US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX T CULTURAL RESOURCES EFFECTS ANALYSIS

NEW APPENDIX ADDED TO THE FINAL EIS

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THIS APPENDIX HAS BEEN ADDED TO THE FEIS TO SUPPORT THE ANALYSES SUMMARIES OF ACTION ALTERNATIVES IN SECTION 3.21, CULTURAL RESOURCES, ENVIRONMENTAL CONSEQUENCES

1.0 EFFECTS TO CULTURAL RESOURCES UNDER ALL ACTION ALTERNATIVES

1.1 Methodology

1.1.1 Qualitative and Quantitative Analyses

The cultural resources effects analyses include qualitative discussions of how actions under alternatives would directly impact a resource type (e.g., erosion, exposure, modification, etc.) and quantitative analysis of the number of cultural resources that would be directly exposed to an action by an alternative.

The extent of exposure of inundated archaeological resources was modeled to compare effects across alternatives. The analyses required two variables: (1) the period of exposure, or the number of days that a portion of the reservoir would be exposed, and (2) the area of the archaeological resources. Archaeological resources can vary greatly in size, from isolated features covering just a few feet to large linear features that stretch for miles.

One way to combine these two variables (time and area) for comparison purposes is to multiply the acreage of archaeological resources in a reservoir by the number of days those acres would be exposed, or an "acre-day," over the course of 1 water year. A single acre-day is the amount of exposure created when an archaeological site covering 1 acre is exposed for 1 day. In the same way, a half-acre site exposed for 2 days would also be 1 acre-day of exposure. Ten acres of archaeological site exposed for 10 days would be 100 acre-days, etc.

Archaeological resources defined as isolates or isolated finds, which are represented by point data and do not have a calculated acreage (because they cover such a small area), were not used in the analysis.

Data used to support this analysis comes from two sources: (1) information regarding the amount of time that particular areas would be exposed come from the reservoir operations modeling described in Section 3.2, Hydrologic Processes, and Appendix B, Hydrologic Processes; (2) the second part of this analysis comes from archaeological research in the reservoirs.

Archaeologists have completed some inventory of the archaeological resources around and within the reservoirs. The boundaries of the archaeological resources have been recorded and converted into polygons using the Geographic Information System (GIS), and these features have calculated acreage (with the exception of isolates/isolated finds).

These data, combined with bathymetric information from the reservoirs, allow a determination of which sites would be exposed when a reservoir reaches a particular elevation. These data also provide a determination of how many acres of archaeological resources would be exposed at a given elevation.

For the alternatives analyses, the polygon site data was changed from differentially sized vector data that did not have corresponding elevation data to equally spaced raster point site data, each measuring 0.0032 acres in size and then paired with reservoir bathymetry from digital elevation models (DEMs) to associate each site point with a given elevation. This effort resulted in the ability to conduct fine scale tabulation of less than 1 acre of site by elevation and fully use the varying elevation within the area of the original polygon. This reduced overcounting or undercounting that would have occurred in the area of the original polygons had the original polygons not been partitioned or adjusted for an averaged elevation.

A Microsoft Excel function was then used to count all points below a given elevation, in 1-foot increments, between the maximum conservation elevation and the minimum operating elevation for each reservoir. These counts were normalized to capture site data that ranged within these maximum and minimum elevation parameters.

Once counts within the appropriate range were derived, they were applied to the median daily elevations known for the 30-year implementation timeframe. These outputs from HEC-ResSim include reservoir elevations spanning October 1, 1935 to September 30, 2019 and provide a timeseries with a length of a single year of exposed acres on each individual day.

Information regarding acreage within each elevation interval was multiplied by the number of days that each interval would be exposed to compile acre-day measurements for each of the reservoirs. The acre-day was then calculated under each alternative at each reservoir. The difference between each action alternative and the No-action Alternative (NAA) was also calculated at each reservoir (shown in percentage).

The analysis is only as reliable as the information that is available regarding archaeological resource locations, elevations, and boundaries. Archaeological inventory of the 13 reservoirs is incomplete, and there is differential coverage of each reservoir. The irregular coverage is largely because archaeological inventory was not completed prior to reservoir filling, and the deeper parts of the reservoirs are exposed only rarely. Dam and reservoir parameters also guide where archaeological surveys occur.

The GIS data used here is the best available record of archaeological resources present in the Willamette Valley System (WVS) reservoirs. Examination of the area of recorded archaeological resources by elevational interval at each of the analyzed reservoirs shows that a greater area of archaeological sites has been recorded in the littoral zone (shoreline) of the reservoirs. This pattern does not reflect precontact or historical settlement practices—it reflects the areas of the reservoirs that are easiest to access and where USACE work typically occurs (e.g., recreation sites or operational zones).

A related concern is reliability and consistency of the bathymetric data, which came from two sources: (1) USACE and (2) State of Oregon Department of Geology and Mineral Industries (DOGAMI) Lidar dataset. Some USACE bathymetry data are more than 50 years old and based on original land surveys conducted as part of mapping each dam and reservoir area for eventual reservoir construction and infill. Other USACE bathymetry data are derived from aerial imagery (drone flights and fixed-wing planes, each capable of carrying different types of sensors, which in turn have varying sensitivities to collect elevation data) or hydrographic surveys that collect elevation data from multi-beam sonar soundings.

DOGAMI data were derived from aerial imagery, primarily collected while reservoirs were at high pool elevations. DOGAMI captures water surface elevation rather than reservoir contours. Data collected from multiple sources can have varying contour ranges and can represent varying degrees of accuracy depending on how the elevation for a given location was derived.

For this analysis, the DEMs were patched together to create a mosaic that covers the 13 WVS dams and reservoirs. As much as possible, elevations were checked against expected elevations of the maximum and minimum reservoir pools and anticipated elevations of documented archaeological sites.

1.2 Archaeological Site Analyses

Effects for each action alternative are compared to the NAA unless stated otherwise.

1.2.1 Overview

All the alternatives would have major adverse effects to cultural resources. This is mainly due to the high number of archaeological resources present in or adjacent to the reservoirs that would be exposed to the annual draft and fill cycle that occurs at the WVS. This draft and fill cycle has occurred for much of the 50- to 80-year existence of the dams and reservoirs, and effects of the annual cycle of draft and fill have resulted in seasonal impacts that have incrementally built upon the damage of prior years and irreversibly impacted the integrity of archaeological sites that are present in the reservoir. Of the 461 documented archaeological resources, 369 (80%) would be impacted by this draft and fill cycle. This adverse, long-term, and irreversible effect to archaeological resources would occur under the NAA as a comparative analysis with the action alternatives but would be common to all the alternatives.

Table 1 demonstrates greatly increased and major adverse impacts related to erosion and exposure of archaeological sites that would occur as a result of Measure 40 (deeper fall drawdown to regulating outlets) and Measure 720 (deep spring reservoir drawdown) and are noted by reservoir and alternative. These measures would drive noticeable increases in erosion and exposure by drafting deeply and quickly to lower regulating outlets, extending the length of reservoir bed exposure outside of storage season, accelerating erosion due to oversaturated unstable topography, and increasing the number of draft and fill cycles that occur in 1 water year.

Table 1. Willamette Valley System Reservoir Locations of Major Adverse Effects to Archaeological Sites Occur (beyond Draft and Fill Annual Cycle) under All Alternatives.

Reservoir	No-Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Fern Ridge	No	No	No	No	No	No	No	No
Cottage Grove	No	No	No	No	No	No	No	No
Dorena	No	No	No	No	No	No	No	No
Dexter	No	No	No	No	No	No	No	No
Lookout Point	No	No	No	No	Yes	Yes	No	No
Fall Creek	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hills Creek	No	No	No	No	Yes	Yes	No	No
Cougar	No	No	No	Yes	Yes	Yes	No	Yes
Blue River	No	No	No	No	Yes	Yes	No	No
Foster	No	No	No	No	No	No	No	No
Green Peter	No	No	Yes	Yes	Yes	Yes	No	Yes
Big Cliff	No	No	No	No	No	No	No	No
Detroit	No	No	No	No	Yes	Yes	No	No
Total WVS Reservoirs (Percent of Total WVS Reservoirs Impacted)	**1 (8%)**	**1 (8%)**	**2 (15%)**	**3 (23%)**	**7 (54%)**	**7 (54%)**	**1 (8%)**	**3 (23%)**

Alternative 3A and Alternative 3B would be the most detrimental to archaeological resources due to the high number of projects that would use these deep drawdown measures (n=7 and 54% of the reservoirs). Alternative 2B and Alternative 5 would be less impactful with the proposed use of these measures at three reservoirs (23% of reservoirs impacted), followed by Alternative 2A, which proposes the use of such actions at two reservoirs (15% of reservoirs impacted). The NAA, Alternative 1, and Alternative 4 would have the least increase in impact to archaeological sites because the drawdown measures would occur only at one reservoir, Fall Creek (8% of reservoirs impacted).

Because these actions occur on such a large scale (per reservoir), these measures cause at least one additional event in a given water year that would have major adverse impact to 80% of archaeological resources. While these effects are not directly measurable (e.g., by observed rate of erosion), it is useful to understand the increased adverse impacts on an order of magnitude.

Spring and/or fall deep drawdowns would occur in two or three reservoirs under some alternative operations. This would be a 100%–200% increase from the NAA in the number of reservoirs where a drawdown measure would have major adverse effects to archaeological resources (Alternative 2A, Alternative 2B, and Alternative 5). For Alternative 3A and Alternative 3B, the use of the deep drawdown measures would increase the number of reservoirs where major adverse effects would occur to archaeological sites to 600% greater than the NAA, Alternative 1, and Alternative 4.

Through use of GIS and HEC-ResSim outputs, one aspect of potential impact to archaeological sites, extent of archaeological site exposure, expressed in acre-days, was modeled for all alternatives. Table 2 shows the results over the course of 1 water year for the 11 reservoirs that would have reservoir elevation changes (Big Cliff and Dexter are reregulating dams and maintain year-round high water elevations), and Table 3 shows the percent change by reservoir and then WVS across the alternatives. In each alternative, all 11 reservoirs follow a rule curve that results in one major cycle of draft and fill per water year, and several of the measures result in reservoir elevation change. Exposure resulting from any reservoir elevation change would impact the 369 (80%) archaeological sites that are adjacent to or within the WVS reservoirs.

Table 2. Effects to Archaeological Resources through Exposure by Reservoir and Alternative (expressed as acre-day).

Reservoir	NAA	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Detroit	25,768	24,267	27,272	27,271	48,013	29,059	27,298	27,292
Green Peter	26,068	22,060	30,240	30,240	30,240	52,148	30,406	30,202
Foster	2,551	2,551	2,532	2,532	2,532	3,516	2,551	2,533
Blue River	895	872	857	870	926	926	856	883
Cougar	1,727	1,632	1,677	2,116	2,112	2,115	1,677	2,116
Fall Creek	34,373	34,371	34,174	34,220	34,336	34,439	34,173	34,277
Hills Creek	14,123	12,384	12,404	12,824	15,992	25,396	12,402	13,620
Lookout Point	25,149	27,217	25,917	26,586	67,870	33,462	25,874	26,693
Dorena	4,344	4,315	4,332	4,342	4,350	4,373	4,363	4,346
Cottage Grove	7,242	7,195	7,170	7,189	7,324	7,249	7,184	7,209
Fern Ridge	21,868	21,869	21,869	21,869	21,869	21,869	21,869	21,869
Total WVS Acre-days	**164,109**	**158,734**	**168,445**	**170,060**	**235,564**	**214,552**	**168,652**	**171,039**

Table 3. Effects to Archaeological Resources by Percent Change in Exposure of Archaeological Resources by Reservoir and Alternative.

Reservoir	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Detroit	-6	6	6	86	13	6	6
Green Peter	-15	16	16	16	100	17	16
Foster	0	-1	-1	-1	38	0	-1
Blue River	-3	-4	-3	3	3	-4	-1
Cougar	-6	-3	22	2	22	-3	22
Fall Creek	0	-1	0	0	0	-1	0
Hills Creek	-12	-12	-9	13	80	-12	-4
Lookout Point	8	3	6	170	33	3	6
Dorena	-1	0	0	0	1	0	0
Cottage Grove	-1	-1	-1	1	0	-1	0
Fern Ridge	0	0	0	0	0	0	0
Total WVS Percent Change	**-3**	**3**	**4**	**44**	**31**	**3**	**4**

Most of the alternatives would result in 3% to 4% higher exposures rates, including Alternatives 2A, 2B, 4, and 5 (Table 2 and Table 3). As noted in prior discussion, Alternative 3A and Alternative 3B would be highly detrimental to archaeological resources, and for this particular analysis would result in markedly higher rates of site exposure (31% to 44 %).

2.0 EFFECTS TO CULTURAL RESOURCES UNDER ALL ACTION ALTERNATIVES

2.1 Alternative 1

Under Alternative 1, there would be an expected system-wide 3% decrease in acre-days of site exposure between the NAA (164,109 acre-days) and Alternative 1 (158,734 acre-days). Several reservoirs would experience decreased site exposure, including Detroit (-6% percent), Green Peter (-15%), Blue River (-3%), Cougar (-6%), Hills Creek (-12%), Dorena (-1%), and Cottage Grove (-1%). Site exposure under Alternative 1 at Lookout Point Reservoir would see an 8% increase in exposure days, though to a lesser extent for the WVS when considering site exposure under the NAA.

2.2 Alternative 2A

Alternative 2A proposes implementing an integrated temperature and habitat flow regime (Measure 30a) rather than adhering to either the 2008 Biological Opinion target flows or the minimum flows to Congressionally authorized minimum flow. This flow regime may minimally affect reservoir elevations and therefore would result in a negligible/minor adverse effect to archaeological sites. This is supported by a minor system-wide increase in acre-days of site exposure from the NAA (3%). By reservoir, however, several of the reservoirs would see decreased acre-days of site exposure, including Foster (-1%), Blue River (-4%), Cougar (-3%), Fall

Creek (-1%), and Cottage Grove (-1%). Adverse effects and increased site exposure at the local level would occur at Detroit (6%), Green Peter (16%), and Lookout Point (3%) while major beneficial reduction of exposure would occur at Hills Creek (-12%).

2.3 Alternative 2B

Under Alternative 2B, there would be a 4% system-wide increase in site exposure as compared to the NAA, including Cougar (22%), Green Peter (16%), and Lookout and Detroit Reservoirs (6% each). The remaining reservoirs would see decreased or no change to site exposure, including Foster (-1%), Blue River (-3%), Fall Creek (0%), Hills Creek (-9%), Dorena (0%), Cottage Grove (-1%), and Fern Ridge (0%).

2.4 Alternative 3A

Alternative 3A would substantially lengthen the amount of time that sites at Detroit, Lookout Point, Cougar, Green Peter, and Hills Creek Reservoirs would be exposed as compared to the NAA. Reservoirs would experience an 86% increase in site exposure at Detroit, a 170% increase at Lookout Point, a 22% increase at Cougar, a 16% increase at Green Peter, and a 13% increase at Hills Creek Reservoirs.

Blue River (3% increase) and Fall Creek (0% increase) Reservoirs would still be subject to high levels of erosion and site exposure during the proposed fall drawdowns, although the change in site exposure between the NAA and Alternative 3A would be minor to negligible at these reservoirs. Regardless, the overall effect to archaeological sites would remain majorly adverse due to the amount of shoreline exposure and human-induced effects from unauthorized collections.

2.5 Alternative 3B

Alternative 3B would also greatly lengthen the amount of time of site exposure at Detroit (13%), Foster (38%), Hills Creek (80%), Cougar (22%), Lookout Point (170%), and Green Peter (100%) Reservoirs and ultimately exposure to human-induced impacts as compared to the NAA. All of these reservoirs have high volumes of recreation and known looting issues. It is anticipated that unauthorized artifact collection would increase in the spring and fall. Fall Creek Reservoir does and would continue to experience illicit collection during the deep fall drawdown (though site exposure would remain unchanged from the NAA), and Blue River Reservoir would see a minor increase in site exposure days (3%). Cottage Grove and Fern Ridge Reservoirs would not see an increase in site exposure days with Alternative 3B. Unique to Alternative 3B, the WVS would experience a 31% higher site exposure rate than under the NAA. Adverse effects specifically to archaeological sites at seven of the reservoirs would be substantially high.

2.6 Alternative 4

Alternative 4 would result in a minor increase in system-wide site exposure (3% increase from the NAA). The most impacted reservoirs would be Detroit (6%) and Green Peter (17%). The remaining reservoirs would either see negligible or minor adverse or beneficial changes in site exposure from the NAA: Lookout Point (3%), Foster (0%), Blue River (-4%), Cougar (-3%), Fall Creek (-1%), Dorena (0%), Cottage Grove (-1%), and Fern Ridge (0%). Hills Creek Reservoir would see a major beneficial decrease in site exposure (-12%).

2.7 Alternative 5

Alternative 5 would increase the number of reservoirs that experience deep drawdowns (up to three, from one under the NAA). Alternative 5 would also greatly lengthen the amount of time that sites at Detroit (6%), Green Peter (16%), Cougar (22%), and Lookout Point (6%) Reservoirs would be exposed to human-induced impacts. These reservoirs experience high volumes of recreationalists when the roads are passable, and it is anticipated that unauthorized artifact collection would increase during peak recreation season. Under Alternative 5, adverse effects specifically to archaeological sites at Cougar, Fall Creek, and Green Peter Reservoirs are substantially high.

2.8 Downstream Cultural Resources under All Alternatives

Cultural resources that are present downstream of the 13 WVS dams and located along the 465 miles of riverbank have the potential to be adversely impacted by measures that increase flooding, which leads to erosion and exposure. Erosion can include water scouring that removes bank materials or mass failure of a section of bank that then destabilizes and falls into the watercourse. In these erosional instances, archaeological resources would be exposed through removal of sediment and more vulnerable to illicit artifact collection, or a site could lose physical integrity if it is part of the bank section that fails and falls into the watercourse.

These same cultural resources would benefit from measures that decrease flooding. Reduced flooding would not improve archaeological sites but would rather support continued stasis of the bank and the cultural resources contained within.

Downstream cultural resources benefit from the screening criterion to exclude measures under any alternative that would have the potential to increase flood risk (Section 3.2.2.1.3, Flood Risk Management). Operations that increase flood risk can include increased maximum releases from WVS dams or reduced flood storage, leading to higher pool elevations and higher releases to mitigate the risk of overtopping.

In general, WVS operations have resulted in higher flows in the summer and reduced peak flows in the winter than historical flows (Section 1.11.2.1, Operational Considerations for Streamflow and Water Quality; Section 1.11.24, Operational Considerations for Environmental Flows). Excess flood water stored above the rule curve during the conservation storage season is released, targeting discharges at or below downstream channel capacity. Resulting effects to downstream cultural resources would be minimal to no erosion and exposure of archaeological resources. Smaller spring flows occur from March to June and typically require augmentation to meet e-flows, which are well within downstream channel capacity. Consequently, it is unlikely that spring flows would create flooding conditions that would cause adverse effects to cultural resources downstream of the WVS dams and reservoirs.

USACE flood data indicates that the WVS has substantially reduced flooding along the 465 river miles that are downstream of the WVS (Section 3.2., Hydrological Processes). Levees, revetments, and other modifications have been placed downstream specifically to reduce flooding throughout the system where there are human populations and agricultural lands.

All alternatives would continue to meet the flood risk management authorization purpose (Section 1.10, Congressionally Authorized Purposes). Consequently, cultural resources downstream of the WVS dams would be beneficially affected by the continued operation of the WVS under all alternatives and to the adherence to operations that reduce flood risk and maintain water discharge that remains within channel capacity. While operations under all alternatives, including the NAA, would generally support site stabilization rather than erosion, the number of downstream archaeological resources is unknown, and the benefits are not quantifiable.

2.9 Built Resources

In Table 4, moderate to major adverse effects to built resources are noted by reservoir and alternative. Effects to built resources are high for all alternatives (54%–31%) with the exception of the NAA, which does not propose any structural measures. Given that the NAA does not propose any structural modifications and all other alternatives do, any of the proposed structural modifications result in a 100% increase in modification to built resources (any increase from 0 results in a 100% increase regardless of the amount). However, the amount of proposed modification varies across alternatives.

Alternative 1 proposes the most structural measures that would have moderate to major effects to built resources, followed by Alternative 2A, Alternative 2B, and Alternative 4. Alterative 3A and Alternative 3B have the fewest structural measures that would have moderate to major effects to the historic WVS. Alternatives that propose structural measures to address upstream and downstream fish passage tend to have fewer negative effects to archaeological resources in the reservoirs, as opposed to alternatives that propose operations measures to accomplish the same goals.

3.0 INTERIM OPERATIONS UNDER THE ACTION ALTERNATIVES EXCEPT ALTERNATIVE 1

Major and long-term adverse impacts to archaeological sites under the Interim Operations would be the same under all action alternatives (except Alternative 1) because of the erosion effect of any drawdown and associated site exposure risks[1]. The timing and duration of Interim Operations would vary depending on a given alternative; however, operations that focus on deep drawdowns, earlier drawdown, and delayed refills for downstream fish passage would greatly increase the erosion and exposure of archaeological sites at the reservoir level, which would be a continuation of major adverse effects under the NAA.

Archaeological resources would continue to steadily degrade with routine draft and fill operations. Delayed fills and early seasonal drawdowns would extend the length that most of the reservoir bed is exposed outside of the storage season (Table 4).

Table 4. Willamette Valley System Locations of Moderate to Major Adverse Effects to Built Resources under All Alternatives.

Reservoir	NAA	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Fern Ridge	No	Yes	No	No	No	No	No	No
Cottage Grove	No	No	No	No	No	No	No	No
Dorena	No	No	No	No	No	No	No	No
Dexter	No	Yes	Yes	Yes	No	No	Yes	Yes
Lookout Point	No	Yes	Yes	Yes	No	No	Yes	Yes
Fall Creek	No	No	No	No	No	No	No	No
Hills Creek	No	No	No	No	Yes	Yes	Yes	No
Cougar	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Blue River	No	No	No	No	Yes	Yes	No	No
Foster	No	Yes	Yes	Yes	No	No	Yes	Yes
Green Peter	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Big Cliff	No	No	No	No	No	No	Yes	No
Detroit	No	Yes	Yes	Yes	No	No	Yes	Yes
Total WVS Reservoirs (Percent of Total WVS Reservoirs Impacted)	**0 (0%)**	**6 (46%)**	**6 (46%)**	**6 (46%)**	**4 (31%)**	**4 (31%)**	**7 (54%)**	**6 (46%)**

[1] Interim Operations under Alternative 3A and Alternative 3B may not be fully implemented or required because long-term operational strategies for these alternatives are intended to be implemented immediately upon Record of Decision finalization.