic pump house	Lakebed and Non-lakebed – Intermediate long-term positive effect as a result of ceasing ground disturbing actions and restoring native plant and animal communities important to indigenous people Lakebed - Minor temporary negative effect as a result of removing historic pump house
Mosquitoes	Lakebed and Non-lakebed – Existing conditions are being maintained, so a neutral effect associated with mosquitoes is expected. Namely, mosquito presence would be associated with irrigation and drainage ditches in and around the lakebed, as well as areas where forest structure is present in proximity to ditches and canals	Lakebed – Minor long-term increase in mosquitoes, particularly associated with 285 acres of palustrine wetlands on fringe of the lakebed Non-lakebed - Minor long-term increase in mosquitoes where wetlands or forest in proximity to wet areas are being restored	Lakebed – Intermediate long-term increase in mosquitoes associated with palustrine wetlands across 800 acres of the lakebed Non-lakebed - Minor long-term increase in mosquitoes where wetlands or forest in proximity to wet areas are being restored
Inundation on Neighboring Lands	Lakebed and Non-lakebed - Existing conditions are being maintained, so neighboring lands would experience a neutral effect	Lakebed – Intermediate long- term negative impacts to private lands within the lakebed as a result of year-round inundation; surrounding lands would experience no negative effects. Possible intermediate long- term negative impacts to TVID's irrigation system. Landowner agreements would be sought prior to implementation Non-lakebed -	Lakebed – Intermediate long- term negative impacts to private lands within the lakebed as a result of year-round inundation. Landowner agreements would be sought prior to implementation Non-lakebed - Implementation of restoration would have a neutral effect on neighboring lands

	Alternative 1 (No action) – Cooperative farming	Alternative 2 – Restoration with a breach and open connection	Alternative 3 (Preferred Alternative) – Restoration with pumping infrastructure
		Implementation of restoration would have a neutral effect on neighboring lands	
Water Rights	Lakebed and Non-lakebed Existing conditions are being maintained so a neutral effect would result	Lakebed and Non-lakebed Actions would not impact water rights on non-Service lands, resulting in a neutral effect	Lakebed and Non-lakebed Actions would not impact water rights on non-Service lands, resulting in a neutral effect
Economics	Lakebed and Non-lakebed – Existing conditions are being maintained so a neutral effect would result	Lakebed and Non-lakebed – Minor long-term negative effect to local economy as a result of ending the cooperative farming program Minor short-term positive impact to the local economy when restoration actions are occurring, e.g., contracts let for construction work, construction crews patronizing local businesses	Lakebed and Non-lakebed – Minor long-term negative effect to local economy as a result of ending the cooperative farming program Minor short-term positive impact to the local economy when restoration actions are occurring, e.g., contracts let for construction work, construction crews patronizing local businesses

	Alternative 1 (No action) – Cooperative farming	Alternative 2 – Restoration with a breach and open connection	Alternative 3 (Preferred Alternative) – Restoration with pumping infrastructure
Land Use	Lakebed and Non-lakebed- Existing conditions are being maintained so a neutral effect would result	Lakebed and Non-lakebed - Minor long-term effect to agriculture acreage in the region; minor long-term positive effect to conservation acreage in the region	Lakebed and Non-lakebed - Minor long-term effect to agriculture acreage in the region; minor long-term positive effect to conservation acreage in the region
Transporta-tion, Rights of Way, and Easements	Lakebed and Non-lakebed - Existing conditions are being maintained so effect on road infrastructure and existing easement would be neutral	Lakebed and Non-lakebed – No changes would occur to local roads, or an existing access easement for owner of inholding, so effect would be neutral Restoration of Service conservation easement land would result in a neutral effect to fee-title holder of that land	Lakebed and Non-lakebed – No changes would occur to local roads, or an existing access easement for owner of inholding, so effect would be neutral Restoration of Service conservation easement land would result in a neutral effect to fee-title holder of that land
Soundscape	Lakebed and Non-lakebed - Minor long-term negative effect as a result of annual farming activity	Lakebed and Non-lakebed – Minor long-term positive effect as a result of ceasing annual farming activity	Lakebed and Non-lakebed - Minor long-term positive effect as a result of ceasing annual farming activity

Aerial view of drained and farmed Wapato Lake during summer, looking north. Tualatin Riverkeepers.

4.2 Soils

Effects Specific to Alternative 1

Lakebed

The continued degradation of freshwater wetland soils would be expected under the No Action Alternative. Sediment deposition from the Tualatin River and new peat soil accumulation would be precluded due to the presence of levees and continued annual drainage for farming. Agriculturally induced subsidence associated with the draining and oxidation of organic soils and compaction by farm equipment would continue. These practices could impact the Service's ability to restore native fish and wildlife habitat in the future.

Non-lakebed

Under the No Action Alternative, hydric and non-hydric soils associated with non-lakebed properties would continue to be farmed annually. While the degree of soil degradation on these properties is unknown, annual farming practices may contribute to compaction, erosion, and oxidation in the case of wetland soils over the long-term. These practices could impact the Service's ability to restore native fish and wildlife habitat in the future.

Effects Common to Alternatives 2 and 3 (Preferred Alternative)

Short-term effects associated with restoration actions in the lakebed would have a minor negative impact on soil resources. Effects would be caused by moving heavy equipment onto and out of the lakebed to remove or replace pumping infrastructure, as well as fill and grade internal drainage ditches. However, construction areas would be re-seeded, replanted, and graded to avoid long-term negative impacts to soils. Overall, Alternatives 2 and 3 would have a long-term beneficial effect on the natural soil processes of the site compared to the effects that have occurred as a result of repeated drainage and farming.

Effects Specific to Alternative 2

Lakebed

There could be beneficial effects to restoring the natural process of sediment deposition within the lakebed as a result of implementing Alternative 2. Reconnecting Wapato Lake to the greater Tualatin River system may restore historic sediment deposition processes that would have occurred during winter river flows. Such deposition could help offset subsidence that has occurred over the past century and contribute positively to other biochemical processes that shape floodplain wetlands. However, the magnitude of that effect is unknown, and Miller 2008 observed that marshes supporting higher densities of emergent vegetation (and thus a source of organic matter) gained land surface elevation (or accreted) faster than wetlands made up of deeper open water, similar to what would result under Alternative 2. More importantly, there is concern that the process of rebuilding the site's peat soils would be limited as a result of restoring connectivity between Wapato Lake and the Tualatin River. Based on water budget and HEC-RAS modeling (Rounds et al. 2016), and due to the subsidence of lakebed soils, growing season water levels would be 3–6 feet deep over a large area of the lakebed. These levels would preclude the establishment of fibrous, persistent emergent vegetation that ultimately contributes to the development of highly organic Labish and other peat soils. Overall, Alternative 2 could have some long-term beneficial effects on the natural soil processes of the site associated with sediment deposition that would

occur through reconnecting the site to the river; however, the historic role of sediment deposition at the site is poorly understood, and the water levels resulting from the reconnection could impair the process of rebuilding the site's peat soils.

Effects Specific to Alternative 3 (Preferred Alternative)

Lakebed

The Preferred Alternative is expected to benefit the site's soils as a result of restoring wetland function with management infrastructure as described in section 2.3. While the Preferred Alternative would preclude potentially beneficial sediment reintroduction from the Tualatin River onto the site, it would allow for the maintenance of shallower growing season water levels during the growing season to favor the re-establishment of persistent emergent and scrub-shrub vegetation across 75 percent of the lakebed; this would contribute to rebuilding of the site's peat soils at a faster rate than an open water system supporting less vegetation (Miller 2008). Short-term soil disturbance would occur during the tasks associated with the wetland restoration (e.g., infrastructure upgrades and ditch filling); however, these short-term effects are considered a less-than-significant adverse impact on soil resources compared to the effects that have occurred as a result of repeated drainage and farming. Despite precluding sediment contributions to the site, overall, the Preferred Alternative would likely have a long-term beneficial effect on the natural peat soil forming process that historically occurred in the lakebed.

4.3 Hydrology and Vegetation

Effects Specific to Alternative1

Lakebed

Under the No Action Alternative, Wapato Lake would remain a degraded, prior-converted wetland. Lakebed vegetation would remain unchanged, with annual agricultural crops as the majority of the vegetation. While it is likely that the small remnant patches of native flora that exist onsite would persist in the wetter areas (levee toe-ditches and in the interior ditches), the invasive plant species that dominate the interior ditch banks and levee system, such as reed- canarygrass and Himalayan blackberry, would continue to outcompete native flora long-term. Overall, wetland functionality would continue to be compromised due to annual draining that occurs to prepare the site for cultivation during the spring and summer. The No Action Alternative would therefore not improve the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat, but have a neutral effect on existing vegetative conditions in the lakebed.

Non-lakebed

Under the No Action Alternative, non-lakebed properties would continue to be farmed and this would preclude the restoration of native upland and wetland plant communities. The No Action Alternative would result in limited benefits to native flora associated with the non-lakebed properties. It would not improve the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat, and it would have a neutral effect on existing vegetative conditions on non-lakebed properties.

Effects Common to Alternatives 2 and 3 (Preferred Alternative)

Lakebed

All farming on Service and privately owned lands within the lakebed would cease as restoration efforts gradually converted lands from agricultural use to native plant communities to support ecological restoration goals. Farming would also cease on the private inholding located in the center of the lakebed.

Within the lakebed, the conversion from agriculture and degraded freshwater wetland to a restored freshwater wetland would preclude farming; however, would result in ecological uplift and improve BIDEH of the Refuge. This would improve the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat.

Non-lakebed

Alternative 2 and 3 would result in the restoration of 206 acres of wetlands and uplands on the periphery of the lakebed associated with the Service's non-lakebed properties. Plant communities to be restored would range from palustrine emergent, scrub-shrub, and forested wetlands and riparian forest, as well as upland prairie. A seventh, 4-acre fee-simple property northeast of the lakebed contains a residence and barn and would be maintained for temporary housing, meetings, and storage.

The conversion from agriculture to restored uplands would preclude farming; however, like the lakebed, it would result in the restoration of native plant communities and would improve BIDEH of the Refuge, thus improving the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat.

Effects Specific to Alternative 2

Lakebed

Under Alternative (2), 800 acres of largely lacustrine and palustrine wetlands would be restored by reconnecting Wapato Lake to the greater Tualatin River system. As described in Section 2.2, this would be accomplished by creating a breach in the existing levee infrastructure where the pump station is currently located. As a result of breaching the levee system, Wapato Lake would be freely connected to Wapato Creek and the Tualatin River and experience some level of inundation throughout the year. Inundation levels would be influenced by multiple variables, including precipitation and Wapato Creek and Tualatin River levels.

Figure 7 illustrates the expected annual hydrograph during a typical year at Wapato Lake as a result of breaching the levee system. Of particular importance are water depths between April and August, or the period where wetland plant germination and growth would be occurring. Water levels during this portion of the growing season would have a strong influence on what plant species occupy the site. While water levels drop during this period following winter highs, the average maximum water surface elevation during the growing season is 168 feet NAVD88, equivalent to maximum water depths approaching 6 feet in the lowest elevation portions of the site. Note, that the growing season water levels shown in Figure 7 are consistent when modeled under every year of precipitation data available in the WMST (1992–2014), with the exception of2001. 2001 represents the lowest total precipitation in the data set. During an exceptionally dry year like 2001, growing season water levels would be 3 feet lower that what is shown in Figure 7 and may

result in Wapato Lake being disconnected from Wapato Creek, however, during most years Wapato Lake inundation patterns would be consistent with the hydrograph in Figure 7.

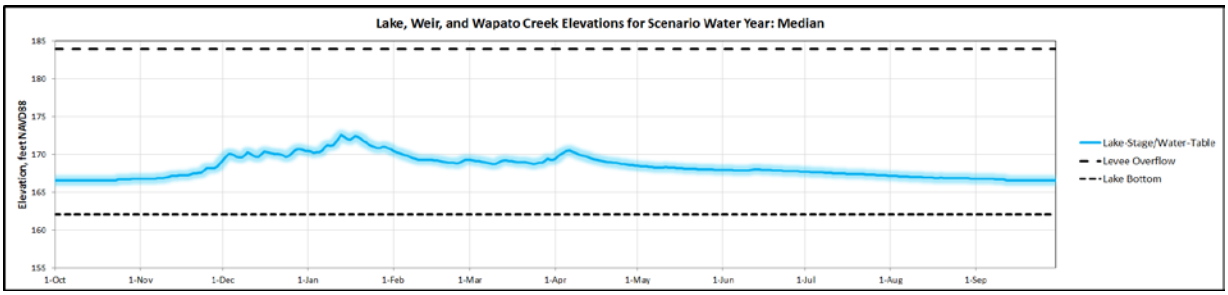

Figure 7. Annual hydrograph for Wapato Lake under Alternative 2 where a breach is used to connect Wapato Lake to the greater Tualatin River system.

The lakebed has more topographic variability than the hydrograph suggests, so Figure 8 can be used to visualize the full range of depths expected during the growing season (April–August) assuming a maximum average water surface elevation of 168 feet NAVD88 during this time period. Over 64 percent of the area, or 513 of the 800 acres that comprise Wapato Lake, would be inundated with 3–6 feet of water. Given these hydrologic conditions, this portion of the lake would support a lacustrine wetland system, characterized by deeper, open water, and where vegetated, dominated by aquatic bed species (Table 4). The remaining inundated area (180 acres, or 23 percent of the lakebed) would support palustrine wetlands with 0–3-foot water levels, while 105 acres (13 percent) would sit above the growing season water line.

It should be noted that with Alternative 2, control of water levels in the lakebed would be eliminated. Factors like beaver dam influences in Wapato Creek and extreme wet or dry years could change lakebed water levels and plant community composition from the expected conditions described above. If undesirable habitat conditions arose under Alternative 2, management prescriptions could be limited due the inability to manipulate water levels. Alternative 2, overall, would still result in benefits to flora and wetland resources associated with the lakebed and improve the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat.

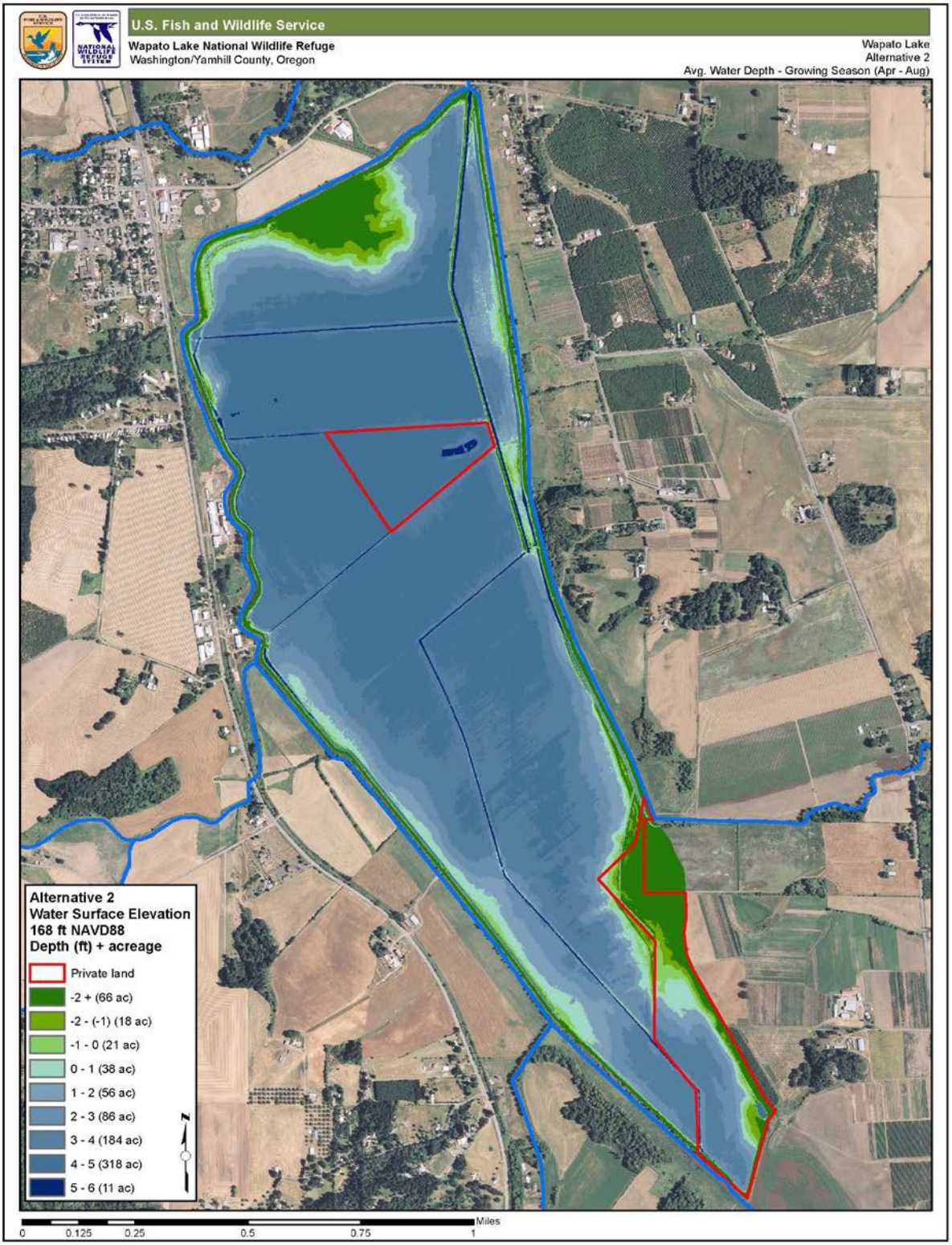

Figure 8. Water depth gradient of Alternative 2 during the growing season (April - September). Negative values represent feet above the water line. For example, -2 – (-1) is equivalent to 1 to 2 feet above the water line.

Effects Specific to Alternative 3 (Preferred Alternative)

Lakebed

Under the Preferred Alternative, 800 acres of diverse palustrine emergent wetlands would be restored. While the historic connection to the greater Tualatin River system would not be re-established, the Preferred Alternative would provide some advantages in restoring native wetland plant communities; managers would have the ability to manipulate and experiment with water levels (using pumping infrastructure) to favor a broad range of plant community types. In contrast, Alternative 2 would provide no control of water levels and would likely result in large areas of deeper open water, surrounded by a fringe of palustrine community types.

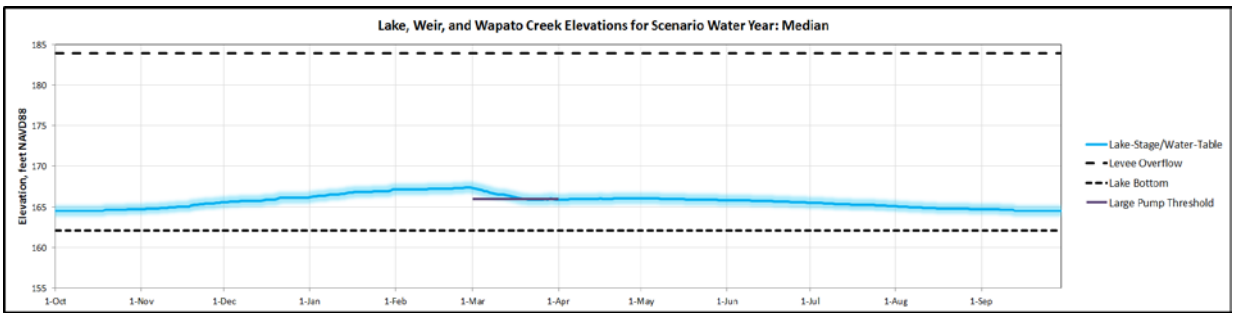

Figure 9. Annual hydrograph for Wapato Lake under the Preferred Alternative where pumping infrastructure is used to manage water levels in Wapato Lake.

Under the Preferred Alternative, water management with the pump system would target an average maximum water surface elevation in the wetland basin of 165.5 feet NAVD88 during the growing season. To achieve this, we would expect to run a large capacity pump from March to April to lower water levels to 166 feet NAVD88. Through the course of the growing season, water levels are expected to drop to about 165 feet NAVD88 by September via evaporation and evapo-transpiration. Figure 9 illustrates the expected annual hydrograph as a result of managing the lakebed with the pump system. In contrast to Alternative 2, the Preferred Alternative would support 556 acres (69.5 percent of the area) of 0–3 feet water depths during the growing season (Fig. 10 and Table 4). Most of the remaining acreage (236 acres or 29.5 percent of the area) would not be inundated, while <1 percent of the area would be deeper than 3 feet. The gradient of palustrine plant community types expected to occupy these depths (listed in order from deepest to most shallow zones of the wetland basin), include aquatic bed, emergent, scrub-shrub, and forested wetlands. Table 4 summarizes the anticipated plant community under the Preferred Alternative.

Unlike Alternative 2, the Preferred Alternative offers flexibility to manipulate water levels. As a result, managers would have the ability to easily alter the hydrology onsite in response to undesirable habitat conditions or invasive plant, animal, or fish issues (e.g., reed-canarygrass proliferation or colonization by common carp). Overall, the Preferred Alternative would result in benefits to native plant communities and improve the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat.

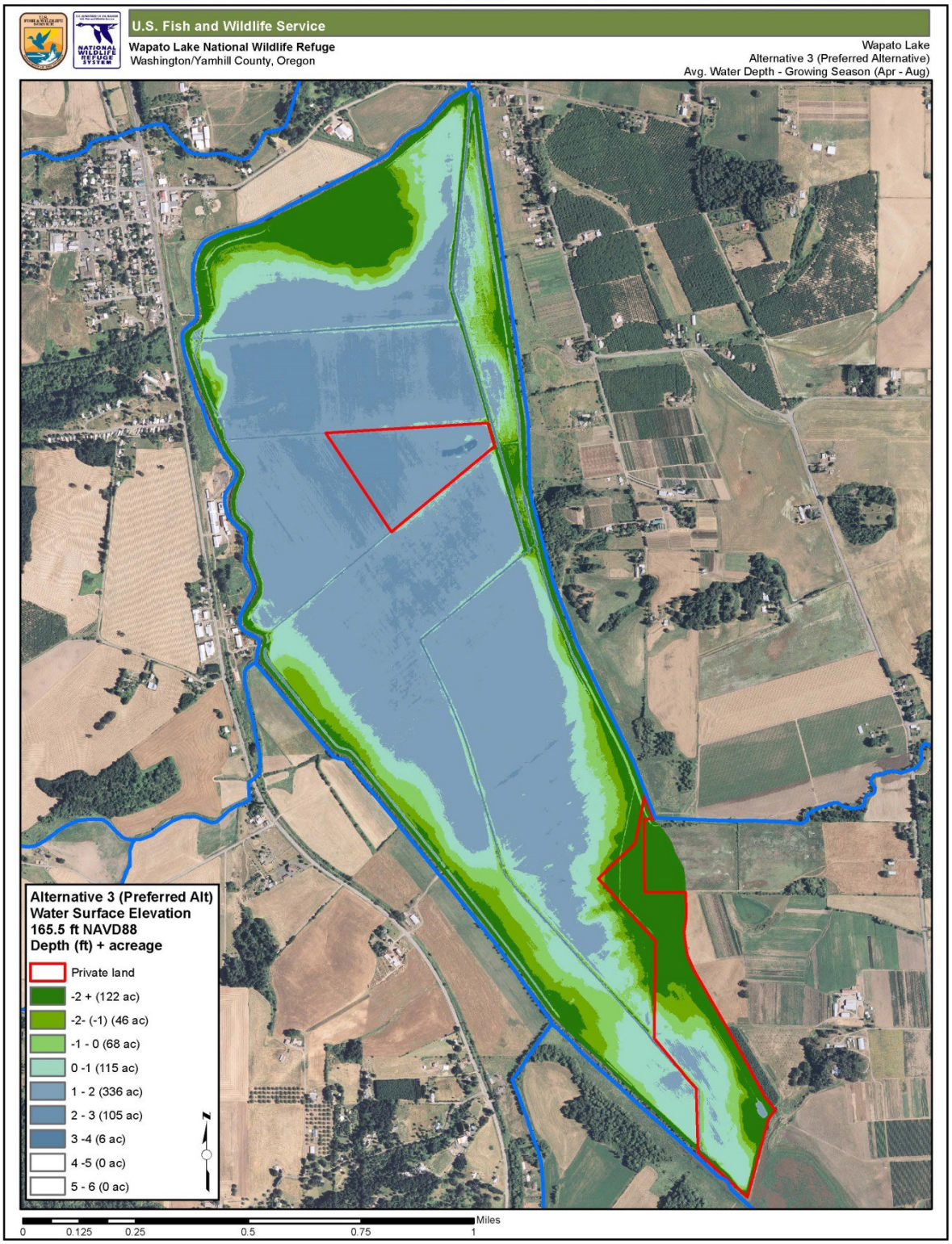

Figure 10. Water depth gradient of the Preferred Alternative (Alt 3) during the growing season (April - September). Negative values represent feet above the water line. For example, -2 – (-1) is equivalent to 1 to 2 feet above the water line.

Table 4. Palustrine and lacustrine wetland type and common plant community associations expected to occupy the range of growing season water depths under Alternative 2 and the Preferred Alternative (negative values represent feet above the water line. For example, -2 – (-1) is equivalent to 1 to 2 feet above the water line).

Depth (ft)	Wetland Type (Cowardin)	Common Plant Associations	Acreage Alt 2	Acreage Pref Alt
(-2) plus	Palustrine Forested	Oregon ash, black cottonwood, red alder, Pacific dogwood, willow sp.	66	122
-2 - (-1)	Palustrine Scrub-shrub	Willow sp., Douglas spirea, red osier dogwood	18	46
-1 - 0	Palustrine Scrub-Shrub/Emergent	Willow sp., Douglas spirea, red osier dogwood/cattail, sedge sp., rush sp.	21	68
0 - 1	Palustrine Scrub-Shrub/Emergent	Willow sp., Douglas spirea, red osier dogwood/cattail, sedge sp., rush sp.	38	115
1 - 2	Palustrine Emergent	Cattail, soft-stem bulrush, wapato, bur-reed, water plantain, rush sp.	56	336
2-3	Palustrine Emergent/Aquatic Bed	Cattail, soft-stem bulrush/ pondweed spp., water-milfoil spp.,	86	105
3 - 4	Palustrine Aquatic Bed or Lacustrine Aquatic Bed	Pondweed spp., water-milfoil spp., American wild celery	184	6
4 - 5	Lacustrine Aquatic Bed/ Unconsolidated Bottom	Pondweed spp., water-milfoil spp., American wild celery/open water	318	0
5 - 6	Lacustrine Unconsolidated Bottom	Open water	11	0

Palustrine emergent wetland near Scappoose, OR. Emergent plant community composition similar to expected conditions at Wapato Lake during the growing season. Curt Mykut/USFWS

4.4 Wildlife and Fish

Effects Specific to Alternative 1

Lakebed

Under the No Action Alternative, restoration would not occur on 800 acres of historic wetlands and would likely result in no changes to wildlife and fish diversity and abundance compared to current conditions described in 3.8.1. Waste grains remaining from the harvest of crops in the lakebed would benefit migratory waterfowl, particularly as the lakebed re-floods during fall and winter, and mudflats available in the fall and spring would continue to support migrating shorebirds. The site would provide limited benefits to other wetland dependent taxa dependent upon native plant communities and seasonal ponding, particularly during the growing season (e.g. marsh birds and wading birds, pond-breeding amphibians, turtles, and marsh-breeding passeriformes). Therefore, overall, the No Action Alternative would not improve the Service's ability to meet its legally mandated mission to protect other trust resources, and preserve and enhance wildlife habitat, and it would have a neutral effect on wildlife currently using the lakebed.

Non-lakebed

Under the No Action Alternative, restoration would not occur on 206 acres of historic wetlands and uplands that make up the non-lakebed properties and would likely result in no changes to wildlife

and fish diversity and abundance compared to current conditions described in 3.7.1. Waste grains remaining from the harvest of crops on five of the six properties would continue to benefit small numbers of migratory waterfowl during fall and winter, and small remnant patches of scrub-shrub and forested wetlands would continue to provide value to a small number of native wildlife taxa, but no new benefits would be realized. Therefore, overall, the No Action Alternative would not improve the Service's ability to meet its legally mandated mission to protect other trust resources, and preserve and enhance wildlife habitat, and it would have a neutral effect on wildlife resources compared to existing conditions.

Effects Common to Alternatives 2 and 3 (Preferred Alternative)

Lakebed

As a result of abandoning agricultural operations, as well as a change in lakebed water levels during the fall, use by foraging western Canada geese and cackling geese is expected to decline during this time period. Under Alternatives 2 and 3, the lakebed would be inundated and no longer provide waste grains resulting from cooperative farming operations, so while birds would have access to wetland plant resources, these species would likely utilize surrounding agricultural fields where waste grains are readily available and easily accessible in dry fields.

North American beaver are currently present in proximity to Wapato Lake, and restoration actions would improve conditions for these local populations (e.g. increase in food supply with restoration of shrub-scrub wetlands and maintenance of perennial ponding across the lakebed).

Restoration of a large wetland system would also provide conditions favorable for invasive nutria. Currently nutria are limited to perennial water found in the exterior and interior canals associated with the lakebed. We expect more individuals to occupy Wapato Lake as a result of perennial lakebed inundation. The primary concerns associated with nutria include damage to restored emergent and aquatic bed wetland plant communities via foraging and burrowing in levee infrastructure. If nutria populations increased to levels that resulted in detrimental effects in the restored lakebed, control measures would be implemented similar to what is described in Tualatin River NWR's Refuge Integrated Pest Management plan (CCP Appendix G).

Non-lakebed

Alternatives 2 and 3 would result in the restoration of 206 acres of wetlands and uplands on the periphery of the lakebed associated with the Service's non-lakebed properties. Plant communities to be restored would range from palustrine emergent, scrub-shrub, and forested wetlands, as well as upland prairie. Restoration of these native plant communities has the potential to support a wide range of native wildlife species (described in 3.3 above) either currently found in low numbers or not present on the properties due to habitat loss (i.e., due to agricultural disturbances). Due the lack of permanent emergent marsh, non-lakebed properties are expected to support wildlife taxa that occupy palustrine scrub-shrub and palustrine forested wetlands, similar to the higher elevation zones of the lakebed (described below).

While non-lakebed properties are made up of small, disjunct tracts totaling 206 acres, their value to wildlife as a result of restoration would be greatly enhanced considering that most of the properties adjoin the 800-acre lakebed. Therefore, put in the context of the larger lakebed restoration, non-lakebed restoration associated with Alternatives 2 and 3 would improve the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat.

Effects Specific to Alternative 2

Lakebed

Under Alternative 2, breaching the existing levee infrastructure would result in year-round inundation on the site and ultimately restore lacustrine and palustrine wetlands across 800 acres within the lakebed. The most significant changes expected, compared to existing conditions, would be an increase in fish and wildlife use during spring and summer months and the potential for overwinter off-channel use by salmonids (namely Upper Willamette ESU steelhead, coho, and coastal cutthroat trout), as a result of improved habitat conditions and reconnection of the site to the greater Tualatin River system. Under existing conditions, there are no ingress opportunities for fish into Wapato Lake.

Abandoning agricultural operations in favor of ecological restoration would provide improved habitat to a broad diversity of species dependent upon wetlands that currently do not exist. For example, 180 acres comprised of scrub-shrub and emergent palustrine wetlands inundated with shallow water, and possessing a diversity of vertical plant structure, would provide new brood-rearing habitat for locally breeding waterfowl species such as mallard, gadwall, cinnamon teal, wood duck, and pied-billed grebe, and also support two regionally sensitive turtles: western pond turtle and western painted turtle. This same zone would provide valuable nesting habitat for sora and Virginia rail, American bittern, pied-billed grebe, Wilson's snipe, spotted sandpiper, marsh wren, and red- winged and possibly yellow-headed blackbird, as well as provide optimal breeding conditions for the regionally sensitive red-legged frog, and foraging areas for great-blue heron and great egret.

At or above the growing-season water line, 105 acres would support scrub-shrub and forested wetlands and likely provide optimal breeding habitat for two regionally sensitive bird species, willow flycatcher and yellow-breasted chat, both of which ODFW considers to be threatened with extirpation from the Willamette Valley (ODFW 2008).

The 285 acres that make up the outer shallower fringe of the wetland would also be expected to improve conditions for foraging bats resulting from an increase in insect use of restored wetland plant communities. Based on baseline surveys conducted at Tualatin River NWR during summer 2016, we would expect to support seven bat species (big brown, silver-haired, hoary, California myotis, long-eared myotis, little brown, and Yuma myotis).

The remaining 513 acres of the lakebed would be dominated by deeper water, ranging from 3 to 6 feet and mostly lacustrine aquatic bed wetland. While this large area would provide limited value to breeding wildlife due to the expected lack of vertical vegetative structure and fewer foraging resources compared to the shallower fringe of the lakebed, this deeper water zone would provide new foraging habitat for breeding osprey and bald eagles as the potential to support fish in the lake increases, and passeriformes such as violet-green, cliff, and barn swallows seeking out aquatic insect hatches. This area would also likely provide optimum habitat for native western floater mussels based on baseline mussel surveys conducted in the canals on the exterior of the lakebed.

Alternative 2 would largely result in benefits to native wildlife dependent on aquatic systems, as well as potentially provide benefits to a suite a native fish throughout the year (e.g. rearing habitat for steelhead, coho and cutthroat trout, rearing and foraging habitat for reticulated sculpin, three-spine stickleback, and red-side shiner). However, non-native fish such as common carp, bluegill, smallmouth bass, catfish would also occupy Wapato Lake under Alternative 2 due to the open connection with the Tualatin River. Of particular concern would be the establishment of common carp. Similar to nutria, carp would threaten restored emergent and aquatic bed wetland plant

communities as a result of foraging on vegetation, and increasing lakebed turbidity, thus limiting plant productivity. If nutria or carp populations increased to levels that resulted in detrimental effects in the restored lakebed, control measures would be implemented similar to what is described in Tualatin River NWR's Refuge Integrated Pest Management plan (CCP Appendix G).

Finally, waterfowl use, particularly dabbling ducks and tundra swans, would be expected to change as a result of changes to fall/winter water depths and the plant communities that are expected to establish post-restoration. For example, under Alternative 2, water levels during the mid-winter waterfowl peak would likely be higher than what is currently observed resulting from the re-connection of Wapato Lake to the Tualatin River. In addition, the re-establishment of seed producing emergent plants would be limited due to deeper growing season water depths across a large portion of the lakebed. As a result, Wapato Lake would continue to provide valuable loafing and roosting habitat for dabbling ducks, swans, and geese; however, foraging resources important to meeting their energetic demands during winter would likely decline. Conversely, the changing conditions could favor migrating and wintering mergansers and some diving ducks due to their preference for animal matter (e.g., fish, mollusks, crustaceans) and their ability to exploit foraging resources at greater depths.

Despite the expected changes to fall/winter waterfowl use of the lakebed, implementation of Alternative 2 would provide benefits to a wide range of fish and wildlife species native to the Tualatin Basin throughout the year and improve the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat.

Effects Specific to Alternative 3 (Preferred Alternative)

<u>Lakebed</u>

Under Alternative (3), 800 acres of palustrine wetlands would be restored by managing water within the lakebed via pumping and levee infrastructure. The most significant change expected, compared to existing conditions, would be an increase in wildlife use during spring and summer months as a result of improved habitat conditions.

Abandoning agricultural operations in favor of ecological restoration would improve habitat for a broad diversity of species dependent upon wetlands that currently do not exist. For example, 556 acres of a range of palustrine wetland plant communities inundated with relatively shallow water (0–3 feet), and possessing a diversity of vertical plant structure would provide new brood-rearing habitat for locally breeding waterfowl species such as mallard, gadwall, cinnamon teal, wood duck, and pied- billed grebe and also support two regionally sensitive turtles: western pond turtle and western painted turtle. This same zone would provide new foraging habitat for osprey and bald eagle and provide valuable nesting habitat for sora and Virginia rail, American bittern, pied-billed grebe, Wilson's snipe, spotted sandpiper, marsh wren, and red-winged and possibly yellow-headed blackbird, as well as provide optimal breeding conditions for the regionally sensitive red-legged frog, and foraging areas for great-blue heron and great egret. Finally, 236 acres at or above the growing season water line would support more woody dominated plant communities ranging from scrub-shrub to forested wetlands and likely provide optimal breeding habitat for two regionally sensitive bird species, willow flycatcher and yellow-breasted chat, both of which ODFW considers to be threatened with extirpation from the Willamette Valley (ODFW 2008).

The entire restored lakebed would also be expected to improve conditions for foraging bats resulting from an increase in insect production with restored wetland plant communities. Based on baseline surveys conducted at Tualatin River NWR during summer 2016, we would expect to

support seven bat species (big brown, silver-haired, hoary, California myotis, long-eared myotis, little brown, and Yuma myotis). These habitat conditions would similarly improve foraging conditions for passeriformes such as violet-green, cliff, and barn swallow.

Under the Preferred Alternative, as native herbaceous wetland plant communities are re-established, we would expect winter tundra swan use to increase in the shallowly flooded lakebed due to their preference for and ability to exploit below-ground food resources associated with aquatic plant root systems. Increases in diving duck numbers would be expected as well, assuming a restored wetland would support preferred food items such as crustaceans and mollusks.

While similarities exist with respect to expected wildlife use under both Alternatives 2 and 3, the Preferred Alternative (Alternative 3) would support a greater abundance and diversity of wildlife throughout the year. Greater plant community diversity and structure, and habitat heterogeneity (i.e., structurally complex), may provide more niches and various ways of exploiting the environmental resources, which would increase species diversity (Bazzaz 1975). For example, Tews et al. (2004) conducted a literature review and reported that 85 percent of the studies demonstrated a positive correlation between animal species diversity and habitat heterogeneity, particularly with vertebrate taxa. Further, Morrison III and Bohlen (2010) suggest that management practices that foster a greater diversity of vegetative cover may supportmore diverse and populous wetland invertebrate communities. Beckett et al. (1992), working in littoral zone sediments, demonstrated that invertebrate fauna was less diverse and much less abundant in littoral zone sediments where vegetation was sparse or absent (i.e., where open water dominated). In addition, expected winter water levels differ significantly between Alternative 2 and the Preferred Alternative (Alternative 3) as discussed previously, and as a result would have profound effects on fall/winter waterfowl use of the lakebed. Shallower water levels and a higher abundance of foraging resources under the Preferred Alternative would support a greater abundance of waterfowl during the winter.

American bittern using an emergent marsh. USFWS.

4.5 Threatened and Endangered Species

Effects Common to All alternatives

Lake and Non-Lakebed Actions - Plants and Wildlife

Because no federally listed plant or wildlife species occur in the project area, none of the alternatives would have effects to listed plant or wildlife species.

Effects Specific to Alternative 1

Non-Lakebed Actions – Fish

The No- Action alternative would have minor-long term negative effects on ESA listed fish as a result of continuing cooperative farming operations on non-lakebed properties, namely resulting from pesticide residue, fertilizer and sediment entering the Tualatin River system from agricultural runoff.

Effects Specific to Alternative 1 and 3 (Preferred Alternative)

Fish

While ESA listed fish would not have access to off-channel habitat in Wapato Lake under the No Action Alternative and Preferred Alternative, these alternatives would not impede rearing, migrating and spawning individuals from using suitable habitat within the Tualatin River above the project area. There could be minor short-term negative effects associated with replacing the pump station. For example, placement of a coffer-dam to isolate a construction work area in Wapato Creek would require a fish salvage operation prior to placement of the coffer-dam and dewatering of the work area. Overall, the effects of this action would be minor considering that few, if any, listed fish would occupy Wapato Creek during the summer construction period. Water quality impacts associated with dewatering or lowering Wapato Lake water levels via pumping were considered; however, since the 2008 levee breach event, a multi-agency plan has been put in place that imposes restrictions on pumping, limiting it to the time of year when higher flows and cooler water temperatures prevail in the Tualatin River to prevent water quality issues.

Effects Specific to Alternative 2

Fish

ESA listed fish migrating and rearing in the Tualatin River in the vicinity of Wapato Lake would have access to a large expanse of off-channel refugia under Alternative 2. Currently individuals bypass Wapato Lake due to the presence of the levee system. The breach created under Alternative 2 would re-establish connectivity between Wapato Lake and the Tualatin River resulting in a minor beneficial effect to ESA listed fish, namely steelhead.

Effects Specific to Alternative 2 and 3 (Preferred Alternative)

Non-Lakebed Actions – Fish

Restoration of non-lakebed properties would have minor long-term positive effects on ESA listed fish as a result of restoring forested buffers and other native plant communities along Tualatin

River tributaries, and reducing pesticide fertilizer, and sediment into these tributaries by ceasing the cooperative farming program.

4.6 Water Quality – Harmful Algal Blooms

Effects Specific to Alternative 1

Likely water quality effects in Wapato Lake

Under the no-action alternative, the lake is completely dewatered via pumping in spring prior to May 1 and farmed in summer. As long as these timelines are met, no water-quality problems are likely to occur in the lake. During winter and spring when water is present in the lake, the water is likely to be cold to cool and sunlight is likely to be insufficient to induce a bloom of algae. The risks to water quality are therefore low. The patterns in water quality under this alternative are known and have been measured and do not represent any undue risks for humans or the ecosystem. The greatest risk of a harmful algal bloom results from a failure of the pumping system or a breach in the levee system that causes water to remain in the lake into the summer, when sunlight, nutrients, and water temperatures could favor the formation of an algal bloom that could be harmful to the lake ecosystem.

Likely water quality effects downstream

Downstream risks for a harmful algal bloom are a result of discharges from the Wapato Lake system. In this alternative, discharges from Wapato Lake typically occur in spring (March–April) when the Tualatin River flows are still relatively high from the winter rainy season, thus providing a favorable dilution. Municipal water withdrawals occur downstream of the Wapato Lake discharge. Water treatment costs can occur during spring water discharges; those costs have been adequately managed in the past. In the event of a pump failure or levee breach that causes water to remain in the lake into the summer, the risks and costs of water treatment can greatly increase. In 2008, after a levee breach the previous winter, a large nuisance algal bloom in the lower Tualatin River was tied to Wapato Lake discharges during June and July. That algal bloom resulted in a public health advisory that closed the river to recreation and other uses.

Effects Specific to Alternative 2

Likely water quality effects in Wapato Lake

With an open connection between Wapato Lake and the Tualatin River, a substantial amount of water is likely to enter the lake from the river during winter when the river levels are high. Much of this water would slowly leave in spring and early summer, eventually reaching a condition in summer where the channel connecting the lake and Wapato Creek may remain wet, but with little to no flow in or out. Several feet of water could remain in the lake because the connecting channel to Wapato Creek has a higher elevation than the bottom of the lake or the river. In a particularly dry summer, that connecting channel could dry up. Alternatively, large rain events or a high water table during the normally dry summer season could cause water to flow out of the lake and into Wapato Creek. In summer, the water temperature in the lake would increase and plentiful sunlight and nutrients would create favorable conditions for algal blooms if there is sufficient open water. Shading by vegetation or floating aquatic plants could decrease the chance of an algal bloom. Dissolved oxygen levels could be low as a result of decomposing organic matter and vegetation in lake sediments, but production of oxygen through photosynthesis from plants and algae could offset that loss.

Likely water quality effects downstream

Downstream water quality problems due to water released from Wapato Lake depend on the quality of the water released from the lake. During winter when water levels are high, the lake water quality is likely to be good—similar to river- or rainwater. During spring when water levels in the lake are receding, nutrients (phosphorus and nitrogen) and organic matter are likely to become more concentrated in the lake water. Depending on sunlight and the amount of water exiting the lake in late spring and early summer, the risk of an algal bloom in the lake, along with higher concentrations of organic matter from the lake sediments, may pose significant difficulties for municipal water treatment downstream. Algae-laden water leaving the lake, along with increased nutrient loads, also may pose some risks for altered and augmented algae communities much farther downstream in the lower Tualatin River. Once the flow exchange between the lake and river diminishes to near zero in a typical summer, the downstream water quality effects should disappear. Large rain events or a high water table may temporarily cause water to be discharged from Wapato Lake during the normally dry summer season, thus posing some risk to downstream water quality. As long as the amount of water is small relative to Tualatin River flows, that risk should be small.

Effects Specific to Alternative 3 (Preferred Alternative)

Likely water quality effects in Wapato Lake

In this scenario, active pumping would result in highly managed water levels in Wapato Lake. Control of the water level should result in more control over the lake's habitat conditions, the health of the restored vegetation in and around the lake/wetland system, and therefore the amount of shading provided to the lake surface. In this alternative, once sufficient rooted and floating aquatic vegetation is in place, the vegetation would shade a substantial portion of the lake surface, thus decreasing the probability and magnitude of a harmful algal bloom. Warm water temperatures and high nutrient levels could support an algal bloom, and dissolved oxygen concentrations could still be at risk of decreasing to low levels, but the aquatic vegetation should produce enough oxygen to offset the losses due to decomposition of organic materials in lake sediments.

Likely water quality effects downstream

Downstream water quality effects under this alternative are tied to the timing, magnitude, and quality of any discharges from Wapato Lake. During winter, the water quality should be sufficiently high that releases do not pose a significant risk to water treatment or downstream water quality. During spring, organic matter and some algae in the lake releases could pose a risk to downstream municipal water treatment that is similar to what occurs today and in the recent past. The greatest risks are posed by releases of lake water, probably in early summer, when high concentrations of organic matter, nutrients, and/or algal communities could make municipal water treatment difficult and expensive, causing serious water quality problems in the lower Tualatin River. Such risks are minimized through active management of lake releases and should decrease in summer as water levels in the river and lake recede, thus decreasing the need for pumping.

The Preferred Alternative would result in water being pumped out in the spring, similar to Alternative 1, but at a smaller volume and for a shorter time because the goal would not be to pump the lake dry but rather to lower the level and maintain a particular depth over the summer. Both of those factors reduce the risk for negative downstream effects because the discharges would be a small percentage of the flows in the Tualatin River. Under Alternative 3, water released from the

lakebed would also be expected to have temperature and pH preferable to Alternative 1 due to shade from vegetation on the lakebed.

Effects Specific to Alternative 1

Non-lakebed

There would be a minor long-term negative effect on water quality as a result of continuing farming operations on non-lakebed properties due to fertilizer, pesticide, and sediment contributions entering waterways adjacent to non-lakebed properties.

Effects Specific to Alternatives 2 and 3 (Preferred Alternative)

Non-lakebed

There would be an intermediate long-term positive effect on water quality as a result of restoring native plant communities on non-lakebed properties.

4.7 Air Quality

Effects Specific to Alternative 1

Lakebed and Non-lakebed

The No Action Alternative would likely have minor long-term effects on air quality conditions. Current effects from existing Refuge operations include farming, which may cause slightly elevated levels of particulate matter during planting and harvest seasons as a result of exhaust and dust from heavy equipment use necessary to conduct farming operations. In addition, it is often necessary to apply Service-approved herbicides to combat weeds; this application can be expected to produce slight negative short-term air quality impacts from gas- and diesel-powered equipment and possible herbicide drift.

Effects Common to Alternatives 2 and 3 (Preferred Alternative)

Lakebed and Non-lakebed

Under these alternatives, restoration activities might cause a minor short-term negative effect on air quality as a result of exhaust and dust from heavy equipment necessary to conduct habitat restoration. In addition, it is often necessary to apply Service-approved herbicides to combat weeds and this application can be expected to produce minor negative short-term air quality impacts from gas- and diesel-powered equipment and possible herbicide drift. Overall, however, restoration actions would result in a minor long-term positive effect on air quality as a result of ceasing annual farming operations and reducing the amount of herbicide used on an annual basis.

4.8 Cultural Resources

Effects Common to All Alternatives

Lakebed and Non-lakebed

Protections to cultural resources would be maintained under all alternatives through compliance with the National Historic Preservation Act (NHPA) and the Archaeological Resources Protection

Act (ARPA) as needed. Maintenance and replacement projects would need to be evaluated per NHPA regulations. Under Section 106 of the NHPA, archaeological sites, buildings, structures, and landscape features more than 50 years old are considered eligible for nomination to the National Register of Historic Places (NRHP) until determined not eligible. Determinations of eligibility are ascertained through formal recordation, consultation with the State Historic Preservation Office, Tribes, and interested parties and evaluation under four criteria of significance to American history.

The first criterion (A) is association with major events that have contributed to broad patterns of history, such development of agricultural tools and techniques. The second criterion (B) is association with a person or people that played a major role in history, such as an explorer or president. The third criterion (C) is an association with distinctive construction method, style, or material. Criterion C includes the work of a master, such as a well-known architect. The fourth criterion (D) is data that has or may be obtained from the resource that has or is likely to yield information important to prehistory or history. Typically this is knowledge gathered from excavations of an archaeological site.

The resource eligibility for nomination to the NRHP is based on integrity of the resource; for instance, does it convey the characteristics, the setting, the design, material, or workmanship in association with one or more of the above criteria. Of the five sites identified by the cultural resources study only one site was determined to warrant further investigation. The site remains unevaluated. The Wapato Lake Drainage System was also evaluated and was determined to be not eligible for listing on the NRHP.

Effects Specific to Alternative 1

Lakebed and Non-lakebed

Under the No Action Alternative, no impacts to significant cultural resources are anticipated. The historic levee and drainage system would continue to be maintained. The pump station bridge and crossover culverts with gate, which are less than 50 years old, may need to be replaced. The lakebed would not be suitable for supporting wapato or other wetland produce of significant cultural value to Native Americans.

Effects Specific to Alternative 2

Lakebed and Non-lakebed

Restoration of the lacustrine and palustrine wetlands under Alternative 2 requires a breach in the levee at the north end of the lake. This would occur at or near the existing nearly 80-year-old pump houses. Breaching the levee and removal of the pump, pump house, and water control structures would have a major effect on the eligibility of the structures to the NRHP. Given the importance of Wapato Lake to the Euro-American agricultural landscape, these structures are likely to be eligible to the NRHP under Criteria A and D. Eligibility to the NRHP does not preclude removal or alteration of the historic property, but would require some mitigation strategy. Mitigation measures could include extensive recordation of the agricultural drainage system and production of interpretive materials about the system.

An archaeological site (35WN19) occurs near the general breach location. Some additional archaeological survey, including sub-surface testing, is warranted to define the site boundary. Cautious design and placement of the proposed breach should avoid any impacts to the site.

Re-establishment of native vegetation would require continuation of some agricultural practices such as tilling, mowing, herbicide application, and seeding and planting as needed. These activities are not expected to cause any increased effects to known or as yet unrecorded archeological sites. Actions would still be evaluated per NHPA regulations. Survey and sub-surface testing, particularly in the upland areas, may be required.

The deeper water associated with a lacustrine system has the potential to create waves that would cause erosion of known (35WN19) and as yet undiscovered archaeological sites. In addition, deeper water is not conducive to growth of the culturally important wapato.

Finally, if public use of the Refuge is proposed for future NEPA analysis, the interpretation of the cultural history and land use of the Wapato Lake area should become an integral part of environmental education and public use programs for the Unit.

Effects Specific to Alternative 3 (Preferred Alternative)

Lakebed and Non-lakebed

Restoration of the palustrine wetlands under Alternative 3 requires maintaining and updating the nearly 80-year-old water drainage and delivery system. Alteration of the drain tiles, drainage ditches, levees, pump, pump house, and water control structures will alter the use and characteristics of the system. Given the prominence of Wapato Lake to the Euro-American agricultural landscape, these structures are likely to be eligible for nomination to the NRHP under Criteria A. Eligibility to the National Register does not preclude removal or alteration of the historic property, but would require some mitigation strategy. Mitigation measures could include extensive recordation of the agricultural drainage system and production of interpretive materials about the system. The shallower waters associated with a palustrine system would be beneficial to widespread growth of the culturally important wapato.

Finally, if public use of the Refuge is proposed for future NEPA analysis, the interpretation of the cultural history and land use of the Wapato Lake area should become an integral part of environmental education and public use programs for the Unit.

4.9 Mosquitoes

Effects Common to All Alternatives

Current surveillance records of the area indicate that Wapato Lake produces average to above average mosquito levels with the majority of the mosquito species (90 percent) being *Culex pipiens*. This area would continue to produce mosquitoes; however, the scale of production could be influenced by hydrologic actions (water movement) and vegetation management.

The Service considers native mosquitoes a part of the natural ecosystem in the National Wildlife Refuge System habitats in which they occur. Mosquito populations on Refuge lands would continue to be allowed to fluctuate and function unimpeded unless they pose a threat to human health. Mosquitoes inhabiting the Refuge's aquatic habitats are native invertebrates that provide a forage base for fish and wildlife, including migratory birds and anadromous fish. Therefore, mosquito management planning for a national wildlife refuge must consider protecting natural resources as well as protecting public health. The Service relies on public health authorities and mosquito control organizations to determine the risks and threats to public health related to mosquito-borne pathogens and to advise us on management actions to minimize these risks.

Mosquito control activities may include prevention practices, habitat management actions, biological controls, and chemical treatments. The Service will identify acceptable control strategies with a Mosquito Management Plan (MMP). An MMP is necessary to ensure that mosquito management activities on the Refuge are compatible with the establishing purposes of the Refuge. Mosquito management planning provides the Service with the opportunity to assess the impacts of mosquito management activities and helps to ensure the protection of natural resources. The MMP serves as an important tool to communicate with the community and provides common understanding of acceptable and permitted mosquito management strategies among the health authority, mosquito control organization, and Refuge staff.

Effects Specific to Alternative 1

Under the No Action Alternative, breeding habitat for mosquitoes would remain unchanged from existing conditions. Mosquitoes would continue to use perennially wet areas of the Refuge during the spring and summer seasons within the vegetative areas of Wapato Creek, drainage channels, and beaver ponds. Adult mosquitoes would continue to occupy the dense vegetation and forest areas available on and around the Refuge, including nearby private lands. The mosquito population density during a given year would be dependent on climate, weather patterns, and water level manipulations.

Effects Specific to Alternative 2

Given the hydrologic conditions, much of the lake would support a lacustrine wetland system. The portion of the lake within this lacustrine zone, typified by deeper, open water and minimal vegetation, would support below average mosquito production.

The portions of the lakebed where emergent vegetation is more dominant in depth zones ranging from 2 to 3 feet could support an average to below average mosquito production. The mosquito population density within this area during a given year would vary throughout the year as the Tualatin River ebbed and flowed.

The outer fringes of the lakebed, where water depths are expected to be shallower (0–2-feet range), would likely support narrow bands of multiple palustrine plant communities. Total acreage of shallow water intermixed with emergent vegetation would be influenced by multiple variables, including precipitation and Wapato Creek and Tualatin River levels. Of particular importance will be the scale of fluctuating water levels, producing floodwater mosquito habitat for portions of this area that will experience a wet and dry cycle. Current water management practices produce little to no floodwater mosquitoes (*Aedes sp.).* This zone of wet and dry cycles, along with the stagnant shallow water and combined with emergent vegetation within this area, possibly would support mosquito production by providing optimum mosquito habitat. Compared to similar habitats in the region, mosquito production activity for this area would occur between March and September. The overall mosquito population densities could result in mosquito production levels at or above averages for the region.

Effects Specific to Alternative 3 (Preferred Alternative)

Under the Preferred Alternative, the lakebed would consist largely of palustrine emergent wetlands, providing optimum mosquito habitat. Water management of the area would directly influence mosquito production activity patterns. As mentioned in Alternative 2, of particular importance would be the scale of the fluctuating water levels, producing floodwater mosquito habitat for portions of this area that would experience a wet and dry cycle. Current water

management practices produce little to no floodwater mosquitoes (*Aedes sp.).* The zones with fluctuating shorelines could be used by our region's primary floodwater mosquito *Aedes vexans*. The majority of this area would be shallow stagnant water with emergent vegetation that would presumably support mosquito production. Compared to other similar habitats in the region, typical mosquito production activity for this area would occur between March and September. The overall mosquito population densities could result in mosquito production at levels near average or above average for the region.

4.10 Neighboring Lands

Effects Specific to Alternative1

Lakebed

As a result of maintaining the existing cooperative farming program with the No Action Alternative, there would be no change to the hydrologic (or inundation) patterns that currently exist in the lakebed, resulting in a neutral effect to those private lands.

Effects Specific to Alternative 1 and 3

Non-lakebed

Under the No Action and Preferred Alternatives, pumping and levee infrastructure would remain in place. While management of the lakebed would differ between the two alternatives, there would be no change to the hydrologic (or inundation) patterns that currently exist on non-lakebed properties, resulting in a neutral effect to those neighboring properties.

Effects Specific to Alternative 2

Lakebed and non-lakebed

Under Alternative 2, there would likely be both positive and negative impacts to neighboring lands outside the lakebed. Providing more floodwater storage in the lakebed could alleviate flooding on local roads, the city park, and private lands. However, the Service has not conducted any modeling to determine the extent of those impacts beyond the lakebed footprint.

Additionally, TVID diverts water from the Tualatin River immediately northwest of Wapato Lake. They use a small flashboard dam just north of the pump station in Wapato Creek to create hydraulic head that forces water back to the south in the irrigation canals around the lake for irrigation purposes. This alternative would eliminate the separation between the exterior ditches and the lakebed. An engineered solution would be required to insure that TVID's operations are separated from the Wapato Creek-Wapato Lake connection, otherwise the potential exists for irrigation water to simply flow into the lake and be unavailable in the exterior ditches.

Effects Common to Alternatives 2 and 3 (Preferred Alternative)

Lakebed

Inside the lakebed exist 90 acres of privately owned land that would experience long-term inundation as a result of implementing the action alternatives. These properties would be inundated with water year-round as a result of restoring wetlands associated with both

Alternatives 2 and 3. As discussed under Alternative 2, these properties would be inundated naturally if the Service removed the dikes and pumps and restored the lakebed's natural hydrology. If an action alternative is selected, an appropriate agreement would be sought prior to implementation, however, the Service is under no obligation to drain the lakebed to maintain artificially low summertime water levels. The Service has discussed a range of options with both landowners, if they want to consider them, that may include flowage easements, property acquisition, or land exchanges.

4.11 Water Rights

Effects Common to Alternative 1

Lakebed and non-lakebed

Water rights retained by private landowners within the lakebed (inholdings) and who own land outside the lakebed, but rely on water conveyance and drainage systems under the operation of TVID would not be affected. Landowners along Wapato and Ayers Creeks would continue to exercise their existing water rights under the delivery authority of TVID.

Effects Common to Alternative 2

Non-lakebed

Water rights retained by private landowners who own land outside the lakebed, but rely on water conveyance and drainage systems under the operation of TVID would not be affected. An engineered solution could be required; however, to ensure that TVID's operations are separated from the Wapato Creek-Wapato Lake connection; otherwise the potential exists for irrigation water to back flow into the lake during summer months, potentially reducing the amount of water available in the exterior ditches for irrigation.

Effects Specific to Alternative 3 (Preferred Alternative)

Lakebed

Under this alternative, the Service may be required to obtain a reservoir permit from the Oregon Water Resources Department (OWRD) to legally store water in the lakebed. The storage rights would authorize the Service to retain the water collected in the lakebed between November and March (namely as a result of precipitation), and use it to meet wetland management objectives.

A water storage right is required by the OWRD anytime water is stored in a reservoir regardless of the source of that water. While the Service does not consider Alternative 3 a reservoir, from an OWRD regulatory standpoint, the presence of the artificial dam associated with the pumps and the levee system may trigger the reservoir designation. Alternative 2 would not require a storage permit because as a result of restoring full connectivity between Wapato Lake and the Tualatin River no impediments would exist preventing water flowing from Wapato Lake to downstream users.

Effects Common to Alternatives 2 and 3 (Preferred Alternative)

The inholding at the southern end of the lakebed utilizes an electric pump, as well as remnant WID infrastructure in the lakebed, to irrigate their nursery operation upslope of Wapato Lake (outside of

the lakebed). Water is delivered from their point of diversion on the exterior of the lakebed levees to an interior lakebed ditch. The pump is then used to move water from the ditch to irrigate the nursery. To continue this operation, the point of diversion and pump station may need to be relocated under alternatives 2 and 3, because the pump would be inaccessible and water would no longer be delivered through the existing point of diversion. The Service is currently working with the landowner on the pump/irrigation issue concurrently with real property negotiations.

4.12 Economics

Effects Common to all Alternatives

The Service would continue to acquire lands from willing sellers within the established acquisition boundary. Fee title lands under management of the Service would continue to be subject to revenue sharing payments to Washington and Yamhill Counties.

Effects Specific to Alternative 1

Lakebed and Non-Lakebed

The No Action Alternative would result in a neutral effect to the local economy. Under the No Action Alternative, the Service would continue to make annual payments to Washington and Yamhill Counties, and the cooperative farming program would continue for wildlife management purposes.

Effects Common to Alternatives 2 and 3 (Preferred Alternative)

Lakebed and Non-Lakebed

Construction associated with Alternatives 2 and 3 restoration actions would require construction crews, logistical support (such as food and lodging), materials, and other products. Sources have yet to be determined, but some crews and materials would be from the local area, thus increasing local revenue generation. Out-of-town staffing would require local support services, also increasing local revenue. The restoration of the lakebed and non-lakebed properties to native Willamette Valley habitats would require that current agricultural practices cease. If future Refuge planning efforts result in an increase in public access and recreational opportunities, there could be a greater attraction to Wapato Lake by individuals seeking wildlife-dependent recreational opportunities not currently available. These additional visitors could potentially generate additional revenue to the local economy. Proposals for future wildlife-dependent recreation would be analyzed according to NEPA.

Ceasing annual farming operations that are associated with lakebed and non-lakebed properties would have a minor long-term negative effect on the local economy (e.g., reduced crop yields, fewer purchases associated with agricultural work).

4.13 Land Use

Effects Specific to Alternative 1

Lakebed and Non-lakebed

The No Action Alternative would have a neutral effect on land use, because the Service would maintain the status quo and continue to cooperatively farm lakebed and non-lakebed properties.

Effects Common to Alternatives 2 and 3 (Preferred Alternative)

Lakebed and Non-lakebed

Both action alternatives would have an impact on the land use of the area. As the Service transitions lands from agricultural use to native habitats for fish and wildlife resources, this action would have minor negative impacts to agricultural land use, but a minor beneficial effect to open space and wildlife-dependent recreational and educational land use in the area, subject to future NEPA analysis.

4.14 Transportation, Rights-of-Way, and Easements

Effects Common to All Alternatives

Lakebed and Non lakebed Roads

Under all alternatives, effects to Hwy 47, Flett Road, and Springhill Road would be neutral. Flooding patterns would remain the same and no alterations to these roads would be proposed.

Easements

Under all alternatives, there would be a neutral effect to the existing access easement which provides ingress and egress for the landowner of the approximately 30-acre inholding in the center of the lakebed, because the easement would remain in place. Additionally, there would be a neutral effect associated with the approximately 35-acre non-lakebed conservation easement on the east side of the lakebed. While the Service has permitted farming on the property as an interim weed management tool, the conservation easement is intended to facilitate restoration actions on the property.

Bridges

Under all alternatives, Service-owned bridges that provide access to Wapato Lake need to be replaced or repaired. Two bridges will be replaced in 2019.

4.15 Soundscape

Effects Specific to Alternative 1

Under the No Action Alternative, no changes to the soundscape on or near the project area would occur. Sounds associated with the cooperative farming operations would continue indefinitely.

Effects Common to Alternatives 2 and 3 (Preferred Alternative)

Both Alternatives 2 and 3 would result in short-term impacts to the local soundscape from construction activities involving heavy equipment to conduct restoration activities. However, work would be seasonal in nature and confined to average weekday hours. Although minor, cessation of farming would result in a minor long-term reduction in noise during the summer and early fall.

Chapter 5

Cumulative Effects

5.1 Introduction

Cumulative effects can result from the incremental effects of a project when added to other past, present, and reasonably foreseeable future projects in the area. Cumulative impacts can result from individually minor but cumulatively significant actions over a period of time. This analysis is intended to consider the interaction of activities at the Refuge with other actions occurring over a larger spatial and temporal frame of reference.

The Council on Environmental Quality (CEQ) regulations for implementing the provisions of the National Environmental Policy Act define several different types of effects that should be evaluated in an Environmental Assessment, including direct, indirect, and cumulative effects. Direct and indirect effects are addressed in the resource-specific sections of this draft EA. This section addresses cumulative effects.

CEQ (40 CFR 1508.7) (CEQ 1997) provides the following definition of cumulative effects as:

The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.

It should be noted that the cumulative effects analysis has essentially been completed by virtue of the comprehensive nature by which direct and indirect effects associated with implementing the various alternatives were presented. The analysis in this section primarily focuses on effects associated with reasonably foreseeable future events and/or actions regardless of what entity undertakes that action.

5.2 Cumulative Effects Associated with the Preferred Alternative

The area considered in the evaluation of the Preferred Alternative's contribution to cumulative effects is the Tualatin River watershed (Fig. 11). The Tualatin River watershed drains 712 square miles and ranges from densely populated areas of southwest Portland, Hillsboro, Tigard, and Beaverton to agricultural areas near Scholls, Gaston, Banks, Mountaindale, and North Plains to the forests of Oregon's Coast Range, Tualatin Mountains, and Chehalem Mountains. Set within a growing and thriving metropolitan area and a large temperate rain forest, the Tualatin River watershed is at the center of a dynamically changing region of the country. Its lowlands, historically and still prevalently agricultural, are giving way to increased residential and industrial development. As the population and economic base of the region has grown, stresses on the Tualatin River watershed have increased (Tualatin River Watershed Council 1999). Most of the

fast-growing urban population—more than 560,000 residents—resides in 15 percent of the watershed's area. Agricultural uses make up 35 percent, and 50 percent of the watershed is forest (Clean Water Services). The population is expected to increase from 455,000 in 2005 to 700,000 by 2040 (Tualatin Soil and Water Conservation District).

The watershed has been used and modified by humans for some 6,000 years (Cass 1993). Indigenous people inhabiting the watershed harvested plant and animal resources for subsistence

and modified the landscape to enhance their ability to exploit these resources (e.g., using fire to create open savannahs)(Cass 1993). More significant alterations to the watershed began post-European settlement circa 1850, driven by increased timber harvest activity, clearing and draining

View of Wapato Lake from Bald Peak. USFWS.

of floodplain wetlands for agricultural development, and modifications to the Tualatin River channel for navigation purposes. With increased economic opportunity came improvements to transportation and urbanization. In fact, since 1920, the rate of population growth in most of the Tualatin River watershed (primarily Washington County) has exceeded that of Oregon's as a whole during every census (Cass 1993). By 2030, the population of the greater Portland area, including the Tualatin River watershed, is expected to be as high as 3.5 million people (USFWS 2013). Population growth would continue to place stress upon the ecology of the Tualatin River watershed, both directly through elimination and indirectly through fragmentation and degradation of remaining naturally functioning ecosystems.

Although a number of natural areas have been designated and are maintained in the area by regional partners such as Clean Water Services, Metro, and the City of Hillsboro, modification and loss of functional ecological systems continue at a regional scale. A clear trend of regionally increasing population growth is bringing increased development and associated ecological degradation, particularly in the greater Portland metropolitan area. Invasive species and altered ecosystem processes are widespread within the area. Within this context, region-wide biological integrity may be at risk. While implementation of the Preferred Alternative would improve the value of Refuge lands and waters for a wide variety of native wildlife at a local and watershed scale, it would also result in minor adverse economic effects at a local scale as a result of ceasing the cooperative farming program. These effects represent less than significant impacts to the biological and human environment in the context of the landscape changes that have occurred, and would occur, within the watershed.

A separate EA will include plans for compatible wildlife-dependent recreational use, but because that EA has yet to be developed, it is not possible to anticipate the type of recreational use and its resulting cumulative effects in the basin.

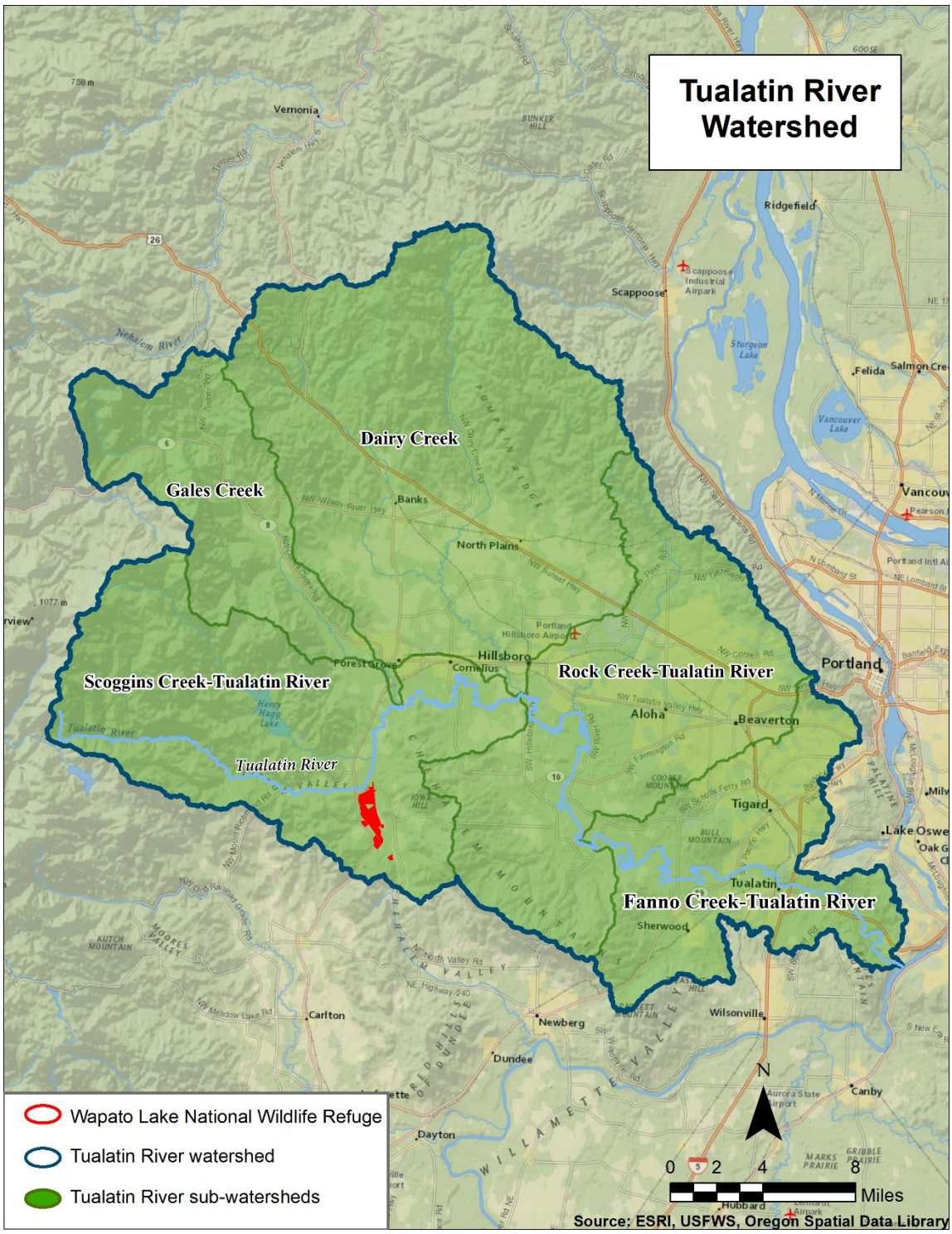

Figure 11. Tualatin River Watershed.

5.3 Potential Effects from Climate Change

According to the Climate Impacts Group at the University of Washington, "even subtle changes in Pacific Northwest precipitation and temperature have noticeable impacts on the region's mountain snowpack, river flows and flooding, the likelihood of summer droughts, forest productivity and forest fire risk, salmon abundance, and quality of coastal and near-shore habitat" (Climate Impacts Group 2011). Warming is expected to affect a variety of natural processes and associated resources. However, the complexity of ecological systems and interactions means that there is tremendous uncertainty about the exact effect climate change would have. In addition, localized effects still require more research (Parmesan et al. 2011). The following paragraphs attempt to identify the key potential effects of climate change on Refuge-specific habitats and plants and wildlife, using the available science and projections, combined with awareness of Refuge-specific conditions. By necessity this brief assessment is incomplete and all projected effects should be treated as hypotheses and tested over time using scientific methods.

Vegetation models indicate that in western Oregon, areas of mixed evergreen and subtropical mixed forest are projected to expand, marking a major transition from temperate to subtropical species (Oregon Climate Change Research Institute [OCCRI] 2010). Pests and diseases would continue to expand northward into Oregon, affecting forest species (Waring et al. 2011). Mountain pine beetle occurrence has been increasing over the last 8 years and would likely continue to increase in a warmer climate, along with forest pathogens. Drought also increases vulnerability to mountain pine beetle. Other pests and diseases, including sudden oak death, have been spreading northward from California into southwestern Oregon since the beginning of the twenty-first century. In the case of sudden oak death, extreme precipitation events tend to infect more trees, which then become more vulnerable to mortality during droughts. Generally, insects and diseases would expand northward in latitude, toward the coast, and upward in elevation in a warming climate.

Wildfires would likely increase in all Oregon forest types in the coming decades. Warmer and drier summers leave forests more vulnerable to fire, while wetter winters provide abundant fuel in the form of grasses and shrubs. Wildfire frequency in western forests increased fourfold during 1987–2003 compared to 1970–1986, while the total area burned increased sixfold (Westerling et al. 2006). Westerling et al. (2006) demonstrated that earlier snowmelt dates correspond to increased wildfire frequency. Trouet et al. (2006) confirmed that these increases in area burned are tied to climate conditions, despite forest suppression management practices such as thinning. As shown above, virtually all climate model projections indicate that warmer springs and summers would occur over the region in coming decades. Prolonged dry and hot periods are generally required for large fires (Gedalof et al. 2005), and future conditions would likely make these periods, and resultant wildfires, more likely.

Climate change effects on species' ranges, phenology, and physiology have been well documented (Lovejoy and Hannah 2005, Parmesan 2006, Rosenzweig et al. 2008, Schneider and Root 2002). Fish and wildlife in the Willamette Valley include both migratory and resident species. There is evidence that the abundance and distribution of species are shifting in response to climate change, and would shift more rapidly as habitats on land and in water are altered due to increasing temperatures and related environmental changes (OCCRI 2010). Among the observed species changes:

- Insects are moving in from the south of Oregon
- Frogs are reproducing earlier in the year

- Landbirds are shifting their distributions northward and migrating earlier
- Fish are losing their cool-water habitats

Rising temperatures, shifts in precipitation patterns, and other climatic change may also affect other ecological interactions, such as densities of species; timing of events such as spring flowering times, emergence timing, patterns for insect and pollinator species, egg laying, and migration; changes in morphology, such as body size and behavior; and changes in genetic frequencies such as those caused by a disruption in the connectedness among species (Root et al. 2003). These changes can unfold in complex cascading direct and indirect effects such as those described by Martin and Marin (2012). The Refuge's wetland, riparian, and aquatic species are perhaps the most vulnerable to these effects (Lawler et al. 2008).

However, predicting biological response at the population level is difficult (Akcakaya et al. 2006, Pereira et al. 2010). In a warmer climate, plant and animal species may respond by occupying different parts of the landscape. Rare or endangered species may become less abundant or extinct; insect pests, invasive species, and harmful algal blooms may become more abundant. Declines in abundance of species may be caused directly by physiological stress related to changes in temperature, water availability, and other environmental shifts, and indirectly by habitat degradation and negative interactions with factors that are benefited by climate change (diseases, parasites, predators, and competitors). It remains difficult to model how species' range and population abundance (increasing or declining) can be projected from a suite of interrelated climate-related variables (Fordham et al. 2012). Researchers are improving models, and the Refuge would evaluate the results of a new Willamette Valley vegetative and species response model currently being undertaken by the University of Washington (led by Dr. Josh Lawler and funded by the North Pacific Landscape Conservation Cooperative).

The increase of invasive species risk is due to a variety of reasons. For example, invasive species have a broader climate tolerance and larger geographic ranges, along with characteristics that favor rapid range shifts. Also, climate change may alter transport and introduction mechanisms, establish new invasive species, alter the impact of existing invasive species, and affect other risk factors (Hellmann et al. 2008, Rahel and Olden 2008, Willis et al. 2010). One example that would affect Wapato Lake NWR is the potential population growth of nutria. Nutria are currently at a nuisance level at the Refuge in terms of physical damage to embankments and vegetation, but with milder winters projected, they may become more abundant and more disruptive to water management, recreation access, and native species conservation.

The good news is that hotter and drier summers generally favor fire-adapted communities such as Willamette Valley prairie and savanna communities (Bachelet et al. 2011). Bachelet et al. (2011) also found that:

> *Many of the aggressive exotic species that occur in both wet and dry prairies in the western Pacific Northwest currently have wide range distributions in the U.S. (Dennehy et al. 2011), so it is reasonable to assume that they will be relatively adaptable to changing climate.*
>
> *Consequently, they may provide even more of a competitive challenge to native Pacific Northwest prairie species in the future than they do currently. However, as we mentioned above, many native prairie species are well adapted to summer drought, which could give them an advantage over many exotic species as summer drought extends and intensifies . . .*
>
> *Directly relevant to the future of prairies and oak savannas, Shafer et al. (2001) showed significant contraction of the range of Garry oak [Oregon White Oak] on the west side of the*

Cascades and a shift and expansion to the east side of the mountains by the end of the 21st century. However, a recent study conducted by Bodtker et al. (2009) found that climate suitability for Garry oak is likely to improve overall in Washington, Oregon, and British Columbia, where it is the dominant oak species, with some declines in specific areas . . .

The effects of warming on grasslands have also been experimentally studied by a variety of scientists who focused on plant community structure, productivity, or phenology . . . Findings include: warming often causes a decrease in plant biodiversity (Zavaleta et al. 2003; Klein et al. 2004; Walker et al. 2006), while species-specific effects are mediated through changes in litter quantity (Weltzin et al. 2001; Klein et al. 2004; Weltzin et al. 2005; Suttle et al. 2007) and nutrient availability (Shaver et al. 2000; De Valpine and Harte 2001; Rustad et al. 2001, An et al. 2005; Suttle et al. 2007). Pfeifer-Meister and Bridgham (2007) showed strong seasonal controls of temperature and moisture on carbon and nutrient cycling in a Willamette Valley/Puget Trough/Georgia Basin prairie, with competition between native and exotic species mediated by moisture and nutrient availability (Pfeifer-Meister et al. 2008).

A recently completed vulnerability assessment for the Willamette Valley provides an analysis of effects to many species and habitats managed by the Refuge (Steel et al. 2011). A summary of the findings is excerpted here:

Of the 46 species and subspecies assessed, the four most vulnerable to climate change were Coastal Cutthroat Trout (Southwest Columbia River ESU; Oncorhynchus clarkii pop. 2), Chinook Salmon (Lower Columbia River ESU, Fall Run; Oncorhynchus tshawytscha pop. 22), Way-side Aster (Aster vialis), and Fender's Blue Butterfly (Icaricia icarioides fendereri).

Among the species assessed, invertebrates, fishes, and plants tended to be the most vulnerable groups on average. The ecological parameters that most contributed to climate change sensitivity were inferred limitations in temperature tolerance, negative response to disturbance regimes, dependence on current precipitation/hydrologic regimes, dependence on specific habitat attributes, and dependence on cooler microsites within habitats.

When analyzing Conservation Opportunity Areas (COAs), the authors focused on climate sensitivity and overall vulnerability. The Tualatin River is ranked as a highly vulnerable area. However, the authors also note that in many cases non-climate factors may remain more threatening to COAs than climate change.

Chapter 6

Communication, Consultation, and Coordination

6.1 Public Involvement

Table 5. Summary of public involvement and meetings.

Date	Event	Participants
November 14, 2014	Open House – public scoping	Gaston, OR and surrounding area community members and

Date	Event	Participants
		stakeholders
January 27, 2015	Restoration scoping	Mixed interagency and stakeholder organizations
March 25, 2015	Water Rights discussion	USFWS, OWRD, JWC, CWS
May 1, 2015	Informal meeting to discuss restoration planning efforts	Confederated Tribes of the Grande Ronde
August 2015	Wapato Showdown Car Show	Outreach with public in Gaston, OR
Various dates - 2015	Informal meetings to discuss restoration planning efforts	Various government agencies, non-governmental organizations, the City of Gaston, private landowners in and around Gaston
March 10th, 2016	Meeting to discuss EA	Private landowner with lakebed inholding
March 15, 2016	Review of EA process and preliminary alternatives	Mixed interagency and stakeholder organizations
August 2016	Wapato Showdown Car Show	Outreach with public in Gaston, OR
October 26, 2016	Meeting to discuss EA	Private landowner with lakebed inholding
Various dates - 2016	Informal meetings to discuss restoration planning efforts	Various government agencies, non-governmental organizations, the City of Gaston, private landowners in and around Gaston
February 15, 2017	Meeting to discuss EA	Private landowner with lakebed inholding
May 5, 2017	Announcement cards for open house mailed	General public and stakeholders
May 15, 2017	Open House for draft EA	General public and stakeholders

Date	Event	Participants
June 3, 2017	End of 30-day public comment period	General public and stakeholders
June 16, 2017	Meeting to discuss EA	Confederated Tribes of the Grande Ronde

6.2 Individuals Involved with EA Preparation

Table 6. List of preparers and reviewers

NAME	TITLE	AGENCY/ORGANIZATION
Richard Mykut	Wildlife Biologist	USFWS - TRNWRC
Erin Holmes	Assistant Refuge Supervisor	USFWS – R1
Eva Kristofik	Deputy Project Leader	USFWS - TRNWRC
Larry Klimek	Project Leader	USFWS - TRNWRC
Sarah Williams Brown	Biological Science Technician	USFWS - TRNWRC
Trevor Sheffels	Manager	USFWS – Conboy Lake NWR
Scott McCarthy	Chief, Conservation Planning	USFWS – R1
Gary Ball	Hydrologist	USFWS - R1 Water Resources
Tim Mayer	Supervisory Hydrologist	USFWS - R1 Water Resources
Steve Pilson	GIS Specialist/Hydrologist	USFWS - R1 Water Resources
Mary Lindenberg	Hydrologist	USFWS - R1 Water Resources
Erin Stockenberg	Inventorying and Monitoring Data Manager	USFWS - R1 Inventorying and Monitoring Program
Kevin O'Hara	Conservation Planner	USFWS - R1 National Wildlife Refuges
Nicole McCarthy	Conservation Planner	USFWS - R1 National Wildlife

NAME	TITLE	AGENCY/ORGANIZATION
		Refuges
Bridgette Flanders-Wanner	Regional Refuge Biologist	USFWS - R1 National Wildlife Refuges
Joe Engler	Regional Refuge Biologist	USFWS - R1 National Wildlife Refuges
Chris Lapp	Project Leader	USFWS – Ridgefield NWRC
John Goetz III	Water Resources Project Manager	Clean Water Services
Carol Murdock	Water Resource Program Manager	Clean Water Services
Joe Rutledge	Water Manager	Tualatin Valley Irrigation District
Nick Valentine	Archaeologist	USFWS - R1 Cultural Resources
Virginia Parks	Archaeologist	USFWS - R1 Cultural Resources
Don VandeBergh	District Wildlife Biologist	ODFW
Mark Nebeker	Sauvie Island WA Manager	ODFW
Ken Carver	Mosquito Control Coordinator	Washington County - Public Health
Curt Zonick	Senior Natural Resource Scientist, Parks and Nature	Metro
Peter Guillozet	Senior Natural Resource Scientist, Parks and Nature	Metro
Ryan Ruggiero	Real Estate Negotiator, Parks and Nature	Metro
Kristel Griffith	Water Resources Program Coordinator	Joint Water Commission
Steward Rounds	Team Lead - Hydrologist	USGS - Water Resources
Dr. John Christy	Wetland Ecologist	Portland State University

6.3 Tribal Coordination

Coordination with the Confederated Tribes of the Grand Ronde (CTGR) has occurred informally over the past several years. On May 1, 2015, Refuge staff met with CTGR staff at Wapato Lake to discuss restoration planning. In January 2015, the Refuge invited the Cultural Protection Program of the CTGR to participate in an interagency meeting that was hosted on 01/27/15. While they were unable to attend this meeting, they later met with Refuge staff for a discussion about lakebed restoration planning efforts (May 1, 2015). CTGR was also invited to participate in the 2nd interagency meeting held on 03/15/16, as well as the public meeting on 05/15/17. In both instances CTGR staff were unable to attend. Refuge staff met with CTGR staff on 06/16/17 to discuss the EA.

Chapter 7

References

Akcakaya, H.R., S.H.M. Butchart, G.M. Mace, S.N. Stuart, and C. Hilton-Taylor. 2006. Use and misuse of the IUCN Red List Criteria in projecting climate change impacts on biodiversity. Global Change Biology 12:2037–2043.

Bachelet, D., B.R. Johnson, S.D. Bridgham, P.V. Dunn, H.E. Anderson, and B.M. Rogers. 2011.Climate change impacts on western Pacific Northwest prairies and savannas. Northwest Science 85(2):411–429. http://www.bioone.org/doi/full/10.3955/046.085.0224.

Bazzaz, F.A. 1975. Plant species diversity in old-field successional ecosystems in southern Illinois. Ecology, 56, 485–488.

Beckett, D. C., T. P. Aartila, A. C. Miller (1992). Contrasts in Density of Benthic Invertebrates Between Macrophyte Beds and Open Littoral Patches in Eau-Galle Lake, Wisconsin. American Midland Naturalist, 127(1), 77–90.

Cass, P.L. 1993. The Historical Tualatin River Basin. Oregon Water Resources Research Institute, Oregon State University.

Centers for Disease Control and Prevention, Division of Vector-Borne Diseases. 2013. U West Nile Virus in the United States: Guidelines for Surveillance, Prevention, and Control. U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control and Prevention National Center for Emerging and Zoonotic Infectious Diseases, Division of Vector-Borne Diseases. Fort Collins, CO. 4th Revision, June 14, 2013.

Christy, J.A. 2015. Historical Conditions at Wapato Lake, Washington and Yamhill Counties, Oregon. Oregon Biodiversity Information Center. Institute for Natural Resources, Portland State University.

Christy, J.A., E.R. Alverson, M.P. Dougherty, S.C. Kolar, C.W. Alton, S.M. Hawes, L. Ashkenas & P. Minear. 2011. GLO historical vegetation of the Willamette Valley, Oregon, 1851–1910. ArcMap shapefile, Version 2011_04. Oregon Biodiversity Information Center, Portland State University. http://pdx.edu/pnwlamp/glo-historical-vegetation-maps-for-oregon-0.

Climate Impacts Group. 2011. Climate Impacts Group, University of Washington. http://cses.washington.edu/cig/. Accessed June 2012.

Cowardin, L.M., V. Carter, F.C. Golet, E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31. U.S. Fish and Wildlife Service: Washington, D.C.

Cox, Wendell. 2016. Population growth in the largest counties: Texas, Florida, and the South. New Geography 03/30/2016. http://www.newgeography.com/content/005204-population-growth-largest-counties-texas-florida-and-south.

Fordham, D.A., H.R. Akcakaya, M.B. Araujo, J. Elith, D.A. Keith, R. Pearson, T.D. Auld, C. Mellin, J.W. Morgan, T.J. Regan, M. Tozer, M. Watts, M. White, B.A. Wintle, C. Yates, and B.W. Brook. 2012. Plant extinction risk under climate change: are forecast range shifts alone a good indicator of species vulnerability to global warming? Global Change Biology 18(4):1357–1371.

Gedalof Z., D.L. Peterson, and N.J. Mantua. 2005. Atmospheric, climatic, and ecological controls on extreme wildfire years in the Northwestern United States. Ecological Applications, 15:154-174.

Gilmour, D.M. V. L. Butler, J. E . O'Conner, D.E. Byrd, B.J. Culleton, D.J. Kennett, and G. Hodgins. 2014. Chronology and Ecology of Late Pleistocene Megafauna in the Northern Willamette Valley, Oregon. Anthropology Faculty Publications and Presentations. Paper 95.

Haskell, O. and J. Dummer. 2010. Wapato Area Pipeline Project Concept. Clean Water Services Draft Technical Memorandum.

Hawksworth, J.T. 2000. Upper Tualatin-Scoggins Watershed Analysis. Washington County Soil and Water Conservation District.

Hellmann, J.J., J. Byers, B.G. Bierwagen, and J.S. Duke. 2008. Five potential consequences of climate change for invasive species. Conservation Biology 22(3):534–543.

Kasch, M. and T. Dupuis. 2016. Wapato Lake Restoration Alternatives and Risk of Harmful Algae Blooms; Technical Memorandum To: Clean Water Services. Joint Water Commission. U.S. Geological Survey

Lawler, J.J., M. Mathias, A. Yahnke, and E. Girvetz. 2008. Oregon's biodiversity in a changing climate. Prepared for the Climate Leadership Initiative, University of Oregon. University of Washington. Seattle, WA. 55 pp.

Lewis, Meriwether, William Clark, et al. March 29, 1806. The Journals of the Lewis and Clark Expedition. Ed. Gary Moulton. Lincoln: U of Nebraska Press. 2002. The Journals of the Lewis and Clark Expedition. 2005. U of Nebraska Press / U of Nebraska-Lincoln Libraries-Electronic Text Center. 5 Oct. 2005. https://lewisandclarkjournals.unl.edu/item/lc.jrn.1806-03-29#lc.jrn.1806-03-29.02.

Lovejoy, T.E. and L. Hannah, eds. 2005. Climate change and biodiversity. New Haven, CT: Yale University Press.

Martin, T.E. and J.L. Marin. 2012. Climate impacts on bird and plant communities from altered animal-plant interactions. Nature Climate Change 2:195–200.

Morlan, J. C., E. F. Blok, J. Miner, and W. N. Kirchner. 2010. Wetland and Land Use Change in the Willamette Valley, Oregon: 1994 to 2005. U.S. Fish and Wildlife Service, Portland, Oregon, and Oregon Department of State Lands, Salem, Oregon.

Nelms, K.D. 2007. Wetland Management For Waterfowl Handbook. Natural Resource Conservation Service, Mississippi River Trust, and U.S. Fish and Wildlife Service.

Miller R.L., M.S. Fram, R. Fujii, G. Wheeler. 2008. Subsidence reversal in a re-established wetland in the Sacramento-San Joaquin Delta, California, USA. San Francisco Estuary and Watershed Science 6(3): article 1.

Morrison III, W.R. and P.J. Bohlen. 2010. Influence of Vegetation on Invertebrate Communities in Grazed Freshwater Wetlands in South-Central Florida Southeastern Naturalist 9(3):453–464.

Oregon Agricultural Statistics Service 2012–2013. OSU Extension Service, Oregon Agricultural Information Network.

OCCRI (Oregon Climate Change Research Institute). 2010. Oregon climate assessment report. In:

K.D. Dello and P.W. Mote, eds. Oregon climate assessment report. College of Oceanic and Atmospheric Sciences, Oregon State University. Corvallis, OR. http://www.occri.net/OCAR.

Oregon Department of Environmental Quality (DEQ). 2011c. Oregon air quality data summaries. http://www.deq.state.or.us/aq/forms/2010annualReport.pdf.

Oregon Department of Fish and Wildlife. 2008. ODFW Sensitive Species List. Salem, OR.

Oregon Department of Fish and Wildlife. 2016. Oregon Conservation Strategy. Salem, OR.

Parmesan, C. 2006. Ecological and evolutionary responses to recent climate change. Annual Review of Ecology, Evolution, and Systematics 37(1):637–669.

Parmesan, C., C. Duarte, E. Poloczanska, A.J. Richardson, and M.C. Singer. 2011. Overstretching attribution. Nature Climate Change 1:2-4 doi:10.1038/nclimate1056.

Pereira, H.M., P.W. Leadley, V. Proenca, R. Alkemade, J. P.W. Scharlemann, J.F. Fernandez-Manjarrés,

M.B. Araújo, P. Balvanera, R. Biggs, W.W.L. Cheung, L. Chini, H.D. Cooper,E.L. Gilman, S. Guénette,

G.C. Hurtt, H.P. Huntington, G.M. Mace, T. Oberdorff, C. Revenga, P. Rodrigues, R.J. Scholes, U.R. Sumaila, M. Walpole. 2010. Scenarios for global biodiversity in the 21st century. Science 330:1496-1501.

Rahel, F.J. and J.D. Olden. 2008. Assessing the effects of climate change on aquatic invasive species. Conservation Biology 22(3):521–533.

Root, T.L., J.T. Price, K.R. Hall, S.H. Schneider, C. Rosenzweig, and J.A. Pounds. 2003. Fingerprints of global warming on wild animals and plants. Nature 421:57–60.

Rosenzweig, C., D. Karoly, M. Vicarelli, et al. 2008. Attributing physical and biological impacts to anthropogenic climate change. Nature 453:353-357.

Rounds, S.A., K.D. Carpenter, K.J. Fesler, and J.L. Dorsey. 2015, Upstream factors affecting Tualatin River algae—Tracking the 2008 Anabaena algae bloom to Wapato Lake, Oregon: U.S. Geological Survey Scientific Investigations Report 2015–5178, 41 p., http://dx.doi.org/10.3133/sir20155178.

Rounds, S.A., T.Z. Freed, D.T. Snyder, C.D. Smith, M.C. Doyle, H. Holmes, R.C. Mykut, T. Mayer, M.K. Lindenberg, E. Stockenberg, and S. Pilson. 2016. In prep. Restoration Planning Using Water-Budget Tools for the Wapato Lake National Wildlife Refuge, Oregon.

Schneider, S.H. and T.L. Root, eds. 2002. Wildlife responses to climate change, North American case studies. Washington, D.C.: Island Press.

Steel, Z.L., M. Wilkerson, P. Grof-Tisza, and K. Sulzner. 2011. Assessing species and area vulnerability to climate change for the Oregon Conservation Strategy: Willamette Valley Ecoregion. Prepared for the Oregon Department of Fish and Wildlife and the Defenders of Wildlife.

Conservation Management Program, University of California, Davis.

Tenth annual report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1888–89, by J. W. Powell, Director. xxx + 822 pp., 54 pls., 1291 figs., 116 small unnumbered cuts. 1893 [1894].

Tews, J., U. Brose, V. Grimm, K. Tielbörger, M.C. Wichmann, M. Schwager, and F. Jeltsch. 2004. Animal species diversity driven by habitat heterogeneity/diversity: the importance of keystone structures. Journal of Biogeography 31 (1); 79–92.

The Intertwine Alliance. 2012. Regional Conservation Strategy for the Greater Portland-Vancouver Region. A. Sihler, ed. The Intertwine Alliance, Portland, OR. www.theintertwine.org.

Trouet, V., A.A. Taylor, A.M. Carleton, and C.M. Skinner. 2006. Fire-climate interactions in forests of the American Pacific Coast. Geophysical Research Letters 33:L18704.

Tualatin River Watershed Council. 1999. Tualatin River Watershed Action Plan.

U.S. Department of Agriculture. 2012. National Agricultural Statistics Service Census of Agriculture, County Profile, Washington County, OR.

U.S. Department of Agriculture. 2012. National Agricultural Statistics Service Census of Agriculture, County Profile, Yamhill County, OR.

U.S. Fish and Wildlife Service. 2016. Draft Handbook for Mosquito Management on National Wildlife Refuges.

U.S. Fish and Wildlife Service. 2014. Tualatin River National Wildlife Refuge Complex, Total Maximum Daily Load Implementation Plan. Sherwood, OR: Tualatin River National Wildlife Refuge.

U.S. Fish and Wildlife Service. 2014. NEPA for National Wildlife Refuges, A Handbook.

U.S. Fish and Wildlife Service. 2013. Tualatin River National Wildlife Refuge, Comprehensive Conservation Plan and Environmental Assessment. Sherwood, OR: Tualatin River National Wildlife Refuge.

U.S. Fish and Wildlife Service. 2007. Tualatin River National Wildlife Refuge, Proposed Wapato Lake Unit. Land Conservation Plan and Environmental Assessment. Sherwood, OR: Tualatin River National Wildlife Refuge.

U.S. Geological Survey. 2016. West Nile Virus Human Provisional 2016 Data. https://diseasemaps.usgs.gov/mapviewer/.

Waring, R.H., N.C. Coops, and S.W. Running. 2011. Predicting satellite-derived patterns of large scale disturbances in forests of the Pacific Northwest Region in response to recent climatic variation. Remote Sensing of Environment 115:3554–3566.

Westerling A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science 313(5789):940-943. http://www.sciencemag.org/cgi/content/full/313/5789/940.

Willis, C.G., B.R. Ruhfel, R.B. Primack, A.J. Miller-Rushing, J.B. Losos, and C.C. Davis. 2010. Favorable climate change response explains non-native species' success in Thoreau's woods. PLoS One 5(1): e8878.

Maps throughout this book were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri® software, please visit www.esri.com.

Appendices

Appendix A

Summary of Comments Received on Draft EA

The draft Environmental Assessment (EA) for the Wapato Lake NWR was issued May 3, 2017, and was made available for review during a 30-day public comment period that extended from May 3 – June 3, 2017. In addition, the Service held a public meeting on May 15, 2017 to describe the alternatives that were considered and provide rationale for selecting the preferred alternative. Copies of the planning document were available at local libraries, refuge headquarters, and online. English and Spanish versions of the planning update announcing the availability of the EA and the public meeting were posted in multiple businesses in Gaston, Forest Grove and Cornelius, included as an insert to Forest Grove Pacific Gas and Electric customers, sent via e-mail to all Gaston School District families, written about in a Forest Grove News Times story, and sent via e-mail to 40 individuals representing local, state and federal government agencies, as well as non-governmental organizations.

A total of 11 responses were received from individuals and organizations, either as a letter to the USFWS or on the Public Comment Form that was distributed at the Public Meeting or found online with the EA. Some responses simply checked a box in favor of an alternative, some provided a comment on one topic, while others contained multiple comments on various topics. Six of the responses received were from the general public, while the remaining 5 were from non-profit organizations, state agencies, and local governments. Some commenters indicated the alternative that they preferred, while others expressed their comments across the variety of alternatives.

All of the comments received were considered and are organized below by subject matter with the

U.S. Fish and Wildlife Service's (USFWS's; Service's) response. Similar comments on a topic were grouped together and the Service response applies to the comments as a group.

Reconnection of Wapato Lake to the Tualatin River

Comment: Could the Service consider implementing Alternative 2 at some point in the future, including removal of the entire levee and outer ditch infrastructure?

Response: The Service may consider infrastructure removal and restoration of a more dynamic system where Wapato Lake is connected to the greater Tualatin River system at some point in the future provided that project goals could continue to be met. Variables that currently constrain implementation of Alternative 2 would need to be re-evaluated. For example, complete removal of levee and exterior canal infrastructure would require development of an alternative irrigation system that replaces use of the exterior canal and funding for implementation of the new system. As discussed in the draft EA, upgrading to a pressurized line irrigation system would be costly. Additionally, the FWS would need to assess how a new hydrologic regime would affect native plant communities that were restored with the preferred alternative. Finally, while it's possible that native wetland plant communities established under the preferred alternative could help to moderate water quality risks posed by a reconnection scenario (as discussed in the draft EA), the FWS would need to re-evaluate those risks.

Lakebed subsidence

Comment: Has the Service considered sediment dynamics and soil formation processes, including restoration of historic tributaries, to promote aggradation within Wapato Lake?

Response: Wapato Lake's soil characteristics and soil formation processes were considered for the development of the draft EA. We know that decaying plant material contributed significantly to Wapato Lake's soil characteristics and formation processes given the high peat content of the soils. The planning team did discuss possible sediment contribution from restored tributary creeks and Tualatin River flooding; however, sediment dynamics were not modeled or quantified. The planning team surmised that sediment contribution from Tualatin River flooding events in particular would be minimal given that the River does not carry a high sediment load, especially closer to the headwaters where Wapato Lake sits. We concluded that native emergent plant re-establishment would provide the best opportunity to aggrade the lake bottom and reverse some of the subsidence that has occurred over the past century.

Wildlife damage

Comment 1: Under Alternatives 2 and 3 there may be sufficient water for American beaver to re-establish themselves inside the levees causing damage to levee infrastructure.

Response: The Service recognizes the infrastructure damage that can be caused by beaver and nutria based on experiences at the Tualatin River NWR. Given that beaver and nutria are both currently present in close proximity to Wapato Lake their activities will be monitored to ensure that the integrity of levee system is not compromised.

Comment 2: As a result of implementing the preferred Alternative larger mammals like black-tailed deer and Roosevelt elk may become more prevalent and could negatively impact private lands surrounding the Refuge.

Response: As a component of the restoration, the Service will be monitoring wildlife response to restoration actions, including large mammals. In addition to quantifying wildlife response, the Service will work closely with ODFW and the local community to address potential deer and elk conflicts that may occur on private lands as a result of restoration activities.

Comment 3: To prevent invasive fish from entering Wapato Lake under Alternative 2, install netting where Wapato Lake and Wapato Creek would connect.

Response: While Alternative 2 will not be pursued, infrastructure is available that is intended to exclude undesirable fish (e.g. carp) from wetlands. Rather than netting, metal fish screens could be installed.

Comment 4: What if carp become established, will Wapato Lake be drained to control them?

Response: Lowering water levels or draining the wetland may be a viable strategy to address potential carp problems. A vegetation monitoring protocol will be developed for Wapato Lake prior to implementation of the preferred alternative that establishes a threshold for management actions to address non-native invasive plants and animals. Generally speaking, as it relates to carp, a decline in the distribution and abundance of native wetland plant communities, particularly

emergent and submerged aquatic vegetation, will be the primary trigger to implement a management action.

Nesting islands

Comment: In the deepest area of a restored lake create a small island to support bird nesting. If this is not created, humans and larger animals will disturb nesting areas.

Response: While the creation of one or multiple islands might support some waterfowl nesting, the biological benefit would be minor, and would not outweigh the financial cost of constructing a nesting island (or islands). While Wapato Lake itself may not support an abundance of waterfowl nests, it will provide optimum brood rearing habitat for ducks and geese nesting on the periphery of the lakebed or moving in from areas in close proximity to the lakebed, thus providing habitat (the lakebed) that will be inaccessible to mammalian predators. Other species guilds like secretive marsh birds (rails and bitterns) and passerines like common-yellowthroats and red-winged black birds will nest in the wetland vegetation that will be re-established with the restoration.

Water quality

Comment 1: To reduce water quality concerns under Alternative 2, drain rock could be used to improve the quality of water exiting Wapato Lake into the Tualatin system.

Response: One of the primary concerns related to water quality at Wapato Lake are harmful algal blooms. If a harmful algal bloom originated in Wapato Lake under a scenario where it was reconnected to the Tualatin, a rock filtering system would do little to prevent movement of cyanobacteria from Wapato Lake to Wapato Creek.

Comment 2: Consider a partnership with the USGS to install a permanent water quality monitoring station within the restored lake bed area. Continuous water quality monitoring would further support the overarching goals of the proposed action while also providing valuable data at a critical point of the Tualatin Basin for downstream stakeholders.

Response: Considering that water quality was a heavily weighted variable in the alternatives selection process, the installation of a monitoring station within the lakebed would further strengthen our ability to meet project water quality goals. While a monitoring station was not discussed in the EA, the Service is open to exploring a partnership with the USGS, the Joint Water Commission and Clean Water Services to discuss options and costs.

Farmland preservation

Comment: Prefer alternative 1 because Oregon is losing farmland to suburbanization of land within the Tualatin Valley. Taking Wapato Lake out of the farmland base exacerbates the problem.

Response: The USFWS is sensitive to the issue of farmland loss, however, the maintenance of farming operations would not be compatible with the Refuge's long-term goals of restoring a large permanently inundated wetland complex at Wapato Lake (which was drained to create farmland).

Levee maintenance

Comment: A request was made that the Service increase annual funding for levee maintenance to an amount greater than $5,000 for Alternative #3. At a minimum, increase in funding for preventative maintenance for the first five years of the project in order to compensate for the deferred maintenance of the levee system.

Response: The $5,000 cost estimate found in the EA would cover annual mowing and/or invasive vegetation removal on the levee system and does not account for repairing any structural degradation of the levee. Because a geotechnical investigation has not been conducted, nor any problem areas identified, such a cost estimate is difficult to project. The Service does agree with the suggestion to invest in preventative maintenance and plans to have a geotechnical investigation on the levee system conducted. To facilitate access to and improve visibility of the levee system, the Service will be working with Clean Water Services to remove Himalayan blackberry, reed-canary grass, other invasives, and any large trees prior to the start of restoration. Once the initial vegetation removal work is completed on the entire levee system (both internal and external sideslopes, as well as levee tops), it is anticipated that subsequent annual maintenance costs (e.g. mowing, herbicide treatment) will not exceed $5,000. This assumes that no structural repair work will be needed.

Comment: A discrepancy exists between the annual levee maintenance cost estimates provided in Table 1, and the following statement at the bottom of page 20, "cost estimates for any levee work havenot been formulated."

Response: The reference to not formulating any costs estimates for levee work on page 20 applied specifically to tree removal and a geotechnical investigation of the levee system. The costs shown in Table 1 refer to anticipated annual maintenance costs associated with weed management, and do not account for unforeseen levee repairs.

Water rights

Comment: The water rights analysis under Alternative #2 omitted consideration of how Wapato Lake would be managed to assure that water in the Tualatin River would bypass Wapato Lake and remain available to downstream users that are senior water right holders, or that are users of stored water released from Barney Reservoir. Also, under Alternative #2 it is unclear how USFWS could ensure that diversion under its own water rights would not exceed the allowed rate and volume.

Response: Alternative #2 did not consider a scenario where the Tualatin River would bypass Wapato Lake. The primary objective of Alternative #2 was to restore Wapato Lake's connection to the Tualatin River. If Alternative #2 would have been selected as the Preferred Alternative further analysis of possible effects to downstream water availability may have been necessary. Regarding the second question, under a scenario where the Service uses its water right for habitat and wildlife purposes, a meter could be installed at the point of diversion to measure flow.

Fertilizer and pesticides

Comment: What is the effect of fertilizer and pesticide runoff from adjacent agricultural land on the management of this wetland?

Response: Under the preferred alternative, Wapato Lake remains disconnected from the Tualatin

River and the surrounding landscape by 5+ plus miles of levee infrastructure. Due to the presence of the levees, no runoff from the surrounding landscape could enter Wapato Lake at this time.

Appendix B

Environmental Compliance

Implementing the Preferred Alternative would comply with Federal laws, regulations, and Executive Orders. The following section describes specifically how the proposed action would comply with the National Environmental Policy Act (NEPA), National Historic Preservation Act (NPHA), Endangered Species Act (ESA), and other relevant Federal laws, regulations, and Executive Orders.

National Environmental Policy Act

As a Federal agency, the Service must comply with provisions of NEPA, as amended (42 U.S.C. 4321- 4347). An environmental analysis is required under NEPA to evaluate reasonable alternatives that will meet stated objectives and to assess the possible environmental, social, and economic impacts to the human environment. This EA serves as the basis for determining whether implementation of the proposed action would constitute a major Federal action significantly affecting the quality of the human environment and it fulfills Service requirements under NEPA. This EA facilitates the involvement of government agencies and the public in the decision-making process.

Executive Order 11593: Protection of Historical, Archaeological, and Scientific Properties and The National Historic Preservation Act

Executive Order 11593 established the policy that the Federal Government shall provide leadership in preserving, restoring, and maintaining the historic and cultural environment of the Nation.

Section 106 of the NHPA (16 U.S.C. 469) requires Federal agencies to take into account the effects of their undertakings on historic properties. This includes complying with the NHPA and other cultural resource preservation laws, and consulting with the State Historic Preservation Office and appropriate Native American governments, if applicable, over any future management actions which may have the potential to affect historic properties.

Pursuant to Section 106 of the NHPA and promulgated regulations, the Service has determined the proposed action constitutes an undertaking under the NHPA (36 CFR 800.3(a)). The FWS has determined that the project should be considered a “no historic properties” outcome if the conditions provided by the Regional Archaecologist are met.

Endangered Species Act and The Magnuson-Stevens Fishery Conservation and Management Act

The ESA (16 U.S.C. § 1531 et seq.) directs all Federal agencies to work to conserve endangered and threatened species and to use their authorities to further the purposes of the ESA. Section 7 of the ESA is the mechanism by which Federal agencies ensure their actions do not jeopardize the existence of any listed species. Under Section 7, Federal agencies must consult with the Service or the National Oceanic and Atmospheric Administration’s National Marine Fisheries Service (NOAA Fisheries) when any action an agency carries out, funds, or authorizes may affect a listed endangered or threatened species.

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) provides that Federal agencies must consult with NOAA Fisheries on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect essential fish habitat (EFH). EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.

There are two ESA-listed threatened or endangered species under National Marine Fisheries Service (NMFS; NMFS 2016) and U.S. Fish and Wildlife Service (USFWS; USFWS 2018a) jurisdiction that may occur in the proposed action area (i.e. Wapato Creek); Threatened (Upper Willamette River ESU) Chinook salmon and Threatened (Upper Willamette River ESU) Steelhead. Threatened Lower Columbia River coho may be present; however, they are not ESA-listed in the Willamette Basin above Willamette Falls. Critical habitat has been designated for these species, but none occurs in the proposed action area. The Service has determined that the proposed action will have no effect on critical habitat; no effect on Threatened (Upper Willamette River ESU) Chinook salmon; and may effect, but is not likely to adversely affect Threatened (Upper Willamette River ESU) Steelhead and EFH for Threatened (Upper Willamette River ESU) Chinook salmon.

Executive Order 11988: Floodplain Management.

Executive Order 11988 requires Federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative.

According to FEMA's National Flood Hazard Layer map the majority of the proposed action area is located within the 100 year floodplain, and a small portion of the area associated with the existing pump station and northern section of levee is located in a regulatory floodway. The proposed action is consistent with EO 11988 because the proposed work (e.g. replacement of pumping infrastructure, possible re-grading of internal ditches and ultimately restoring 800 acres of lakebed wetlands and 200 acres of non- lakebed wetlands and uplands) would not alter the floodplain compared to existing conditions and reduce floodplain storage capacity.

Executive Order 11990: Protection of Wetlands

Executive Order 11990 requires Federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

The preferred alternative would require that the existing pump station and associated infrastructure at the northern end of Wapato Lake be replaced, however, replacement would occur within the footprint of the existing infrastructure, thus avoiding any new impacts to wetlands. Further, the intent of the preferred alternative is to restore 800 acres of drained and degraded wetlands. The Service is coordinating with the U.S. Army Corps of Engineers and the Oregon Division of State Lands regarding the infrastructure replacement.

Comprehensive Environmental Response, Compensation, and Liability Act and Secretarial Order 3127

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980

(CERCLA) (42 U.S.C. 9601 et seq.) requires Federal agencies to evaluate the environmental condition of property and to take remedial actions as necessary to protect human health and the environment. No hazardous wastes have ever been stored on the areas affected by the proposed action, nor have there been any accidents, spills, or other releases of hazardous wastes. No remedial actions are necessary to protect human health and the environment related to hazardous wastes.

Coastal Zone Management Act

The goal of the Coastal Zone Management Act (CZMA) is to preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone. Oregon's federally approved Coastal Zone extends from the coast inland to the crest of the coastal mountain range. The Willamette Valley, including Wapato Lake NWR, is outside Oregon's federally approved Coastal Zone and exempt from the requirements of CZMA.

Executive Order 12372: Intergovernmental Review

Executive Order 12372 was issued with the goal of fostering an intergovernmental partnership by relying on State and local processes for the coordination and review of Federal development projects. The Service initiated government-to-government Tribal coordination with The Confederated Tribes of the Grand Ronde (CTGR) in November 2014. The Service met with the CTGR on two occasions during development and release of the Draft EA to solicit their input on the proposed actions as well as to seek partnership opportunities between the Service and the CTGR at Wapato Lake NWR. Coordination and consultation with local and State governments (Washington County, Oregon Department of Fish and Widllife, OR Department of Environmental Quality, OR Department of State Lands) and other Federal agencies (US Army Corps of Engineers), has been ongoing since November 2015.

Executive Order 12898: Federal Actions To Address Environmental Justice In Minority And Low-Income Populations

All Federal actions must address and identify, as appropriate, disproportionately high and adverse human or environmental effects of its programs, policies, and activities on minority populations, low-income populations, and Indian Tribes in the United States. The proposed action would take place on vacant Refuge land. Implementing the proposed restoration would not result in displacements and would not have adverse human health or environmental effects on minority or low-income populations, Indian Tribes, or anyone else.

Wapato Lake Water Quality Monitoring Plan 2017

This plan is approved by:

Oregon Department of Environmental Quality (DEQ)

Completion of the Plan was assisted by:

Joint Water Commission (JWC)

United States Fish and Wildlife Service (USFWS)

Clean Water Services (CWS)

Executive Summary

The Tualatin River National Wildlife Refuge Complex USFWS Total Maximum Daily Load (TMDL) Implementation Plan (August 2014), referred to here as "the Implementation Plan", describes pumping rates that are designed to minimize downstream impacts on water quality. From January 1 to April 30 of each year the use of either or both of the two pumps at Wapato Lake is allowable under the Implementation Plan. Between May 1 and October 31, discharge from Wapato Lake is limited to pumping rates supplied by the smaller of USFWS's two pumps. This activity is intended to dewater the lakebed for the purposes of habitat management, which includes farming, and is generally intermittent during this time period. The Implementation Plan allows discharge by pumping to occur at a greater level between May 1 and October 31, under a DEQ approved Water Quality Monitoring Plan. If an increased pumping rate occurs, either DEQ, USFWS or the JWC may determine that the high volume of pumping appears to be contributing to water quality problems. If this has been determined, the above-mentioned parties shall work together to develop a solution which may include termination of high volume pumping. Once terminated, USFWS, DEQ, and JWC shall work together to determine when high volume pumping may resume, if necessary.

This document describes the necessary water quality monitoring, and a process for decision-making regarding the pumping rates during the May-October time frame.

Management Background

Wapato Lake is located just east of the town of Gaston, Oregon. It is a natural wetland area that was surrounded by a system of five miles of levees and dikes designed to exclude outside water influences, as well as irrigation canals and a pumphouse containing a small and large pump that allow the area to be dewatered for summer farming activities and habitat management purposes. Historically, lake water levels have been lowered by early spring using the existing two-pump system. Established in 2007 as a refuge unit, and then in 2013 as a national wildlife refuge, Wapato Lake is part of the Wapato Lake National Wildlife Refuge. This

refuge is managed by the USFWS for the purpose for the conservation of fish, wildlife, and their habitats. During the winter of 2007-2008, the dike breached, allowing the lake bed to fill with water. During the summer of 2008, the JWC experienced changes in the quality of incoming Tualatin River water that required significantly different treatment in order to produce drinking water. In addition, for the first time in many years, a bloom of blue-green algae was observed in the lower reaches of the Tualatin River in July, 2008. The source of this adverse water quality was linked to the high volume discharge at Wapato Lake.

In response to these water quality related events of 2008, DEQ assisted with the development of a Water Quality Management Plan for the Wapato Improvement District, and based the allowable rates for pumping on the existing Total Maximum Daily Loads (TMDLs) for total phosphorus, dissolved oxygen and ammonia, as well as improvements noted in water quality when the larger capacity pump was shut down in August of 2008. The Management Plan allowed high capacity discharge to occur between November 1 and April 30, and small capacity pumping to occur between May 1 and October 31. These dates align with the dates when restrictions apply in the TMDLs, and correlate with higher water levels in the watershed that offer greater dilution. The Management Plan allowed for high capacity pumping during the May-October time period only if water quality monitoring indicated that the larger volume of water released from Wapato Lake did not contribute to adverse water quality conditions.

In January of 2010, it became clear that the large pump was not functioning. Water levels in the lake continued to rise. Amid concerns that the lake would again be full and cause water quality in the lake to degrade as the warm weather returned, local partners including CWS, the JWC and the Army Corps of Engineers supplied portable pumps in order to lower the lake water level. Despite these efforts, the pumps were not capable of lowering the lake level prior to the May 1 date identified in the Management Plan. Pumping continued until June 24 and a monitoring plan was developed to ensure water quality was acceptable during that time.

In 2011, the Wapato Improvement District, which owned and managed the lakebed infrastructure dissolved and donated the assets to USFWS. While USFWS acquired the assets, it did not assume the responsibilities of the District. All management actions made by USFWS, including dewatering of the lakebed, must be in accordance to the legislative authorities of USFWS and in accordance with the Environmental Protection Agency (EPA) approved TMDL revision for the Tualatin sub-basin (2012).

In accordance with the Tualatin Subbasin TMDL revision that EPA approved on December 14, 2012 the USFWS was required to develop and submit for DEQ approval a TMDL implementation plan. In 2014, the USFWS submitted a TMDL Implementation Plan that covered both the Tualatin River National Wildlife Refuge (NWR) and the Wapato Lake NWR. This TMDL Implementation Plan was approved by DEQ in August of 2014. These TMDL documents are the current, binding documents that describe the actions that USFWS will take to implement the TMDL. These documents outline the restricted use of the larger (10,000 gpm pump) to not

exceed the April 30 date. The TMDL could allow pumping with the larger pump outside of this timeframe and the plan can be easily amended to accommodate these dates if there is a future desire to lower the lake level after large storm events in the November or December time frame or as needed during other time frames.

In February of 2016, USFWS learned that the large pump was not operational again. This created the potential for alternative pumping to take place beyond May 1 in order to drain the lake before warm weather and the peak algae bloom season. A Monitoring Plan was developed by JWC with support from USFWS, CWS and DEQ to outline water quality monitoring necessary to evaluate the impacts of the higher pumping rate on downstream users.

February of 2017 was one of the wettest on record and resulted in high water levels in Wapato Lake and delayed the ability to discharge water downstream. In April of 2017 it was recognized that use of the large pump past April 30 would be necessary to dewater the lake bed. The Monitoring Plan created in 2016 was updated for 2017.

Monitoring Background

Joint Water Commission

As part of two source water programs, JWC routinely monitors twelve locations in the Tualatin River basin including two locations at Wapato Lake and two locations on the mainstem Tualatin downstream of Wapato Lake (Figure 1). Three tributaries entering the lake were monitored from August 2014 until monitoring of these locations ended in December 2016. These monitoring programs are described in Table 1 and 2.

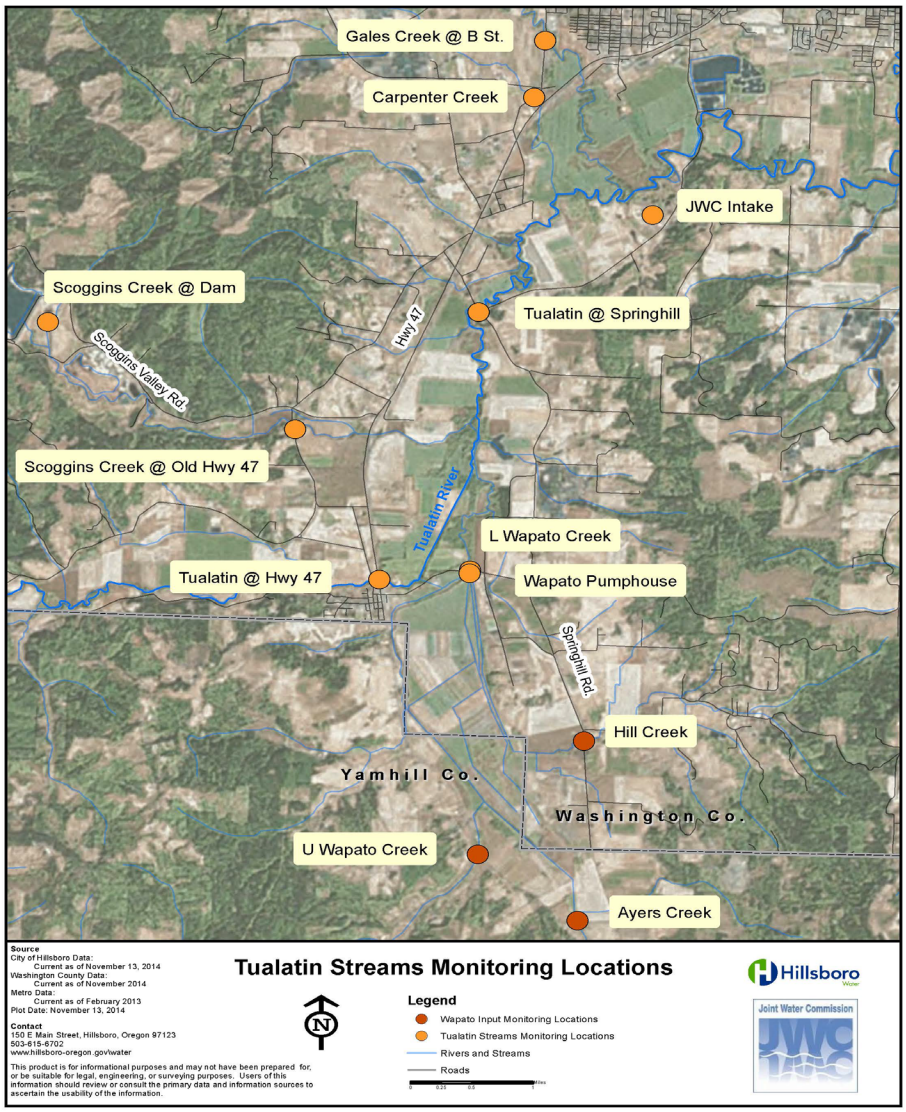

Figure 1. Map of current JWC source water monitoring locations (orange) and Wapato Inlet locations monitored for two years (red).

Table 1. JWC routine source water monitoring locations, parameters and frequency.

JWC Routine Monitoring Sites	Bimonthly Field Parameters	Quarterly Grab Sample Parameters
Tualatin River at Gaston	Temperature	Total Kjeldahl Nitrogen
Wapato Pumphouse	Dissolved Oxygen	Ammonia
Lower Wapato Creek	Conductivity	Nitrate
Tualatin River at Dilley	pH	Nitrite
Scoggins Creek at old Hwy 47	Oxidation/Reduction Potential	Total Phosphorus
Scoggins Creek at Dam	Optical Chlorophyll	Ortho-phosphate
Lower Carpenter Creek	Optical Phycocyanin	Algae speciation
Lower Gales Creek	Turbidity	Geosmin/MIB
JWC RW Intake		Total Organic Carbon (monthly)

Table 2. JWC Wapato Inlet monitoring locations, parameters and frequency.

Wapato Inlets Sites	Bimonthly Field Parameters	Monthly Grab Sample Parameters
Ayers Creek	Temperature	Algae speciation
Hill Creek	Dissolved Oxygen	Total Organic Carbon
Upper Wapato Creek	Conductivity	Total Kjeldahl Nitrogen
	pH	Ammonia
	Oxidation/Reduction Potential	Nitrate
	Optical Chlorophyll	Nitrite
	Optical Phycocyanin	Total Phosphorus
	Turbidity	Ortho-phosphate

JWC laboratory staff also collects and analyzes samples on a weekly or monthly basis at the JWC water treatment plant. Table 3 describes this monitoring, although parameters and frequency of analysis can vary. JWC water treatment plant operators also perform what is called a 2-of-5 test for taste and odor by comparing treated water samples to distilled water samples. This test is done weekly under typical water quality conditions.

Table 3. List of sites monitored by JWC lab staff. Each site is monitored for the parameters listed.

JWC Lab Monitored Sites	Weekly/Monthly Parameters
Lower Wapato Creek	Ammonia
Scoggins Creek at Dam	Ortho-phosphate
Scoggins Creek at old Hwy 47	UV 254
Lower Carpenter Creek	Total Suspended Solids (TSS)
JWC RW Intake	

Clean Water Services

Clean Water Services implements a watershed-based monitoring program for the Tualatin River basin. As part of this monitoring program, Clean Water Services monitors 27 sites in the basin including 10 sites on the mainstem Tualatin River. The mainstem Tualatin River sites include

Cherry Grove, Fernhill (below the JWC intake), Golf Course Road, and several locations in the middle and lower Tualatin River. Most sites are monitored twice per month, as conditions and staff time allow, for field parameters (temperature dissolved oxygen, pH, specific conductance, and turbidity), solids (suspended solids, dissolved solids, total solids), and nutrients. Clean Water Services also conducts monitoring for chlorophyll-a at seven sites in the middle and lower Tualatin River. Additionally, Clean Water Services conducts monitoring for metals on a quarterly basis at 17 of the 27 monitoring sites.

A USGS continuous monitoring station is installed at the Tualatin River at Dilley location. This monitoring station utilizes a YSI EXO2 sensor for monitoring the water quality parameters below.

-Temperature
-Specific Conductance
-pH
-Turbidity
-Chlorophylls
-Colored Dissolved Organic Matter (aka fDOM)
-Phycocyanins

The data from this station will be updated and available for viewing on the USGS website every two hours as well as incorporated into the data system at the JWC water treatment plant.

Monitoring Plan

High Capacity Pumping (HCP) Base Monitoring:

The locations to be monitored in relation to high capacity pumping are: Wapato Pumphouse, Lower Wapato Creek, Tualatin River at Dilley, and JWC RW Intake.

Prior to May 1, JWC routine monitoring will remain at routine levels (field parameters measured every two weeks, etc.), JWC water treatment plant operators will perform 2-of-5 odor tests weekly.

HCP Level 1 Monitoring:

Level 1 monitoring is triggered if

-High capacity pumping continues after May 1

-A visual inspection, routine monitoring or the continuous water quality monitor at Dilley detects a change in water quality prior to May 1. The visual inspection form is found at the end of this document.

- Water leaving Wapato Lake comprises greater than 15% of flow in the Tualatin River as calculated by JWC staff using pumping rates and flow measured at the USGS gauge at Dilley (Springhill Rd.)

Level 1 monitoring at Wapato Pumphouse and Lower Wapato Creek requires

- Samples collected for algae speciation and Geosmin/MIB be collected **every two weeks** along with field parameter measurements. Samples will be analyzed with a maximum turnaround time of 1 week.
- JWC lab will analyze UV 254, TSS, ammonia, and ortho-phosphate samples weekly or as conditions and staff time allow.
- Water treatment operators will perform 2-of-5 test twice a day and perform visual inspections two times per week.

HCP Level 2 Monitoring:

Level 2 monitoring is triggered if

-Level 1 monitoring detects Geosmin at or above 15 ng/L at Wapato Pumphouse

-Bluegreen algae concentrations (cells/mL) at Wapato Pumphouse are at or near the Oregon Health Authority (OHA) guidelines for Harmful Algae Blooms (HABs) (https://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Treatment/Documents/algae/HABResponseFlowChart.pdf)

-A bloom is visibly detected during a visual inspection

-Or downstream water quality is impacted as shown by the USGS water quality monitor at Dilley and/or operations at the JWC water treatment plant

Level 2 monitoring will require

- **Weekly** monitoring at Wapato Pumphouse, Lower Wapato Creek, Tualatin River at Dilley and JWC RW Intake for field parameters with algae speciation and Geosmin/MIB samples collected with rush analysis (2-3 days)
- Consideration of the addition of algal toxin suite monitoring with 2 day analysis.
- JWC lab will analyze UV 254, TSS, ammonia, and ortho-phosphate samples weekly as conditions allow.

HCP Level 3 Monitoring:

Level 3 monitoring may be triggered if

-Algae speciation results from Wapato Pumphouse or Lower Wapato Creek show concentrations of BGA species at 150% of OHA guidelines but no bluegreen algae toxins are detected and Geosmin is below 35 ng/L.

-Or downstream water quality is impacted as shown by the USGS water quality monitor at Dilley and/or operations at the JWC water treatment plant

Level 3 monitoring requires

- Monitoring as described under Level 2 be performed **twice a week** at Wapato Pumphouse, Lower Wapato Creek, Tualatin River at Dilley, JWC RW Intake and JWC Finished Water. In order for results to be received prior to the weekend sampling may need to occur Mondays and Wednesdays.
- JWC lab will analyze UV 254, TSS, ammonia, and ortho-phosphate samples weekly as conditions allow.

HCP Level 4 Monitoring:

Level 4 monitoring may be triggered if

-Bluegreen algae toxins are detected at Wapato Pumphouse or any point downstream

-Geosmin is detected above 35 ng/L at Wapato Pumphouse or any point downstream

-JWC Finished Water Geosmin is detected at or above 5 ng/L

-Or downstream water quality is impacted as shown by the USGS water quality monitor at Dilley or operations at the JWC water treatment plant

Level 4 monitoring requires

- **Daily** monitoring of field parameters, algae speciation, Geosmin/MIB and bluegreen algae toxins at Wapato Pumphouse, Lower Wapato Creek, Tualatin River at Dilley, JWC RW Intake and in the JWC Finished Water.
- JWC lab will analyze UV 254, TSS, ammonia, and ortho-phosphate samples weekly as conditions allow.

Communication and Decision Making Protocols

<u>Communication Procedures</u>

1. Schedule for water quality data circulation:

   Data will be dispersed via email weekly during Level 1 and 2 monitoring and two or three times per week for monitoring Levels 3. Data from Level 4 monitoring will be dispersed daily. Names and contact information are provided as Appendix A to this Plan.

2. Consultation Regarding Pumping Options:

   USFWS will provide information on any pumping changes via email. Decisions to alter the rate of pumping may be based on one or more factors including water quality, the ability to treat water sufficient for drinking water quality, and public safety related to

the dike and its' integrity. If it is determined that there is a potential for water quality issues, JWC will alert USFWS and DEQ and they will work in consultation with Clean Water Services, the Joint Water Commission, and any other appropriate stakeholders regarding pumping rates and timing, depending on the details of the current situation. Contact information for these agencies is included in Appendix A.

The pumping infrastructure of Wapato Lake NWR belongs to the USFWS. It is the responsibility of the Service to not impair water quality downstream of the lakebed, and this may be achieved by altering pumping rates when issues arise. Only USFWS employees may operate and access the pumps.

Decision Procedures:

The decision options apply during the May 1 through October 31 time period. Pumping may occur at a higher rate between November 1 and April 30, unless water quality problems are detected. Decision options are depicted in Figure 2, below.

High Capacity Pumping is ongoing, and Impacts are noted

DEQ, with its mandate to protect water quality, may request that the larger capacity pumps be turned off, allowing only the low capacity pump to function. This decision will be made with the USFWS and be based on either adverse or impending adverse water quality in the Wapato Canal or downstream Tualatin River that is attributed to the volume of the Wapato discharge, or it may be based on the volume of water remaining in the lake and the projected schedule for lowering water levels.

The Joint Water Commission may also make a determination that the water quality from Wapato Lake is impairing drinking water quality or treatment levels at the Fern Hill Treatment Plant. The JWC will contact the USFWS and DEQ to notify them of the water quality levels and request that pumping levels be decreased or discontinued. If there are taste and odor problems, presence of a cyanobacteria bloom, or other conditions which will immediately require additional and expensive water treatment, and DEQ is not available to order changes in the pumping rate, JWC may request that the USFWS terminate pumping with the large capacity pump(s), and the rate of pumping from Wapato Lake decreased.

High Capacity Pumping is Ongoing, and Lake is nearly dry:

USFWS and DEQ, in consultation with Clean Water Services, and the Joint Water Commission, may determine when decreasing the rate of pumping should occur for the remaining water to be pumped from Wapato Lake. As the Lake water is lowered, water pumped from the irrigation canals into Wapato Canal tends to degrade in quality, or may have a higher organic content. At this point, a decreased pumping rate may be required to protect downstream water quality levels, and drinking water treatability.

Low Capacity Pumping is Ongoing; a Stakeholder Requests High Capacity Pumping to Lower Lake Levels:

USFWS and DEQ will determine whether the higher capacity pumps may be activated, allowing pumping at the higher capacity to resume. USFWS and DEQ should consult with Clean Water Services, the Joint Water Commission, or other stakeholders or experts in water quality or dike or dam safety before allowing the high volume pumping to resume.

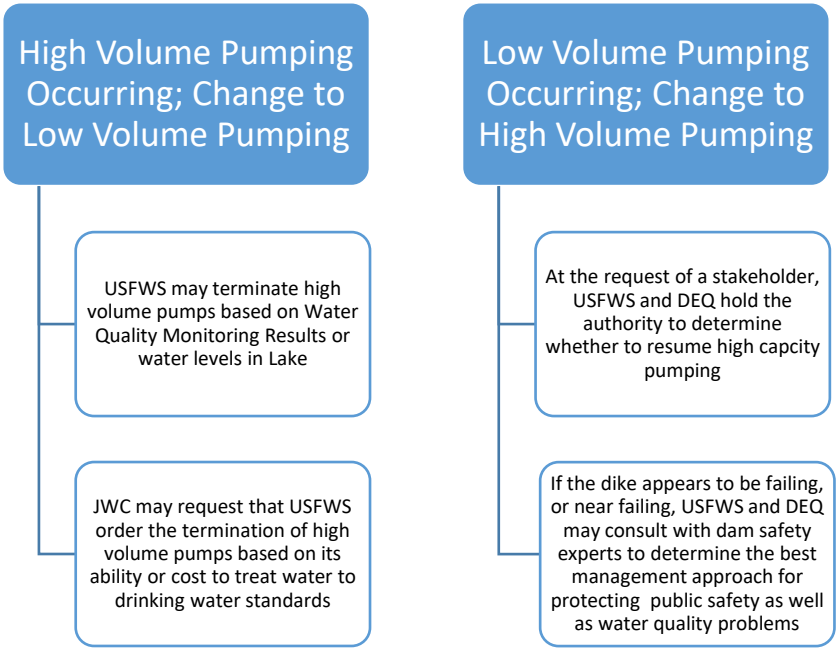

Figure 2. Depiction of responsible parties for decision making regarding pumping rates at Wapato Lake.

APPENDIX A: Contact Information

USFWS:

Larry Klimek
Refuge Manager
Voice: (503) 625-5944
Mobile: (503) 816-1227
Email: larry_klimek@fws.gov

Eva Kristofik
Deputy Project Leader
Voice: (503)625-5944
Mobile: (503)545-8431
Email: eva_kristofik@fws.gov

Curt Mykut
Restoration Biologist
Voice: (503)625-5944; x231
Mobile: (360)608-8779
Email: richard_mykut@fws.gov

DEQ:

Wade Peerman
IWRS Specialist
Voice: (503)229-5046
Email: peerman.wade@deq.state.or.us

Steve Mrazik
NWR Water Quality Manager
Voice: (503) 229-5379
Email: Mrazik.steve@deq.state.or.us

Clean Water Services:

Carol Murdock
Water Resource Program Manager
Voice: (503)681-4473
Mobile: (503)956-6859
Email: murdockc@cleanwaterservices.org

Rajeev Kapur
Water Resource Program Manager
Voice: (503) 681-4424
Mobile: (503) 703-5244
Email: KapurR@cleanwaterservices.org

Joint Water Commission:

Kristel Fesler
Water Program Coordinator
Voice: (503)615-6735
Mobile: (503)928-1445
Email: kristel.fesler@hillsboro-oregon.gov

Chris Wilson
Water Treatment Plant Supervisor
Voice: (503)615-6671
Mobile: (503)504-3713
Email: chris.wilson@hillsboro-oregon.gov

Zac Bertz
Water Treatment Plant Coordinator
Voice: (503)615-6672
Mobile: (503)758-4446
Email: zac.bertz@hillsboro-oregon.gov

Jessica Dorsey
Water Program Coordinator
Voice: (503)615-6579
Mobile: (503)735-5357
Email: jessica.dorsey@hillsboro-oregon.gov

Sophia Hobet
Treatment and Distribution Manager
Voice: (503)615-6736
Mobile: (503)983-5146
Email: sophia.hobet@hillsboro-oregon.gov

Joint Water Commission

Wapato Lake Daily Observation Form

Date: _____

Time: _____

Observers: _____

Wapato Pumpstation

Number of Wapato pumps running: ____

Color of Wapato discharge: _____

Smells / Odors: _____

Dead Fish: _____

Algal mat visible: _____

Other? _____

Fuwikara Bridge

Algal mat visible: _____

Color of water: _____

Smells / Odors: _____

Dead Fish: _____

Other? _____

Weather Factors:

Temp: _____

Sunny / Cloudy / Rainy / Windy / Foggy **(circle one)**

Wind Direction / Speed: _____

PAGE INTENTIONALLY LEFT BLANK

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Anan Raymond, Regional Archaeologist
Region 1+ Region 8 Cultural Resource Team
20555 Gerda Lane, Sherwood, OR 97140
phone:503-625-4377, fax:503-625-4887, cell:503-803-7913
email: anan_raymond@fws.gov

23 July 2019

To: Larry Klimek, Refuge Manager, Curt Mykut, Biologist
Program: Refuges
Funding: Refuges

From: Anan Raymond, Regional Archaeologist

RE: Section 106 Compliance: **Wapato Lake Restoration - Tualatin River NWR,** Washington and Yamhill County, Oregon, SHPO Case No. 19-0685

Thank you for requesting our assistance meeting the responsibilities of the U.S. Fish and Wildlife (FWS) in complying with Section 106 of the National Historic Preservation Act (NHPA) for a habitat restoration project at Wapato Lake National Wildlife Refuge (NWR) in Washington County, Oregon (T1S R4W S 35, 36; T2S R4W S1, 2, 12, 13; T2S R3W S7, 18; Gaston 7.5' USGS quad) (Figure 1).

Undertaking and Area of Potential Effect: The project is proposed on land owned and managed by the FWS. The FWS has completed a Draft Environmental Assessment (EA) for Wapato Lake National Wildlife Refuge (WLNWR) (FWS 2019) which proposes restoration of Wapato Lake and adjacent non-lakebed areas. Recently, our office assisted you in achieving Section 106 compliance for the Wapato Lake NWR - Wapato Lake Bridges and Pump Replacement project at Wapato Lake NWR. That project was an element of the current undertaking, which represents an overarching effort to restore, to the extent feasible, the composition and structure of functioning ecosystems that historically occurred in and around Wapato Lake (Figure 1).

Implementation of the Wapato Lake restoration will improve the biological integrity, diversity, and environmental health (BIDEH) of WLNWR and the surrounding landscape. In addition, the restoration project augments landscape-scale conservation efforts to address habitat loss throughout the Willamette Valley (FWS 2019:1). The Preferred Alternative aims to restore 800 acres of palustrine wetlands within the lakebed and 200+ acres of palustrine wetlands and associated uplands on non-lakebed Service lands. Restoration actions associated with the Preferred Alternative would be accomplished by re-seeding and planting native vegetation, and managing site hydrology (water levels) within the 800-acre lakebed using pumping infrastructure.

The actions described in the EA are proposed for implementation over the next 5 years, including:

- (Bridge removal and replacement and new pump station, which have been previously presented)
- Invasive plant treatment on levee infrastructure and subsequent establishment of native grasses and shrubs on levee tops and side slopes.
- Restore native wetland plant communities and lakebed hydrology
- Restore non-lakebed natural habitat (i.e. properties on exterior of lakebed levee system)

More specifically, activities will involve:

- removal of Himalayan blackberry, reed canary grass, and other invasive plants, as well native and non-native trees from the 5.25 miles of manmade levee infrastructure (comprising 56 acres) that surrounds

Wapato Lake (Figure 2). Levee clearing will be conducted using a combination of mechanical (mowing and chain saw) and chemical treatments (herbicides). Trees will be removed with chainsaws and hauled off site. Following invasive treatment and tree removal, native grasses and shrubs will be re-established on levee tops and side slopes via seeding and bare root planting, respectively.

- Restoration of the 800-acre lakebed by ceasing cooperative farming operations and subsequently re-establishing native wetland plant communities via seeding, with plugs, bare root plants, and cuttings, and restoring lakebed hydrology by retaining water in the lakebed year-round to support re-established native wetland plant communities (Figure 3).

- Restoration of 200 acres of FWS-owned land on the exterior of the lakebed levee system (referred to as non-lakebed habitat via native grass and forb seeding, and tree and shrub re-establishment with bare root plants and cuttings (Figure 4).

Detailed restoration plans have not yet been developed, but all activities will occur within the areas identified in Figures 2-4. The APE includes the physical footprint of restoration activities within the 800-acre area.

Background and Land Use History: Because of its abundant waterfowl, rich Labish soils, accessible water, and the lake's eponymous wapato root vegetable, Wapato Lake has been providing resources for people and wildlife for thousands of years. The watersheds of the Tualatin and Yamhill Rivers were home to the Atfalat'i or Tualatin Kalapuyans, sometimes referred to as the Wapato Lake Indians. The lake shore was known to be a seasonal gathering place for the bands of Kalapuyans. The environment also made the area attractive to Euro-American settlement, including Joseph Gaston, who worked to bring a railroad to the area and developed Wapato Lake as an agricultural enterprise in the 1870s. The soils of the drained lake bed have proven excellent for the production of onions throughout the 20th century. Wapato Lake NWR was established in 2007 and the FWS has been acquiring acreage within the approved boundaries. Currently, FWS owns and manages 958 acres within the 4370-acre acquisition boundary.

Cultural Resource Identification Efforts: The FWS contracted with Willamette Cultural Resource Associates, Ltd. (WCRA) to undertake a comprehensive cultural resources study of the Refuge lands to help inform and guide management planning and implementation (Paraso et al 2019). In addition to completing the phased identification effort for the Wapato Lake Drainage System (evaluation for its significance), the current study provided a context for better understanding and evaluating the cultural resources that occur or are likely to occur on the Refuge. The study included review of reports, records, and other historic documents, pedestrian survey and subsurface probing in areas identified as high probability, and inventory of all accessible portions of the drainage system.

The background research suggested that there is a high probability for precontact archaeological resources outside the APE in uplands adjacent to historic Wapato Lake bed and along natural drainages, while evidence of resource gathering on the various low water shorelines and interior of the lake (in the APE) may have been disturbed or destroyed by subsequent agricultural activity (Paraso et al 2019:35). The authors also note that the potential for evidence of homesteading is likely low, given the perpetually wet setting and long history of agriculture in the APE. The Wapato Lake Drainage System constitutes the primary representation of the farming history.

Pedestrian survey covered 325 acres in seven tracts within the APE (Figure 5) (Paraso et al 2019: Table 5, p.38). A total of 46 subsurface shovel probes were excavated, their locations prioritized by landform, expectations, extent of prior disturbance, and field conditions. As a result of the field identification effort, five new archaeological resources were identified, including 3 precontact isolates, one precontact site, and one multicomponent site with primarily precontact components (summarized in Table 7 of Paraso et al 2019:45). They provided recommendations for future work at each location in Table 8 (Paraso et al 2019:61).

In addition, they prepared a preliminary probability model that can help guide future research on the Refuge (Paraso et al 2019:63). In future, this model will be subjected to further testing and refinement.

The evaluation of the drainage system, which was proscribed during Section 106 review for the recent bridge replacement project, determined that the Wapato Lake Drainage System does not meet the criteria of significance for listing on the National Register of Historic Places (NRHP) (Paraso et al 2019:72) (Figure 6). However the authors note that the interesting history of the area could be included in public interpretation and educational materials.

Tribal Consultation: Tribal consultation was initiated by way of a memo sent via email on 1 May 2019 to the cultural resources staff of the Confederated Tribes of Grand Ronde (CTGR), the Confederated Tribes of Siletz Indians (Siletz), and Confederated Tribes of Warm Springs (CTWS). The memo included a description of the undertaking and APE and project maps as well as the cultural resources report prepared by WCRA. CTWS archaeologist responded via email on 14 May 2019 acknowledging receipt of the report and offering no additional comments. No other responses have been received to date.

SHPO Consultation: The FWS notified the Oregon SHPO of the undertaking and the APE in a memo dated 2 May 2019, and requested consultation on the definition of the APE as well as a review of the report prepared by WCRA and the proposed determination of effect. The project was assigned SHPO Case No. 19-0685.

The SHPO responded by memo dated 28 May 2019 in regard to *above-ground* resources:

> "… we concur that the Wapato Lake Drainage System is not eligible for listing in the National Register of Historic Places. We also concur that the proposed undertaking will result in no historic properties affected."

In regard to *below-ground* resources, the SHPO responded by memo dated 30 May 2019 with several questions regarding the report. FWS sent a memo dated 10 June 2019 responding point-by-point to the questions and supporting the determination of effect. No additional response has been received and the 30-day response period mandated by NHPA expired on 10 July 2019.

Determination of Effect: Because the Wapato Lake Drainage System has been determined not eligible for listing on the NRHP, restoration activities associated with the levee will have no effect on historic-era properties. Likewise, two isolates (#18-89-4-ISO and 18-89-5-ISO) are not eligible for listing on the NRHP. One archaeological isolate (two flakes and a lithic tool, #18-89-1-ISO) and one archaeological site (lithic scatter #18-89-2) were documented but not evaluated for their historic significance because they occur on private lands in the APE (conservation easement) that were not accessible for subsurface testing. A second site (multicomponent artifact scatter #18-89-3) was tested and artifacts were recovered from disturbed contexts, but it was determined to warrant further investigation to identify whether there are any intact deposits or features. Therefore the site remains unevaluated.

While detailed plans for the restoration project are still in development, the current identification effort has provided baseline data and guidelines for considering potential impacts to cultural resources. One benefit of the palustrine wetland restoration will be the presence of shallower waters which will promote widespread growth of the culturally important wapato (*Sagittaria latifolia*) (FWS 2019:64).

The FWS has determined that the project should be considered a "*no historic properties*" outcome under 36CFR800.4.d.1, the implementing regulations of the NHPA Section 106, if the following conditions are met:

- All detailed planting plans will be reviewed by FWS professional cultural resources staff to determine whether additional fieldwork or monitoring is warranted.
- In particular, planting plans will be developed to avoid documented cultural resources (Figure 7). If a specific plan is developed for the vicinity around 18-289-1-ISO, 18-89-2 or 18-89-3, additional subsurface exploration will be conducted to better define site boundaries and evaluate site significance.

- The cultural history and land use of the Wapato Lake area will be integrated into environmental education and public use programs for the Refuge.
- *Inadvertent Discovery* –The presence or absence of cultural resources can never be predicted with certainty. An Inadvertent Discovery Plan is available, detailing the procedures should human remains or significant cultural resources be uncovered during implementation of the project.
- The Refuge staff and construction contractors will be advised that if cultural resources are discovered during implementation of the undertaking, work should cease until the FWS project coordinator and the FWS regional archaeologist are notified and an assessment is conducted. If project activities change, the regional archaeologist should be notified in order to determine whether additional fieldwork is warranted.

Reference:

Paraso, Kanani, Matt Goodwin, Michael Daniels, Breanne Taylor, Donald Shannon, David Ellis
2019 A Cultural Resources Study for the Wapato Lake National Wildlife Refuge, Washington and Yamhill Counties, Oregon. Prepared by Willamette Cultural Resources Associates, Ltd., Portland, Oregon (WillametteCRA 18-89) for GHD, Lake Oswego, Oregon, and U.S. Fish and Wildlife Service.

US Fish and Wildlife Service
2019 Wapato Lake National Wildlife Refuge Draft Environmental Assessment, Washington and Yamhill Counties, Oregon. US Fish and Wildlife Service. Available at: https://www.fws.gov/refuge/wapato_lake/

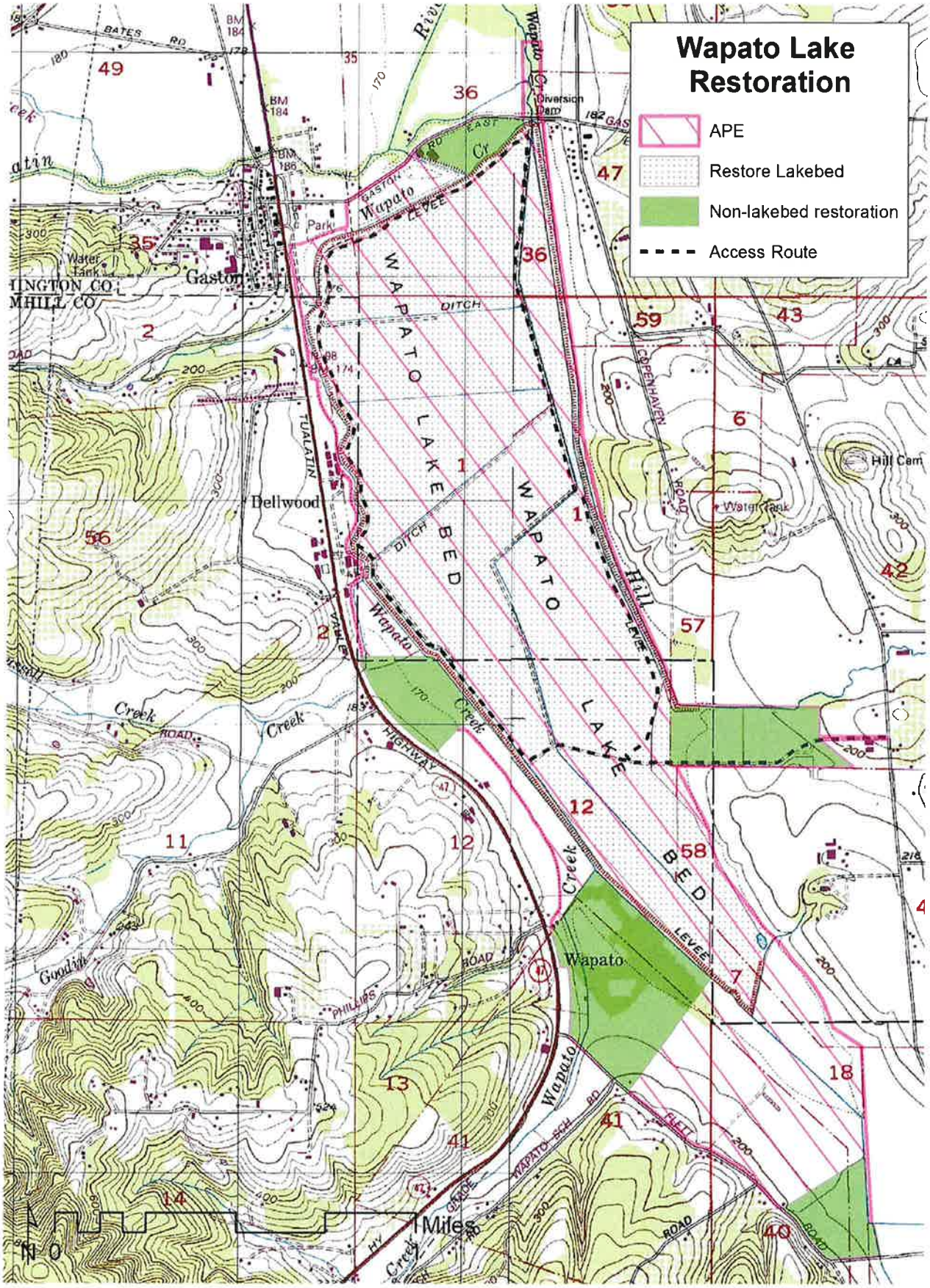

Figure 1. Project location showing all activity areas on Gaston, Laurelwood 7.5' USGS quad

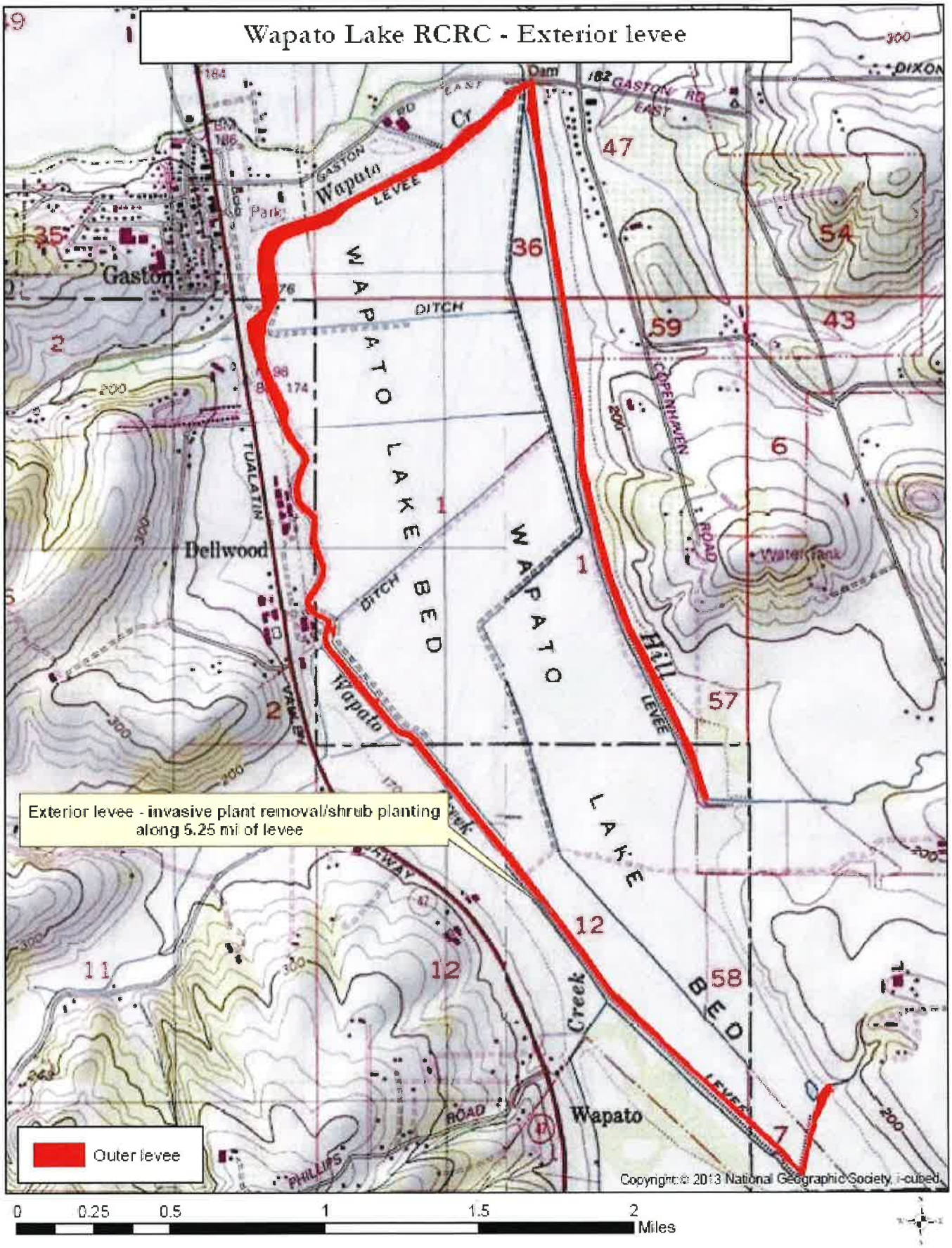

Figure 2. Location of exterior levee activities on Gaston 7.5' USGS quad.

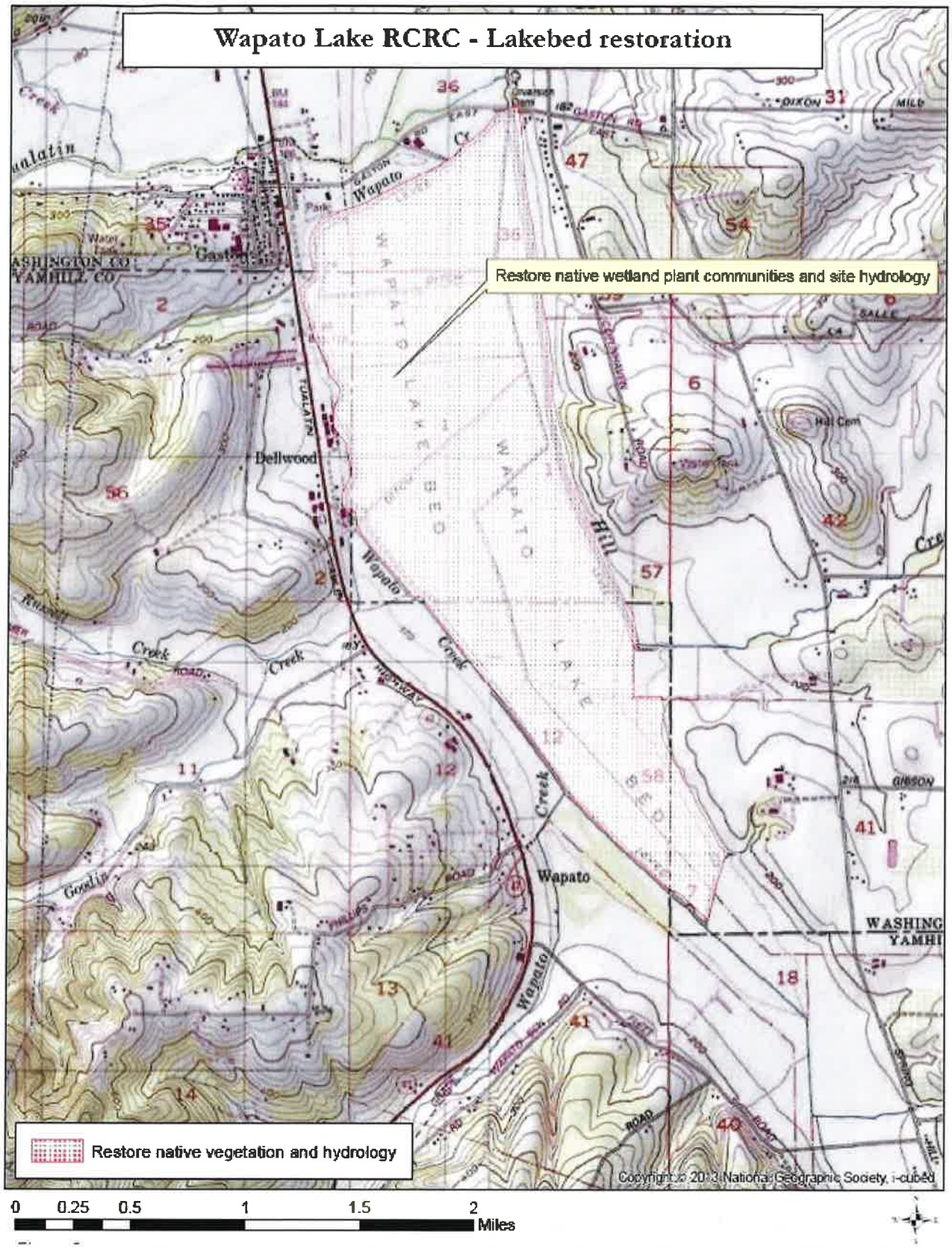

Figure 3. Location of lakebed habitat restoration activities on Gaston 7.5' USGS quad.

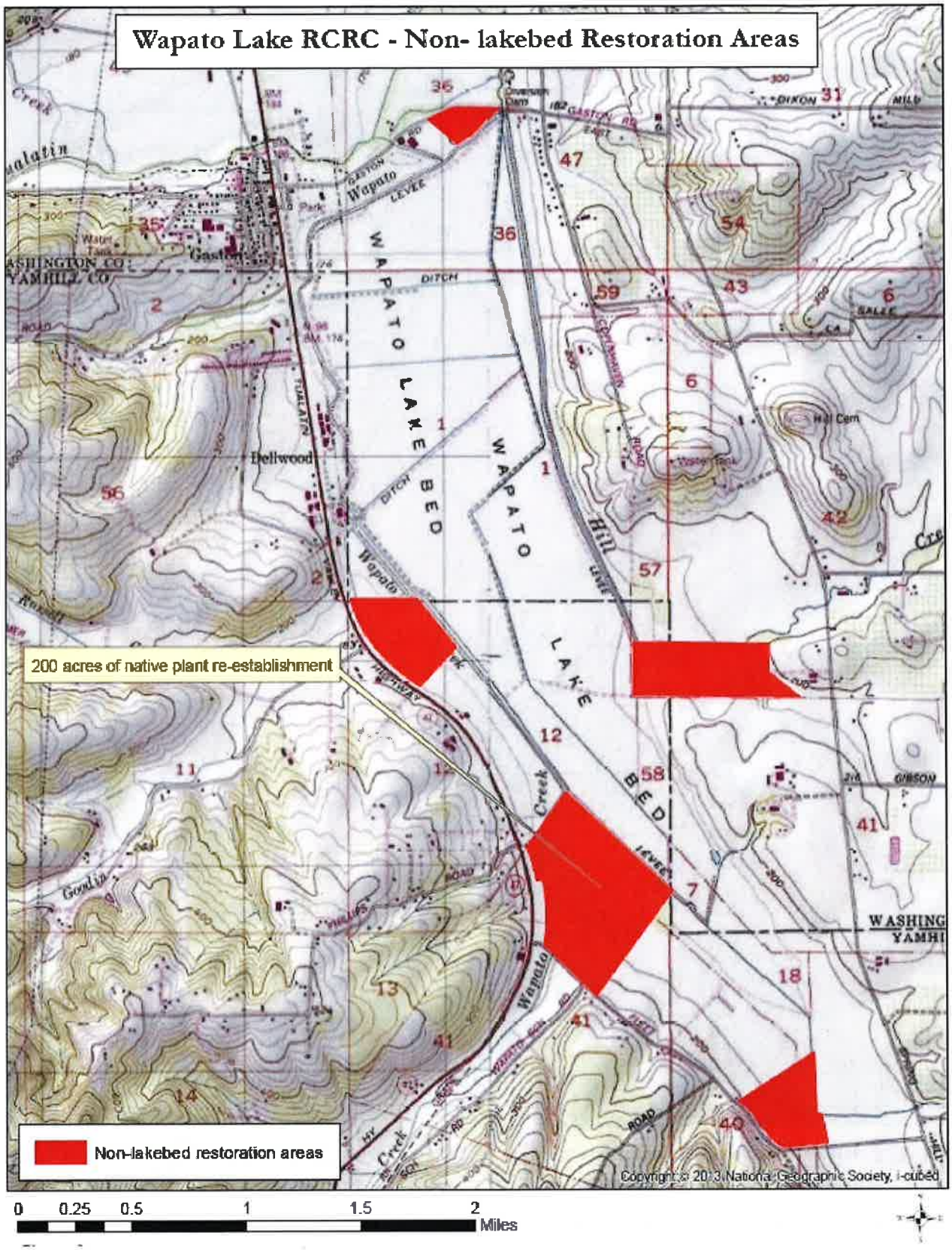

Figure 4. Location of non-lakebed habitat restoration activities on Gaston 7.5' USGS quad.

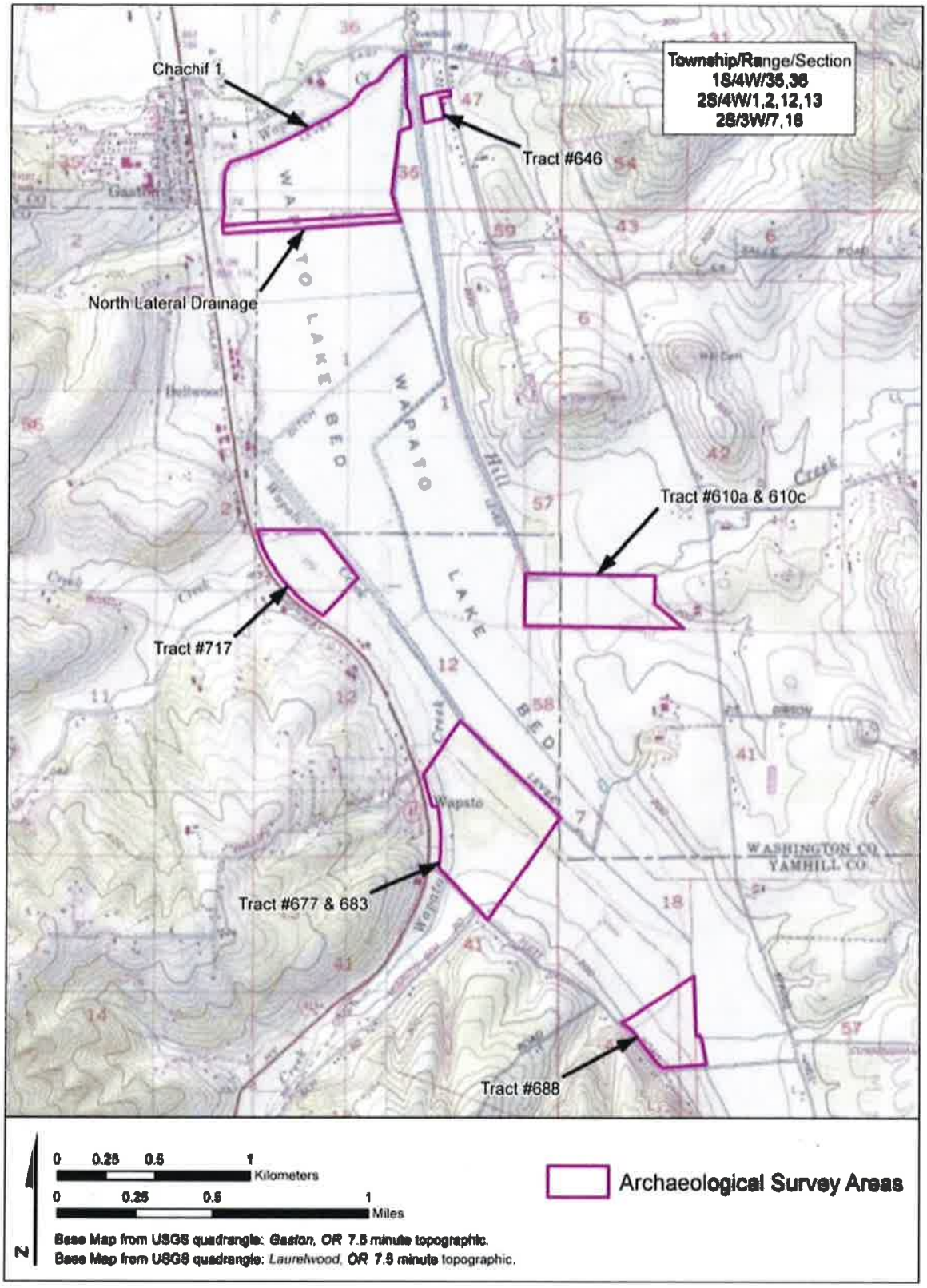

Figure 2a. Project location (Archaeological Survey Areas).

Figure 5. Survey areas on six tracts (excerpted from Paraso et al 2019:3).

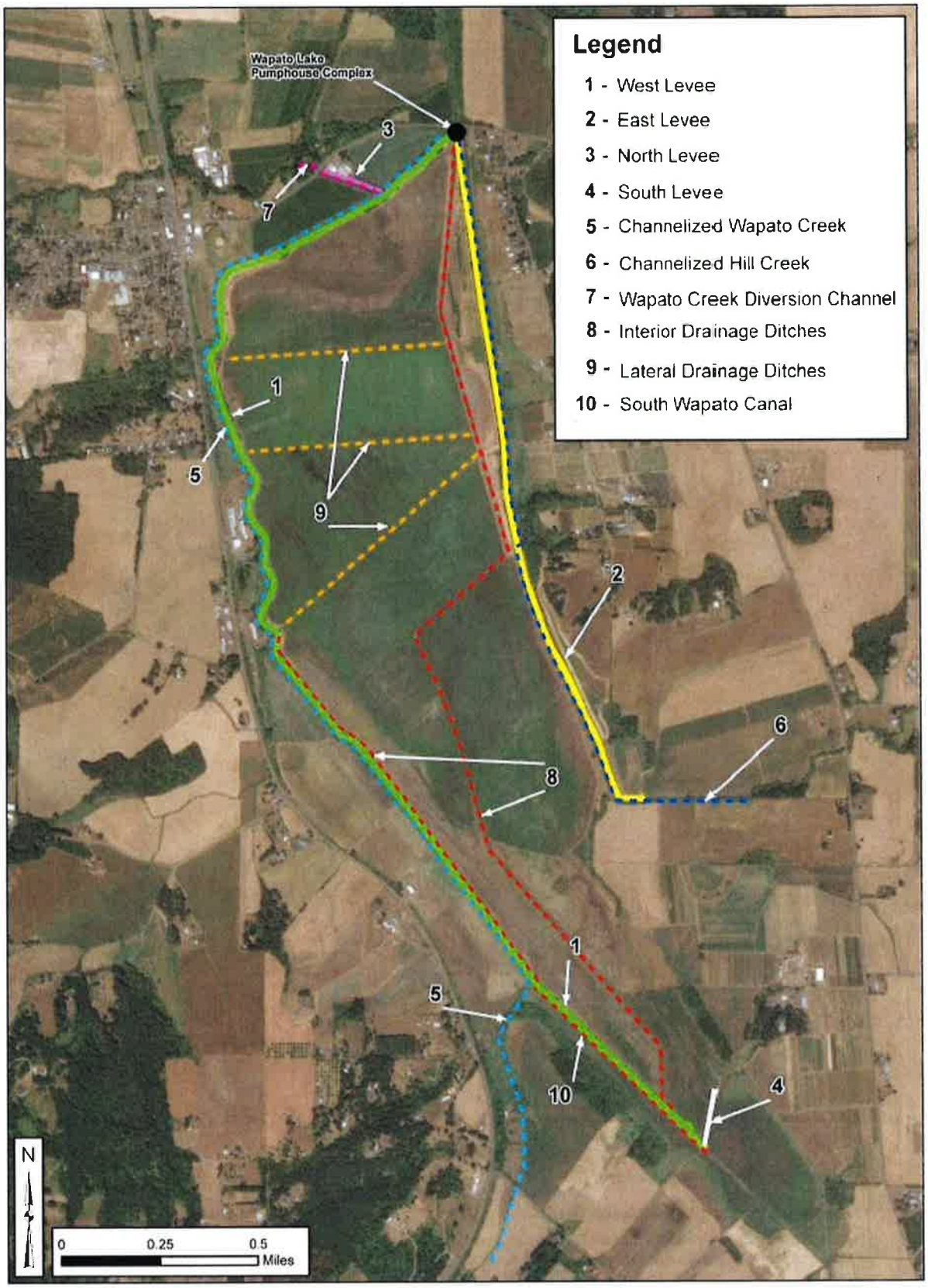

Figure 35. Overview of Wapato Lake Drainage System.

Figure 6. Extent of Wapato Lake Drainage System (excerpted from Paraso et al 2019:65).

Figure 7. Page removed for the protection of archaeological resources.

PAGE INTENTIONALLY LEFT BLANK

INTRA-SERVICE SECTION 7 BIOLOGICAL EVALUATION FORM

Originating Person & Address: Curt Mykut, Wildlife Biologist
Tualatin River National Wildlife Refuge Complex
19255 SW Pacific Highway
Sherwood, OR 97140

Telephone Number: 503-625-5944

Date: November 14, 2018

I. Region: 1

II. Service Activity (Program): Refuges

III. Pertinent Species and Habitat:

The proposed action is located at the Wapato Lake NWR (Figure 1). The Service has completed a Draft Environmental Assessment (EA) for the ecological restoration of 1000+ acres associated with Wapato Lake at Wapato Lake NWR. The Service's Preferred Alternative will restore 800 acres of palustrine wetlands within the lakebed and restore 200+ acres of palustrine wetlands and associated uplands on non-lakebed Service lands (Figure 2). Restoration actions associated with the Preferred Alternative would be accomplished by re-establishing native vegetation, and managing site hydrology (water levels) within the 800-acre lakebed portion of the project with pumping infrastructure. Because the Preferred Alternative aims to achieve an outcome dependent upon water level control, the existing pumps and pump houses would need to be replaced because they have reached the end of their functional lifespan.

The following, describing existing hydrology, plant communities and fish and wildlife use is taken directly from the Wapato Lake NWR Draft Environmental Assessment (USFWS 2018).

Hydrology and Vegetation
Lakebed

Despite the construction of levees, the channelization of the Tualatin River, and the diversion of tributary streams, Wapato Lake forms and inundates its lakebed each winter through a combination of precipitation, runoff, and subsurface seepage (Rounds et al. 2016). Prior to levee construction, Wapato Lake was seasonally connected to the Tualatin River. The lakebed has experienced a relatively consistent hydrologic pattern since the 1930s, where the lake is dewatered every spring in preparation for summer farming followed by recharge of the lake during the fall/winter wet season. On average, 2,500 acre feet of water accumulate in lakebed. The Service has continued to manage the lake similar to its previous owners by maintaining agricultural operations in the lakebed. The Service dewaters the lakebed in early spring and uses a cooperative farming program to control invasive vegetation and provide winter forage for waterfowl. Drainage of the lake is accomplished with the use of two pumps that lift

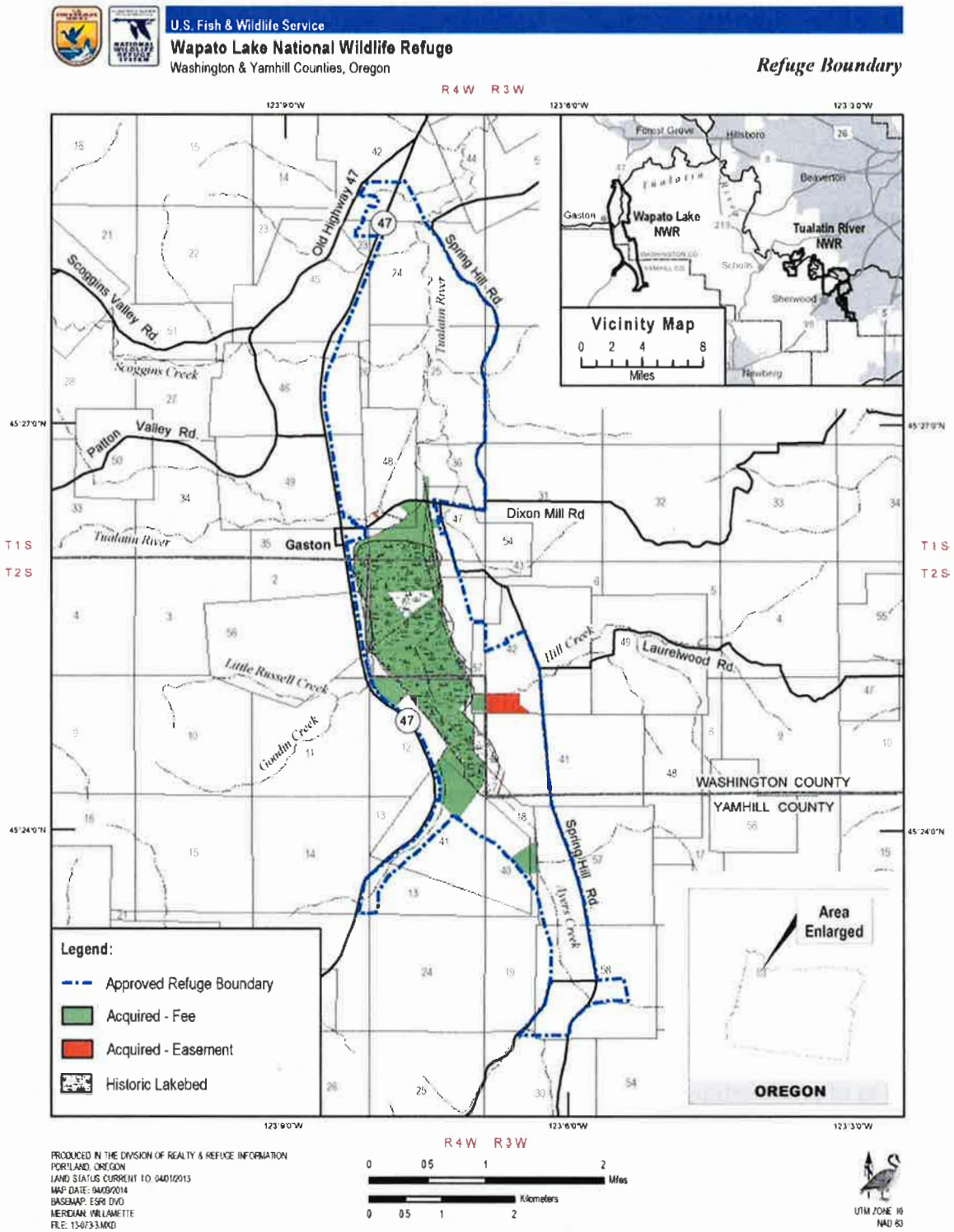

Figure 1. Wapato Lake NWR acquisition boundary and Service real property interests.

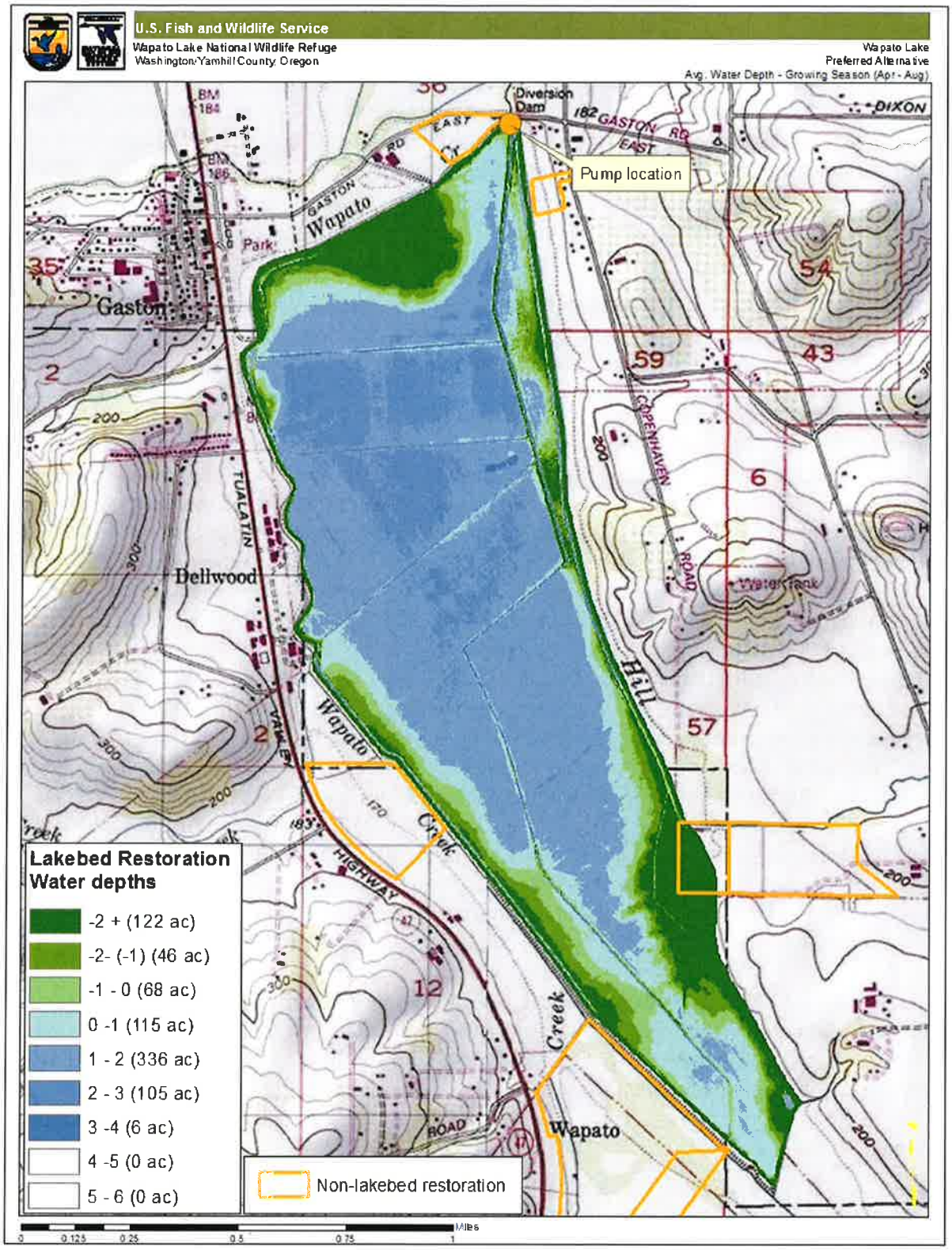

Figure 2. Wapato Lake NWR proposed action area.

water from the lakebed and discharge it to Wapato Creek near Gaston Road on the north end of the lake.

As a result of past and current land use, the lakebed and surrounding area are a patchwork of agricultural and ruderal lands and remnant patches of relatively in-tact riparian forest and emergent wetland. Current conditions in the lakebed are the result of annually draining the site for cultivation of agricultural crops for nearly a century.

Wildlife and non-listed Fish

Birds

Despite being an intensively farmed and degraded wetland basin, Wapato Lake and vicinity supports a wide range of avian guilds, including wintering and staging waterfowl, staging shorebirds, wading birds, raptors, and neotropical migrants.

The most abundant avian taxon observed at Wapato Lake is waterfowl. Beginning in late September, flocks of resident western Canada geese and wintering cackling geese begin arriving at Wapato Lake to take advantage of waste grains associated with harvested crops prior to inundation of the lakebed with fall and winter rains. As rains slowly fill the lakebed, large influxes of Northern pintail arrive. Waterfowl numbers (both geese and ducks) peak from mid-November to mid-December, during which an average of 21,000 birds utilize the lakebed (USFWS unpublished data). Notable waterfowl surveys where numbers far exceeded the mid-winter average include counts during December 2006 and November 2016 where an estimated 66,000 and 40,000 pintail, respectively, were observed on the lakebed (USFWS unpublished data). In addition, during January 2017, over 8,000 ring-necked ducks and 400 canvasbacks were observed at Wapato Lake (USFWS unpublished data). Finally, during January 2018, three-hundred plus tundra swans were observed on the lakebed. Large numbers of green-winged teal, northern shoveler, American wigeon, ruddy ducks, and bufflehead also winter at Wapato Lake. While not observed in large numbers, dusky Canada geese, which is a species of management concern in the Pacific Flyway, also use Wapato Lake and the surrounding landscape during fall and winter. In addition to wintering waterfowl, the exterior and interior canal system associated with the lakebed also supports small breeding populations of mallards, gadwall, wood ducks, and cinnamon teal. In addition, wood duck and mallard broods have been observed using both the interior and exterior ditches during the summer.

One known active bald eagle nest is located just outside the southern end of the lakebed in an Oregon ash-dominated forest and one active osprey nest exists on a man-made platform that sits atop a power pole in the northwestern portion of the lakebed. In total, 191 species of birds from 45 families have been documented using the Wapato Lake area.

Mammals

Systematic mammal surveys have not been conducted at Wapato Lake. Anecdotally, the area appears to provide limited value to mammals in its current state. Intensive agricultural use has eliminated vegetative structure and diversity that was likely important to support diverse and abundant mammal populations. While mammal abundance and diversity has declined in the area, it is not uncommon to observe black-tailed deer, coyote, and Roosevelt elk at Wapato Lake. Smaller rodents, such as western pocket gopher, vagrant shrew, and pacific jumping mouse, have

been observed during summer in the farmed lakebed. Aquatic mammals observed include beaver, North American river otter, and invasive, non-native nutria.

Reptiles and Amphibians

Fourteen species of reptiles and amphibians have been documented in the Wapato Lake area (USFWS unpublished data); however, little is known regarding species abundance. They include Pacific chorus frog, invasive, non-native bullfrog, Northwestern salamander, rough-skinned newt, Northwestern garter snake, common garter snake, and two Oregon state sensitive species: Northern red-legged frog and Western pond turtle.

Fish and Other Aquatic Fauna

Wapato Lake and vicinity are on the southern boundary of the Upper Tualatin-Scoggins sub-watershed of the Tualatin River Watershed (Tualatin River Watershed Council). Mainstem and upper tributaries of the Tualatin River, including Wapato Lake, historically provided spawning, passage, and rearing habitat for native fish. Fourteen species of fish have been observed in the watershed, Many native non-salmonid species are present in streams within the watershed, including sculpin, lamprey, dace, coarsescale sucker, and redside shiner. Introduced, non-native species include bluegill, common carp, and smallmouth and largemouth bass, yellow perch, and bullhead. During summer 2015, Refuge staff and staff from the Pacific Northwest Native Freshwater Mussel Working Group documented the presence of native western floater mussels and non-native Asian clams in the canal system that surrounds the lakebed and in Wapato Creek just north of the lakebed.

A. Listed species and/or their critical habitat within the action area:

There are two ESA-listed threatened or endangered species under National Marine Fisheries Service (NMFS; NMFS 2016) and U.S. Fish and Wildlife Service (USFWS; USFWS 2018a) jurisdiction that may occur in the proposed action area (i.e. Wapato Creek); Threatened (Upper Willamette River ESU) Chinook salmon and Threatened (Upper Willamette River ESU) Steelhead. Threatened Lower Columbia River coho may be present; however, they are not ESA-listed in the Willamette Basin above Willamette Falls. Critical habitat has been designated for these species, but none occurs in the proposed action area.

According to NOAA Fisheries (personal communication Annie Bernie) Chinook are present downstream of the project area in the Tualatin River, however, they do not utilize any portion of the proposed action area. Adult and juvenile steelhead could be present in close proximity to, or within the proposed action area; however, given that Wapato Creek is a degraded, low-gradient, soft substrate stream channel unsuitable for spawning, only juveniles would be expected to occupy the proposed action area during implementation of the proposed action (July – October). Other steelhead life history stages, excluding spawning, could be supported by Wapato Creek outside of the implementation phase of the proposed project action.

Temporal Use of the Tualatin River by adult and juvenile steelhead (personal communication Annie Bernie NOAA Fisheries and ODFW https://nrimp.dfw.state.or.us/FHD_FPB_Viewer/index.html):

- Upstream adult migration occurs primarily from mid-January through April.
- Adult holding occurs primarily from mid-January through April.

- Adult spawning occurs primarily from mid-February through May.
- Juvenile rearing can occur year round.
- Juvenile downstream migration occurs primarily from March until mid-August.

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and the 1996 Sustainable Fisheries Act, potential adverse effects on Essential Fish Habitat (EFH) are also analyzed. Within the proposed action area, Pacific salmon EFH is designated for Chinook salmon and coho salmon.

B. Proposed species and/or proposed critical habitat within the action area:

None

C. Candidate species within the action area:

None

IV. Geographic area or station name and action:

The proposed action is located at the Wapato Lake NWR and will occur in both Washington and Yamhill Counties. The pump removal and replacement work will occur in and adjacent to Wapato Creek, which is a tributary of the Tualatin River.

V. Location (See Maps 1 and 2):

A. Ecoregion Number and Name: 3 – Willamette Valley

B. County and State: Washington and Yamhill County, OR

C. Section, township, and range (or latitude and longitude):

Location of the pump station at the NE corner of Wapato Lake: 45.440/-123.125

D. Distance (miles) and direction to nearest town: Gaston, OR is 0.25 miles north of the project action area.

E. Species/habitat occurrence: Described in III and IIIA above.

VI. Description of proposed action (attach additional pages as needed):

The proposed action entails native plant installation, pumping infrastructure replacement, and long- term management of Wapato Lake water levels to support ecological restoration goals at Wapato Lake NWR.

Native plant installation

Considering that the majority of the approximately 1,000 acres of Service owned lands has been intensively manipulated for agricultural purposes for nearly a century and is largely devoid of native flora, the proposed action would require re-establishment of native herbaceous and woody plant communities. Revegetation of native flora would follow site preparation actions aimed at eliminating or significantly suppressing non-native plant cover. Integrated Pest Management strategies (e.g., mowing, soil tilling, brush clearing, spraying with Refuge-approved herbicides) would be employed first to reduce non-native plant cover and establish site conditions that would favor newly installed native vegetation (e.g. via seeding, plug and bulb planting, and bare root and live-stake planting). Site preparation could span several years and would be conducted concurrently with infrastructure upgrades. Upon preparing the soil for plant re-establishment, native woody and herbaceous plant communities would be installed based on planned growing season water depths in the lakebed and according to the depth gradients that particular species are known to occupy. Soil moisture and soil type will inform the plant restoration plan associated with areas not influenced by lakebed inundation.

Infrastructure replacement

The Proposed Action Alternative entails removing 3 existing pumps and associated infrastructure, maintaining an existing concrete dam that separates Wapato Lake from Wapato Creek and the Tualatin River, and installing 2 new pumps and pumping infrastructure (Figure 3 and 4 and Appendix A). Details regarding the construction methods and specific equipment used will be determined by the contractor(s) selected to perform the construction; however, standard construction methods will be used to complete the project. Mechanized equipment that would be used for project construction includes, but would not be limited to, scrapers, bulldozers, excavators, backhoes, compactors, dump trucks, graders, rollers and cranes.

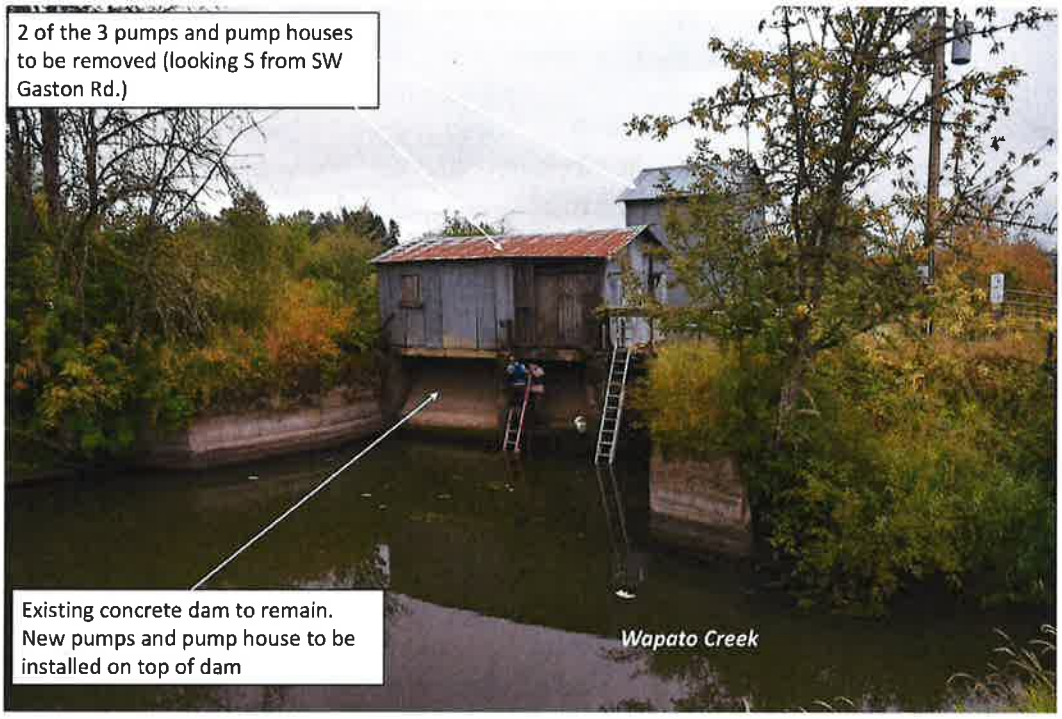

Figure 3. Looking South from Gaston Rd. at pumping infrastructure.

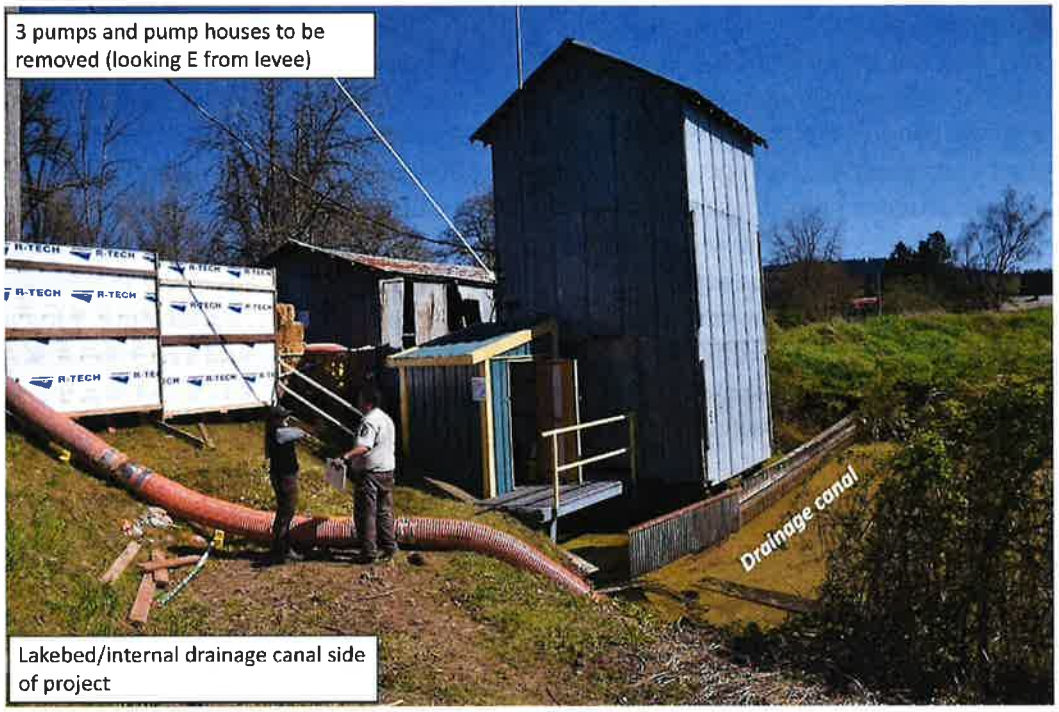

Figure 4. Looking East from Wapato Lake levee at pumping infrastructure.

The new pumps are being installed at the same location, and within the same footprint, of the existing pumps, so there would be very minimal impact to wetlands and waterways. While the majority of the pumping infrastructure will rest above the Ordinary High Water (OHW) mark of Wapato Creek, work area isolation will need to occur to remove old piping as well as install new piping and other pumping infrastructure (e.g. pump intake, trash rack, discharge pipe, and sluice gate plug). Work area isolation will be accomplished with a modular (supersack/sandbag) cofferdam, comprised of 227.1 cy of material and occupying a 0.028 acre area. The cofferdam would only serve to temporarily isolate the work area, and will not impede flows in Wapato Creek, because it would be installed parallel to Wapato Creek flow. Upon installation of the cofferdam, the work area would be dewatered with a pump. A fish salvage operation would occur prior to installation of the coffer dam to minimize impacts to native fish and conducted using one of the following methods: electrofishing, seining, or with dip nets (see Murtagh e-mail).

Water level management

Under the proposed action the Service would utilize the new pumping infrastructure to manage water levels in Wapato Lake to support a mosaic of palustrine forested, scrub-shrub and emergent wetlands. The pumping infrastructure would give the Refuge the ability to lower water levels during the spring to achieve its wetland management goals. Otherwise, water levels resulting from winter precipitation are too deep to support the palustrine wetland targets established by the Refuge. It should be noted that pumps are necessary to manage water levels, because the water surface elevation of the creeks that surround Wapato Lake are higher than the water surface elevation of Wapato Lake, therefore a more traditional head gate type water control structure could not be used to manage water levels via gravity drainage.

Water level management actions would entail running a 10,000 gpm and/or a 4,000 gpm pump during March and/or April and discharging between 1,000 and 2,000 acre-feet of water from Wapato Lake into Wapato Creek and ultimately the Tualatin River. Again, the intent of the discharge of water from Wapato Lake is to lower water levels to support wetland restoration and management goals.

The discharge pipes associated with the pumping infrastructure rest below the OHW of Wapato Creek (Appendix A). To prevent Wapato Creek backflow into Wapato Lake, the discharge pipes would be fitted with duckbill check valves (Appendix A).

The range of velocities for each discharge though the duckbill check valves are as follows:

Small Check Valve (14")
- Minimum: 3,300 gpm at 23 ft/sec
- Maximum: 4,500 gpm at 28 ft/sec

- Large Check Valve (20")
  - Minimum: 8,000 gpm at 24 ft/sec
  - Maximum: 10,500 gpm at 28 ft/sec

VII. Determination of effects:

A. Explanation of effects of the action on species and critical habitats in items III. A, B, and C (attach additional pages as needed):

As described above, while critical habitat has been designated for Threatened (Upper Willamette River ESU) Chinook salmon and Threatened (Upper Willamette River ESU) Steelhead, no critical habitat designation occurs for Chinook within the Tualatin River Basin and the closest critical habitat designation for Steelhead is in the Tualatin River and Gales Creek 3.5 + miles to the north of the proposed action area. The proposed action will have no effect on critical habitat given the distance to the nearest critical habitat designation for listed fish.

While it is possible that multiple life history stages of Threatened (Upper Willamette River ESU) Chinook salmon and Threatened (Upper Willamette River ESU) Steelhead may be supported in the proposed action area throughout the year, the probability of occurrence is low (personal comm. Tom Murtagh ODFW). Effects on listed species are analyzed below by action; native plant installation, pump infrastructure replacement, and water level management.

<u>Native plant installation</u>
Native plant installation would have no effect on Threatened (Upper Willamette River ESU) Chinook salmon and Threatened (Upper Willamette River ESU) Steelhead or EFH for Threatened (Upper Willamette River ESU) Chinook salmon. The lakebed itself has no direct connection to the Tualatin River system and therefore does not support any native fish species, listed or otherwise. While portions of the non-lakebed properties located outside of the levee system are inundated as a result of Tualatin River flooding events, re-vegetation efforts would ultimately provide ecological uplift on those properties that may provide minor benefits to listed

fish (e.g. water quality improvements, improved over-winter refugia). Even if the benefits are negligible, the actions would not result in any negative impacts to listed fish. The same would apply to non-lakebed properties with no direct nexus to the Tualatin River.

Pumping infrastructure replacement

While the majority of the work is occurring above the OHW mark of Wapato Creek, a coffer dam would need to be installed in Wapato Creek to isolate a work area for infrastructure removal and replacement actions. Because the coffer dam would be installed perpendicular to flow in Wapato Creek, passage would not be impeded for any fish using the creek; however, it would require conducting a fish salvage operation to ensure that fish are not present in the work isolation area during the dewatering process. As discussed above in IIIA, while unlikely, juvenile steelhead could occupy Wapato Creek during the summer construction period associated with the pumping infrastructure replacement work. Therefore, this action may effect, but is not likely to adversely affect Threatened (Upper Willamette River ESU) Steelhead and EFH for Threatened (Upper Willamette River ESU) Chinook salmon. However, the action would have no effect on Threatened (Upper Willamette River ESU) Chinook salmon.

Water level management

Water level management would occur with pumping infrastructure as described in VI above and would have no effect on Threatened (Upper Willamette River ESU) Chinook salmon and Threatened (Upper Willamette River ESU) Steelhead or EFH for Threatened (Upper Willamette River ESU) Chinook salmon. Because Wapato Lake would remain disconnected from the greater Tualatin River, fish would not have ingress opportunities into the lakebed, therefore retention of winter precipitation in the large wetland basin to achieve wetland management goals would not result in a stranding risk for listed species. We also considered potential effects to listed fish at the pump discharge pipes (i.e. individuals attracted discharge during pumping and finding their way through the check valves and into the discharge pipe), as well as the potential effects that discharging large volumes of water from Wapato Lake would have on water quality (and in turn fish habitat) in the Tualatin River.

Per conversations with ODFW (pers. comm. Greg Apke, Statewide Fish Passage Coordinator) the check valve structures being used to prevent backflow into the discharge pipes do not present measurable risks to fish. 1.) In the unlikely event that listed fish would be present during pumping operations, discharge velocities entering Wapato Creek through the check valves would preclude fish from entering through the valves and into the discharge pipes, and 2.) when the pumps are not operational, the check valves are sealed shut and exclude fish. Considering this rationale, ODFW indicated that no additional screening measures would be required to exclude fish from the pumping infrastructure.

Considering Wapato Lake's large size and proximity to the headwaters of the Tualatin River, lakebed management actions could have profound effects on water quality in the Tualatin River system. For example, in 2008, a lakebed levee breach occurred during a high-water event and delayed drainage of the lake until June and July when water temperatures begin to increase in the Tualatin River (USFWS 2018).

After river levels receded and the levee damage was repaired, pumping resumed and released warm, stagnant and algae laden waters into the Tualatin River which resulted in a harmful

algal bloom (HAB). This HAB event led to taste and odor problems in drinking water withdrawn at the Joint Water Commission intake. A major blue-green algae bloom also occurred in the lower Tualatin River that prompted a public health advisory to be posted by the State. As a result, DEQ imposed a regulatory framework requiring the Service to develop a TMDL implementation plan to ensure that Wapato Lake is managed in accordance with the Tualatin Sub-basin TMDL revision that the Environmental Protection Agency (EPA) approved (Appendix B). This includes actions to restrict operations of the large 10,000 gpm pump after April 30th, and if operations are necessary then a water monitoring plan must be implemented and corrective actions made as necessary.

Under the Service's preferred alternative, the scenario described above where Tualatin River water quality deteriorated as a result of management actions at Wapato Lake would be unlikely. Since the 2008 event, a multi-agency plan has been put in place that imposes restrictions on pumping, limiting it to the time of year when higher flows and cooler water temperatures prevail in the Tualatin River to prevent water quality issues (DEQ 2016). In addition, water quality is regularly monitored during pumping operations per the aforementioned plan. Further, the preferred alternative aims to restore ecological function to Wapato Lake versus continuing to farm the lakebed, so 1.) in addition to restrictive pumping times, the quality of the water being discharged during pumping operations should improve because less bare soil will be present in the lakebed (i.e. sediment reduction) and a reduction in nutrient and herbicide inputs into the lakebed would occur all as a result of ceasing farming operations and restoring native plant communities, and 2.) the volume of water being discharged would be far less because the Service would no longer completely dewater the lakebed, but rather lower lakebed water levels in the spring to support wetland restoration and management goals.

B. Explanation of actions to be implemented to reduce adverse effects:

The pump replacement work would be subject to ODFW's in-water work restrictions. The in-water work window (i.e. the period when work can occur) for all Tualatin River tributaries is July 15 to September 30. While the proposed action may extend into October 2019, all in-water work would need to be completed prior to September 30, 2019.

The following fish salvage plan would be implemented prior to coffer dam installation:

In addition, a number of best management practices will be employed to address debris and sediment contribution to Wapato Creek as a result of demolition and construction actions. Throughout construction, structural and nonstructural best management practices will be used to minimize erosion and sediment transport. Practical structural erosion control measures such as perimeter control (silt fencing, straw bales, wattles), inlet protection (bio bags, sediment collection basins), and vehicular track-off controls (gravel entryways, tire wash areas as needed) will be employed in accordance with DEQ's Erosion and Sediment Control Manual (DEQ 2005*) and installed prior to the commencement of construction. Structures would properly maintained throughout the duration of the project to keep sediments from exiting the site or entering wetland and waterway areas.

Potential best management practices to minimize erosion and sediment transport include the following:

• Using all reasonable means and methods to control or divert upslope storm water runoff away from cleared and grubbed areas, stockpiled materials, and other disturbed areas that will be open or stockpiled for periods longer than 2 weeks
• Using graveled or paved construction entrances, exits, and parking areas to reduce the tracking of sediment onto public or private roads
• Placing gravel or other effective erosion and sediment control measures on or along unpaved roads to prevent sediment and sediment-laden water from leaving the site
• Preserving existing vegetation where practicable and revegetating open areas after grading or construction
• Using temporary soil stabilization measures or protective cover to protect soil stockpiles from runoff and erosion throughout the project
• Maintaining, repairing, and/or restoring erosion and sedimentation control measures to keep them continually functional
• Stabilizing the entire site using vegetation or a heavy mulch layer, temporary seeding, or another method if construction activities cease for 30 days or more
• Using watertight trucks when hauling saturated soils or drain loads prior to leaving the site to reduce or minimize spillage on roads and streets
• Removing erosion and sedimentation control measures installed during construction only when construction and site disturbance activity are complete and permanent soil stabilization is in place

Water management at Wapato Lake will be conducted in accordance with the Wapato Lake Water Quality Monitoring Plan (DEQ 2016).

Site preparation actions supporting native plant re-establishment where herbicide use is planned would be conducted in accordance with the Tualatin River National Wildlife Refuge Complex's Standard Operating Procedures for Use of Pesticides (USFWS 2016) and use only herbicides approved by the USFWS's Integrated Pest Management and Pesticide Use Proposal System.

VIII. Effect determination and response requested: [* = optional]

A. Listed species/designated critical habitat:

Determination	**Response requested**
No effect/no adverse modification	**__ Concurrence**
May affect, but is not likely to adversely affect species/beneficial effect) **Species:** Threatened (Upper Willamette River ESU) Chinook salmon Threatened (Upper Willamette River ESU) Steelhead **Critical Habitat:** Threatened (Upper Willamette River ESU) Chinook salmon Threatened (Upper Willamette River ESU) Steelhead **EFH:** Threatened (Upper Willamette River ESU) Chinook salmon Threatened (Upper Willamette River ESU) Steelhead	**__ Concurrence**
May affect, and is like to adversely affect species/adversely modify critical habitat (Species:)	**_____ Formal Consultation**

B. Proposed species/proposed critical habitat: N/A

C. Candidate species: N/A

Larry Klimek

Signature

11/14/18

Date

Larry Klimek, Project Leader, Tualatin River NWRC

IX. Reviewing ESO Evaluation:

A. Concurrence _____ Nonconcurrence _____

B. Formal consultation required _____

C. Conference required _____

D. Informal conference required _____

E. Remarks (attach additional pages as needed):

_____ _____

Signature **Date**
(Title/office of reviewing official)

Figure 1. Wapato Lake NWR acquisition boundary and Service real property interests.

Figure 2. Wapato Lake NWR proposed action locations or action area.

U.S. Fish & Wildlife Service
National Wildlife Refuge System
Tualatin River National Wildlife Refuge Complex
19255 S.W. Pacific Highway
Sherwood, OR 97140
503/625 5944

August 2019

Front cover:
Looking south across Wapato Lake, Spring 2016
Clean Water Service, Michael Nipper photographer