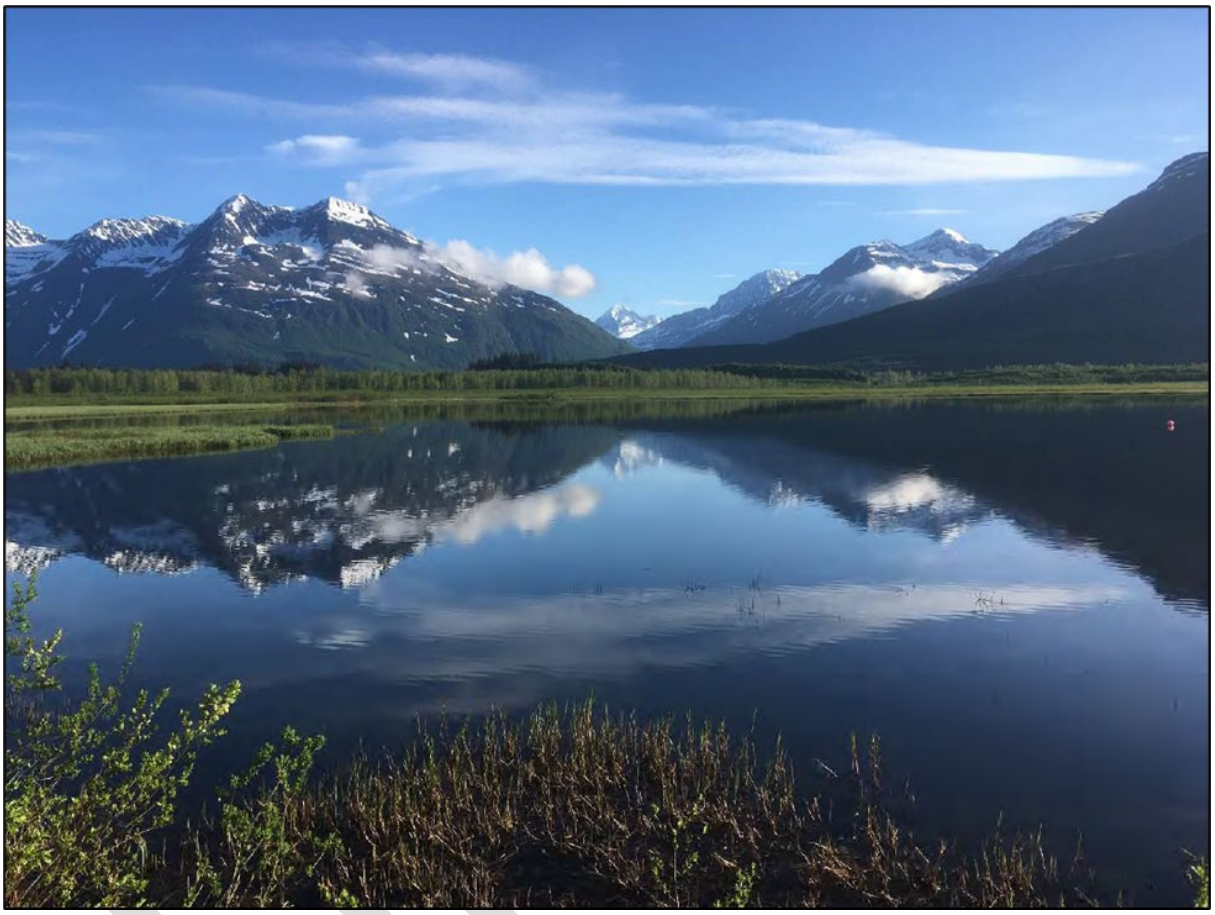
Robe Lake Ecosystem Restoration
Feasibility Study
Appendix E: Economics | DRAFT
Valdez, Alaska



U.S. Army Corps of Engineers
Alaska District

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LIST OF ACRONYMS AND ABBREVIATIONS

AAEQ	*Average Annual Economic Cost*
AAHU	*Average Annual Habitat Units*
ACS	*Alaska Community Survey*
ADFG	*Alaska Department of Fish and Game*
AEP	*Annual Exceedance Probabilities*
AKDOT	*Alaska Department of Transportation*
CAP	*Continuing Authorities Program*
CE/ICA	*Cost-Effectiveness and Incremental Cost Analysis*
EQ	*Environmental Quality*
ER	*Engineer Regulations*
FEMA	*Federal Emergency Management Agency*
FFE	*First-floor Elevation*
FWOP	*Future Without Project*
HEC-FDA	*Hydrologic Engineering Center's Flood Event Damage Reduction Analysis*
HEC-RAS	*Hydrologic Engineering Center's River Analysis System*
IFR-EA	*Integrated Feasibility Report and Environmental Assessment*
IWR	*Institute of Water Resources*
NED	*National Economic Development*
NER	*National Ecosystem Restoration*
NSI 2.0	*National Structure Inventory 2.0*
OMRRR	*Operations, Maintenance, Repair, Replacement and Rehabilitation*
OSE	*Other Social Effects*
RED	*Regional Economic Development*
USACE	*United States Army Corps of Engineers*
VFDA	*Valdez Fisheries Development Association*

1.0 Overview

1.1 Executive Summary

This appendix presents the economic analysis of three structural alternatives for a Continuing Authorities Program (CAP) Section 206 ecosystem restoration project at Robe Lake, a large freshwater lake in Valdez, Alaska. The alternatives were evaluated following U.S. Army Corps of Engineers (USACE) policy for a National Ecosystem Restoration (NER) plan as well as with the four accounts established in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies: National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED) and Other Social Effects (OSE).

Engineer Regulation (ER) 1105-2-100 details that selecting the NER plan must meet the planning objectives and constraints while reasonably maximizing the environmental benefit while passing tests of cost-effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness. Consistent with this policy, Cost Effectiveness, and Incremental Cost Analysis (CE/ICA) was used to support NER plan selection. The ecosystem restoration non-monetary metric used in the CE/ICA are average annual habitat units (AAHUs) restored (presented in units of acres). The cost metric is the average annual economic costs (FY23 price levels), including project first, Operations, Maintenance, Repair, Replacement and Rehabilitation (OMRRR) and interest during construction.

The results from the analysis of each of the four economic accounts, including the CE/ICA analysis, are summarized in Table 1. The Alternatives A-3, B-3, and B-1, and Alternative F (no action) are identified as Best Buy plans through the CE/ICA, meaning these alternatives provide the greatest increase in restored habitat units for the least increase in cost. The NER plan was determined to be Alternative B-3 by the USACE. The incremental cost of additional restored AAHUs from Alternative A-3 to Alternative B-3 (the first best buy plan to the second) is justified due to the ideal location of the extra restored acres (in Old Corbin Creek), the reduced risk of the benefits being realized compared to Alternative A-3 due to the channelization of the diverted flow through Old Corbin Creek into Robe Lake, and the decreased risk of any pooling water near the proposed 450-foot gravel berm—which aims to protect Robe River subdivision from flood events.

Table 1. Four accounts evaluation summary.

	Average Annual Habitat Units Restored (Acres)	Average Annual Economic Cost ($1000)	CE/ICA Results	National Economic Development (NED)	Environmental Quality (EQ)	Regional Economic Development (RED)	Other Social Effects (OSE)
Alternative A-3	235	$281	Best Buy	$32,000	Positive	Increased employment and income for the region and state	Increased recreation and subsistence possibilities
Alternative B-1	292	$811	Best Buy	$32,000	Positive	Increased employment and income for the region and state	Increased recreation and subsistence possibilities
Alternative B-3 (NER plan)	274	$512	Best Buy	$32,000	Positive	Increased employment and income for the region and state	Increased recreation and subsistence possibilities
Alternative F	0	$0	Best Buy	$0	Neutral	Neutral	Neutral

Alternative F is the no action alternative.

1.2 Purpose

The purpose of this economic analysis is to evaluate whether the proposed ecosystem restoration project for Robe Lake is economically justified.

1.3 Elements in the Socio-economic Investigation

To assess the economic effects of the alternative ecosystem restoration plans designed to alleviate the current degradation of the Robe Lake ecosystem, this investigation includes the selection of the NER plan in conjunction with an economic analysis using the four economic accounts consistent with USACE guidance.

1.3.1 NER plan

Ecosystem restoration projects require the selection of an NER plan from the suite of alternative plans which have been developed by the PDT and local community members to restore the Robe Lake ecosystem from its degraded condition. The NER plan maximizes the ecosystem restoration benefits while minimizing monetary cost consistent with the Federal objective. This is done using the tools and methodology discussed in this appendix's Section 7.0 NER plan.

1.3.2 Four Economic Accounts

To present the most comprehensive analysis of the benefits and the costs for this ecosystem restoration project, the alternatives were also evaluated using the four accounts established in the Economic and Environmental Principles and Guidelines for

Water and Related Land Resources Implementation Studies:

- **The National Economic Development (NED):** Displays changes in the economic value of the national output of goods and services.
- **The Environmental Quality (EQ):** Displays effects on significant natural and cultural resources.
- **The Regional Economic Development (RED):** Displays the regional and localized economic impacts that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output, and population.
- **The Other Social Effects (OSE):** Registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts.

1.4 General Methodology

This Economic Appendix presents the socio-economic issues of implementing a CAP 206 ecosystem restoration project at Robe Lake. The primary effects of the project are the costs of implementation and the environmental benefits (i.e., ecosystem restoration and improvements). These costs and benefits are incorporated into a CE/ICA, which is the primary tool used by USACE in the socio-economic evaluation of an environmental restoration project.

Project implementation costs are monetarily expressed in terms of the national project cost (NED costs). Project costs also have regional impacts, as expenditures on the project within the regional economy can cause changes in local and regional earnings, sales, and employment. While the costs of implementation are expressed in traditional monetary terms, ecosystem improvement, the most significant beneficial effect of the project is expressed in non-monetary terms.

Ecosystem improvement is expressed in terms of NER benefits per USACE policy which are average annual habitat units (AAHUs) restored, and more specifically for the Robe Lake ecosystem restoration project are acres of restored habitat for the lifespan of the project (50 years). A plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected for ecosystem restoration projects.

The potential non-environmental restoration economic impacts of a restoration plan are secondary consequences of the environmental improvements and hydrologic changes expected as a result of the proposed structural and operational modifications to the project study area. These projected impacts are contingent upon the successful implementation and operation of restoration plans and subsequent outputs and, therefore, subject to the uncertainties inherent in ecosystem restoration activities.

Environmental restoration benefits are calculated by subtracting the future without project (FWOP) AAHUs from the future with project (FWP) AAHUs for each alternative. To compare measures, environmental outputs, and costs were annualized over a 50-

year planning horizon using the FY23 Federal Discount Rate of 2.5% (per EGM 23-01 dated 15 October 2022). The resulting benefits are then used, along with annual costs, to identify cost-effective plans and perform incremental cost analysis.

2.0 Background

2.1 Study Area

Robe Lake is located within the northern portion of Prince William Sound in southcentral Alaska and lies within the city limits of Valdez. Robe Lake is the largest freshwater lake in the Valdez area, about 680 acres, and has three tributary streams: Brownie Creek, Deep Creek, and Old Corbin Creek (also known as the relic channel of Corbin Creek). Robe Lake empties into Robe River, which flows under the Richardson Highway into the Lowe River. Figure 1 shows Robe Lake, Corbin Creek and its tributaries, Robe River, and the Robe River Subdivision. (For a more detailed description of the study area, please reference Section 1.4 in the Integrated Feasibility Report and Environmental Assessment (IFR-EA).

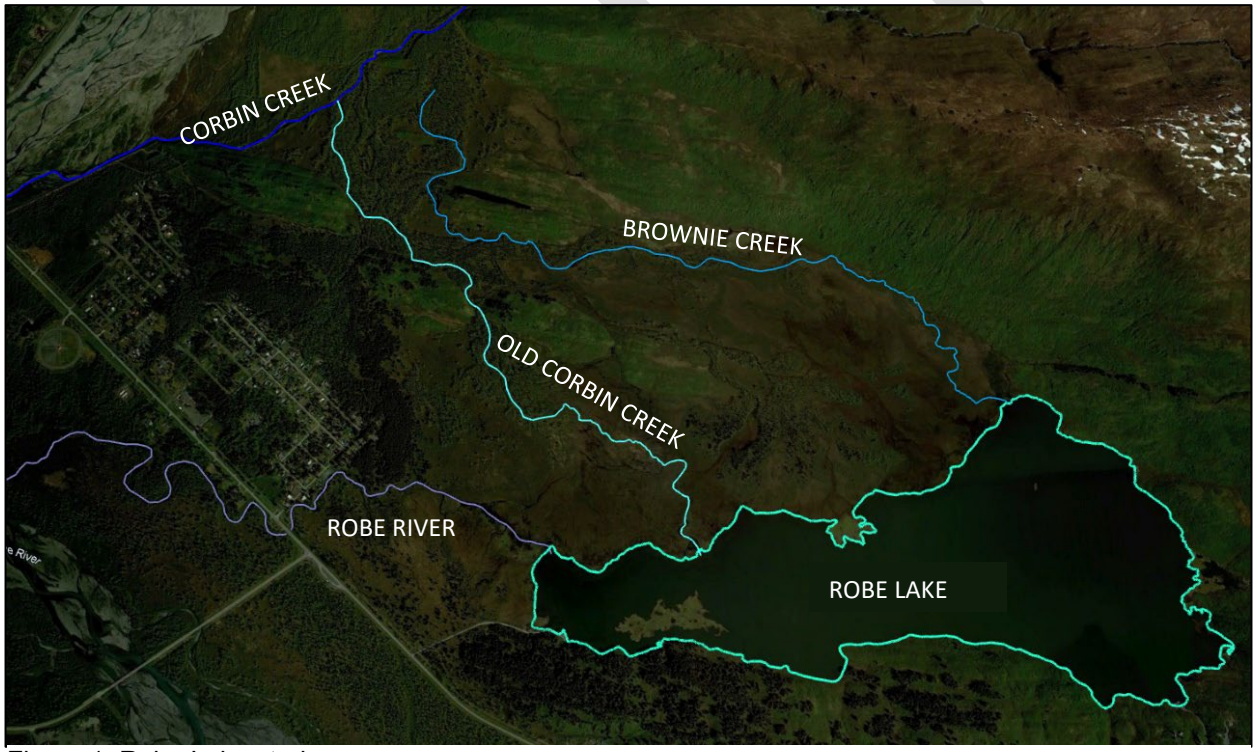


Figure 1. Robe Lake study area.

In the 1950s a gravel berm (Figure 2) was constructed on Corbin Creek to divert flow and prevent flooding and washout of the Richardson Highway. Prior to this diversion, the main channel of Corbin Creek originally flowed into Robe Lake via Old Corbin Creek. Currently, Corbin Creek does not flow into Robe Lake. Corbin Creek's historic channel is now known as Old Corbin Creek, a relic channel with minimal flow.

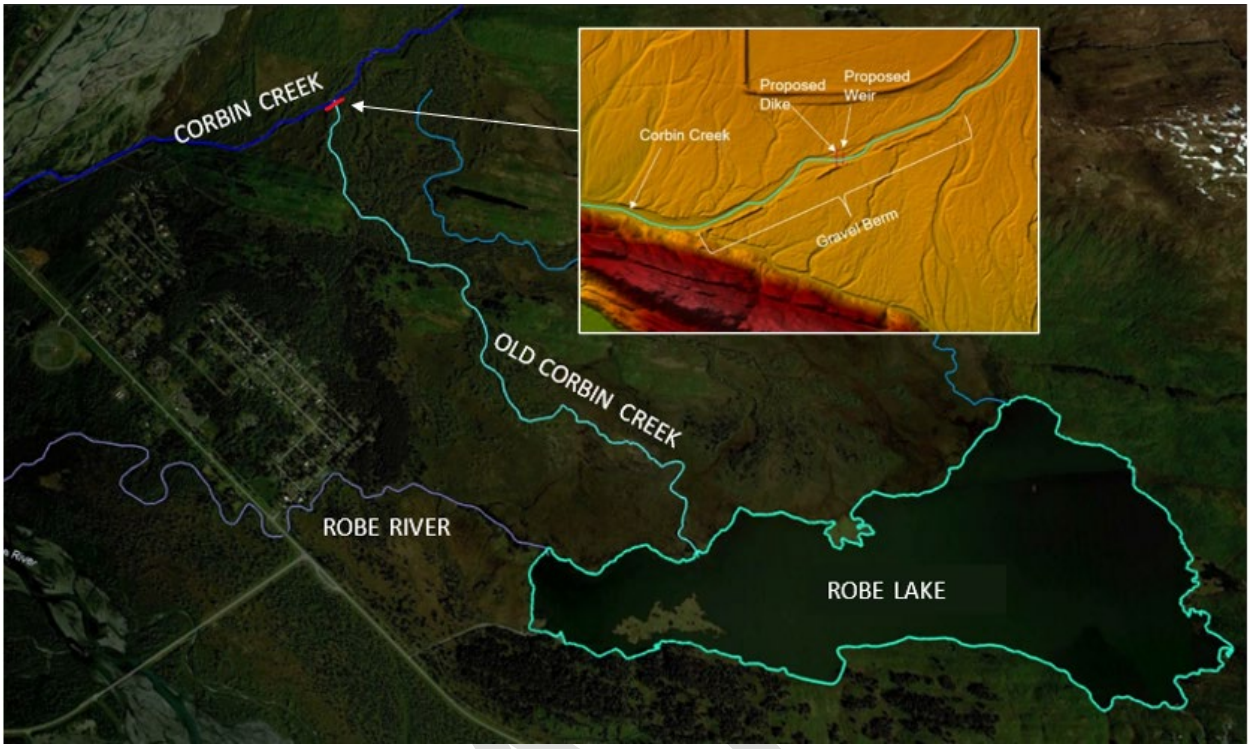


Figure 2. 1950's original gravel berm location

2.2 Problem Statement

At Robe Lake, historical human induced hydrologic impacts resulting from a diversion of Corbin Creek have resulted in broad scale effects. The loss of cold, turbid, glacial flow from the Corbin Creek tributary has led to an excessive overgrowth of macrophytes. The macrophytes have impacted salmonid habitat by reducing available rearing and spawning habitat. Current mitigation requires mechanical harvesting of excess macrophytes. Mechanical harvesting of excess macrophytes has a high operational cost and is time-consuming.

2.3 Opportunities

The opportunities associated with the Robe Lake ecosystem restoration project determined by the local sponsor and the PDT are as follows:

- Improvements to the Robe River crossing on Richardson Highway to incorporate stream function. This can include fish passage, ecosystem connectivity, and flood event risk mitigation.
- Enhance habitat for wildlife species within the area (i.e., migratory birds, furbearing species).
- Decommissioning of heavy machinery used to mitigate the overgrowth of macrophytes, which would reduce operational cost and environmental hazards (i.e., accidents, fuel spills).

- Restore flow into historic tributary channels.
- Opportunities for increased accessibility of recreational activities within the Robe Lake watershed.

2.4 Infrastructure

Infrastructure built around Robe Lake is shown in Figure 3. Important infrastructure for this project includes the Robe River Subdivision, built near Robe Lake and along the Richardson Highway. Several parcels of land along River Dr. either back up to or include sections of Robe River and have been developed as part of the Robe River Subdivision. Also, the Robe River Firehall, responsible for responding to local emergencies, is located near the southern entrance of the Robe River subdivision on River Dr.

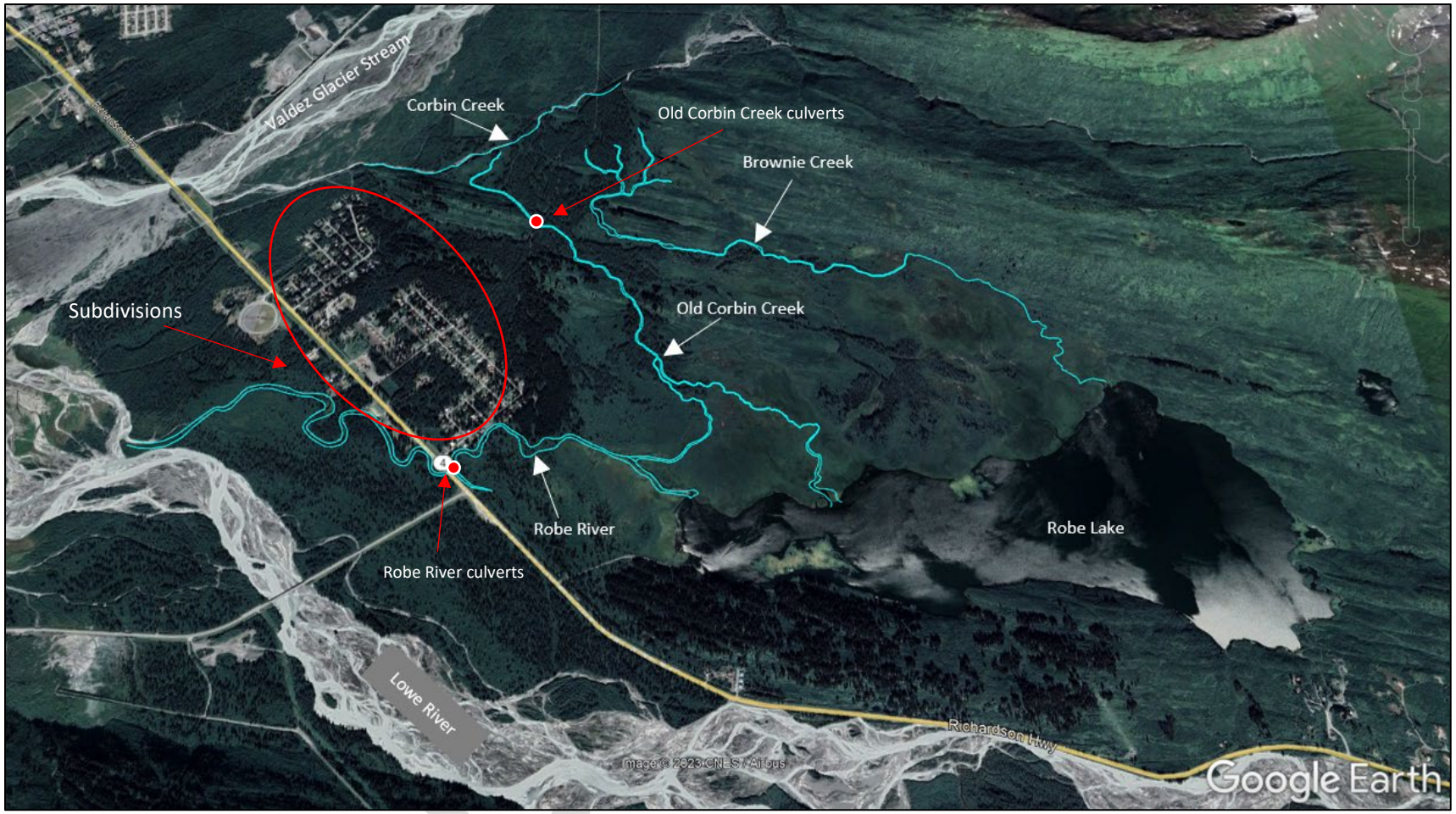


Figure 3. Built environment and existing infrastructure near Robe Lake.

3.0 Demographics

The people who live in the study area, and the economic activity in which they are engaged, comprise important components of the area's total economic environment.

3.1 Population

Robe Lake is within the city limits of Valdez and the Chugach Census Area. Table 2, Table 3, and Table 4 represent the existing and trending population and demographics for the Chugach Census Area, for which the Valdez area makes up roughly 50% of the population. The population, as projected by the American Community Survey (ACS), is estimated to hold relatively steady for the next twenty-five years. Most of the population identifies as white (~76%), with the next highest ethnicity identifying as two or more races (~10%).

Table 2.Current and projected population of the Chugach Census area.

Year	Current or Projected Population	Average Annual Growth Rate
2023	7,102	
2025	7,001	0.0%
2030	6,946	-0.2%
2035	6,855	-0.3%
2040	6,758	-0.3%
2045	6,652	-0.3%
2050	6,547	-0.3%

2020 ACS 5-Year Population Projection Tables.

Table 3. Age and gender profile for Valdez and Alaska, 2020.

Area	Population	Male	Female	Under 5 years old	Under 20 years old	Over 65 years old
Alaska	736,990	384,653	352,337	52,302	200,779	87,629
Valdez City	3,985	2021	1791	266	868	507

2020 ACS 5-Year Estimates Subject Tables.

Table 4. Ethnic profile for Valdez and Alaska, 2020.

	Alaska	Valdez	Percentage of Valdez Population
TOTAL	733,391	3,985	X
White	435,392	3,015	76 %
Alaska Native/Native American	111,575	309	8 %
African American	21,898	33	1 %
Asian	44,032	103	3 %
Other	30,970	113	3 %
More than one race	89,524	412	10 %

US Census Bureau, Decennial Census 2020, and American Community Survey Estimates.

3.2 Economy

Valdez's economy is based on oil, tourism, commercial fishing, shipping/transportation, and city and state government.

The unemployment rate for Valdez is roughly 4.3% roughly the same as that for Alaska. The per capita income in Valdez is $44,859, which is higher than Alaska's $39,509 as of 2021. The city's median household income is also higher than the state's, at $99,151 vs $80, 287 for Alaska[1]. It is important to note that Alaska's high cost of living is a factor in how these should be interpreted.

4.0 Existing Conditions

4.1 Total Study Area Habitat Acres

Ecosystem improvement is expressed in terms of NER benefits per USACE policy which are AAHUs restored. For the Robe Lake ecosystem restoration project, a restored habitat unit is an acre of improved habitat that meets the standard for ideal salmonid spawning and rearing. For further details on determination of ideal spawning and rearing habitat please see the Environmental Appendix's discussion on the *General Salmonid Habitat Model*.

For this project, habitat is being improved in Robe Lake, and whichever tributary (i.e., Old Corbin Creek or Brownie Creek) would be chosen to redirect the flow of Corbin Creek. The study area has a little over 709 acres of habitat; 680 acres stemming from Robe Lake, 10 acres from Brownie Creek, and 19 acres from Old Corbin Creek, respectively (Table 5).

Table 5. Total acres of habitat in the study area.

	Acres
Robe Lake	*680*
Old Corbin Creek	*19*
Brownie Creek	*10*
TOTAL Study Area (Acres)	*709*

4.2 Weed Harvesting

Valdez Fisheries Development Association (VFDA) has a long history of maintaining salmonid spawning habitat within the Robe Lake watershed. VFDA has conducted mechanical weed harvesting of excess macrophytes since the 1990s (Figure 4). However, mechanical harvesting of excess macrophytes has a high operational cost, is time-consuming, and has limited overall success.

Due to the excessive macrophyte growth in Robe Lake, operations include harvesting

[1] U.S. Census Bureau; American Community Survey, 2021 American Community Survey 5-Year Estimates, <https://data.census.gov/cedsci/>

the growth regularly. From FY21-FY23, the city has budgeted an average of $31,506 annually for weed harvesting OMRRR. A new mechanical weed harvester was purchased in 2023 for $289,355 and has an expected service life of 25 years.

Figure 4. Mechanical weed harvesting of macrophytes at Robe Lake by VFDA.

4.3 Flood event Risk

Figure 5 and Figure 6 show the existing condition and FWOP condition during a 1% or 0.2% Annual Exceedance Probability AEP (AEP) flood event (respectively). According to the HEC-RAS flood event models (see the Hydraulics and Hydrology Appendix for further details), during a 1% AEP flood event, two structures would have up to 0.5 feet of flooding over their first-floor elevation (FFE). The FFE was determined to be equivalent to the structure's foundation height and/or the lowest point of entry for water to reasonably enter the structure during a flood event. For a 0.2% AEP flood event, eight structures would have up to 1.26 feet of flooding over their FFE. The objective of this project is to maximize ecosystem restoration benefits while simultaneously not inducing flooding. The USACE screened alternatives that induced any level of flooding relative to the FFE.

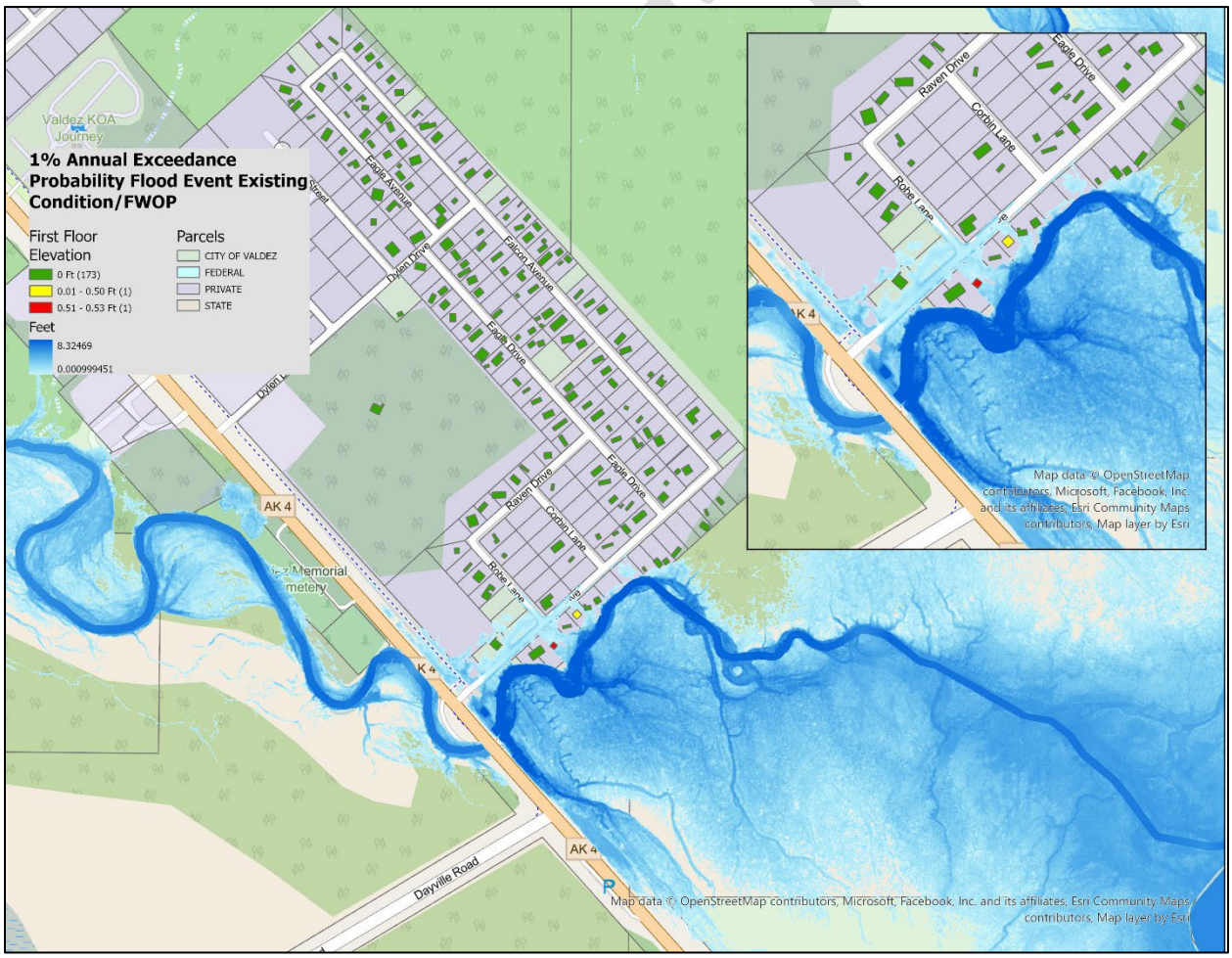


Figure 5. FWOP conditions; the 1% AEP flood event.

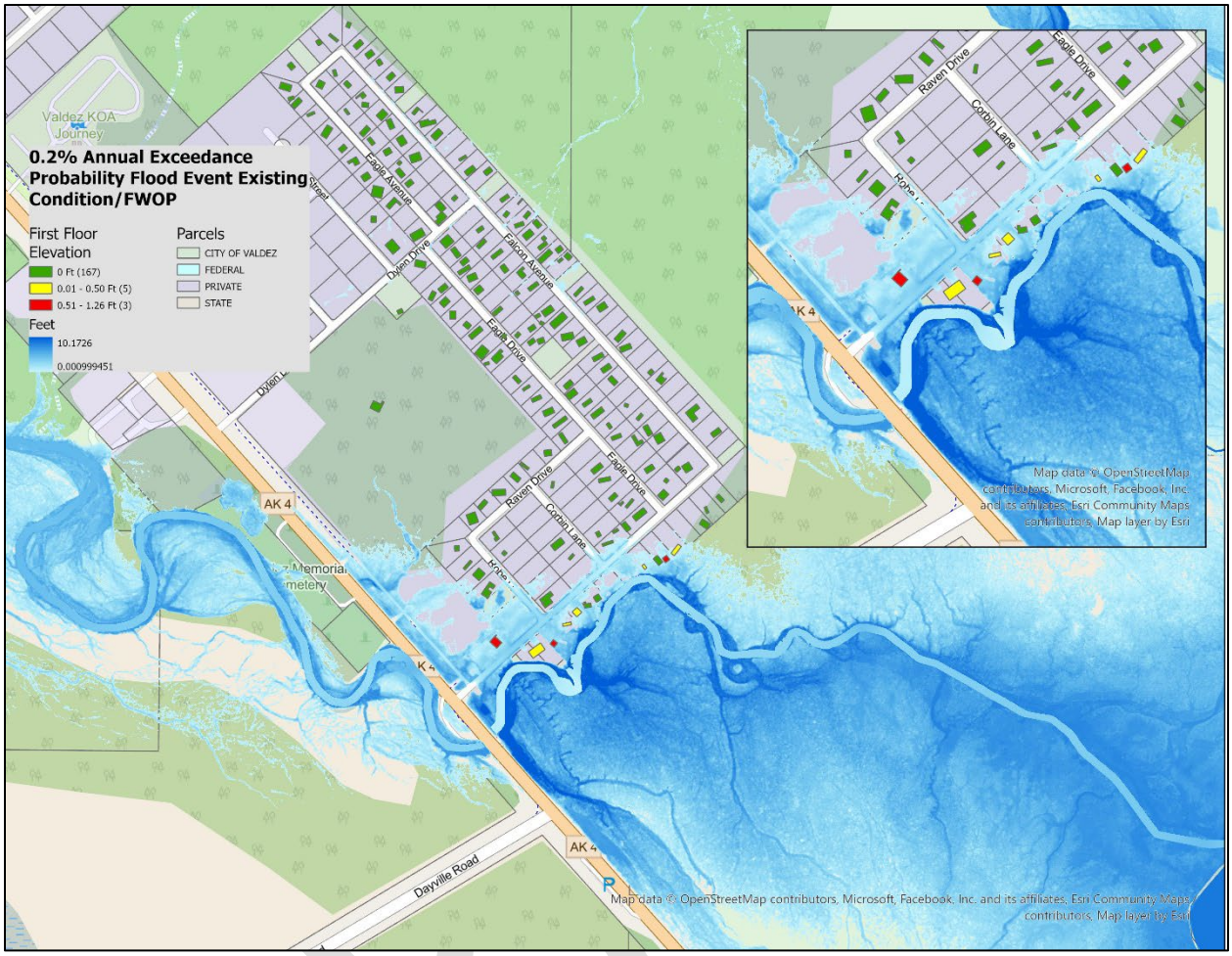


Figure 6. FWOP conditions; the 0.2% AEP flood event.

5.0 Measures and Alternatives

Plan formulation is the process of building alternative plans that meet planning objectives and avoid planning constraints. Alternative plans are a set of one or more management measures functioning together to address the study objectives. A management measure is a feature or activity that can be implemented at a specific location to address one or more of the objectives.

Alternative plans are combinations of management measures used to address the identified problems. During the charrette, the USACE and local community members developed a suite of alternatives (Alternatives A through F); however, the alternatives were iteratively modified to account for additional flood event mitigation measures (discussed in further detail in this appendix's Section 6.0 Flood event Mitigation Analysis). Table 6 shows the full suite of alternatives with a brief description of the management measures they include.

It is important to note that the "B" alternatives include all the same management measures as the "A" alternatives. However, Alternative B includes approximately an extra 1.5 miles of dredging of Old Corbin Creek and Alternative B-1 includes a bridge over the Richardson Highway instead of culverts. The primary purpose of the extra dredging is to provide additional spawning and rearing habitat in Old Corbin Creek and to control the redirected flow more easily into Robe Lake. The second and third iterations of Alternatives A and B (A-2, A-3, B-2, and B-3) include all the measures of the original alternatives (A or B) but with different sized culverts under the Richardson Highway to prevent any induced flooding in the Robe River subdivision by enhancing flow through Robe River while simultaneously maximizing ecosystem restoration benefits.

Alternative C and D were screened out early in the study process due to engineering concerns (See the Hydraulics and Hydrology Appendix for further details) and induced flooding concerns (see this Appendix's Section 6.0 Flood event Mitigation Analysis). Alternative E involved chemical intervention in suppressing macrophyte growth in Robe Lake; this alternative was also screened out due to its nature of not restoring the ecosystem but responding to the symptoms of the problem. For a full breakdown of the alternatives, the measures, or the screening process, please reference Sections 3.0 and 4.0 in the IFR-EA.

Table 6. Initial array of alternatives developed from measures.

	MEASURES										
	TRAINING DIKE ON CORBIN CREEK	CHANNELIZATION OLD CORBIN CREEK	REPLACE ALPETCO CULVERTS WITH BRIDGE	BERM IN LOW AREA BETWEEN BLUFS NEAR ALPETCO CULVERTS	REPLACE ROBE RIVER CULVERTS: THREE 12.75'	REPLACE ROBE RIVER CULVERTS THREE 14'	REPLACE ROBE RIVER CULVERTS DOT BRIDGE	WEIR ON CORBIN CREEK	CHANELIZATION ON BROWNIE CREEK	NON-STRUCTURAL (NATURE BASED)	NON-STRUCTURAL (HERBICIDE, MECHANICAL HARVESTING)
Alternative A	✓										
Alternative A-1	✓	✓	✓	✓							
Alternative A-2	✓	✓	✓	✓	✓						
Alternative A-3	✓	✓	✓	✓		✓					
Alternative B	✓	✓	✓	✓						✓	
Alternative B-1	✓	✓	✓	✓			✓			✓	
Alternative B-2	✓	✓	✓	✓	✓					✓	
Alternative B-3	✓	✓	✓	✓		✓				✓	
Alternative C		✓	✓	✓				✓			
Alternative D	✓								✓		
Alternative E											✓
Alternative F											

Note that Alternative F is the no-action alternative.

6.0 Flood event Mitigation Analysis

The alternatives for this project, apart from a non-structural alternative (Alternative E) and the no-action alternative (Alternative F), involve redirecting Corbin Creek into Robe Lake using either Old Corbin Creek or Brownie Creek. The redirection of Corbin Creek is expected to meet project objectives and improve the ecosystem at Robe Lake; however, it also increases levels of outflow on the Robe River. The Robe River subdivision, located west of Robe Lake and just north of Robe River (Figure 3), became an area of concern for induced flooding in the FWP conditions. USACE did not carry forward any alternative for further analysis that induced flooding to any structure in the area.

6.1 Methodology

To determine if any of the proposed alternatives induced flooding, the USACE hydraulic and hydrology engineers provided flood event maps using HDF files from HEC-RAS modeling to determine the FWOP and FWP water depths in the study area for a 1% and 0.2% AEP flood event. For more information on the HEC-RAS modeling, please see the Hydraulics and Hydrology Appendix. Data for parcel and structure information was acquired through the City of Valdez, Federal Emergency Management Agency (FEMA), and the USACE National Structure Inventory 2.0 (NSI 2.0).

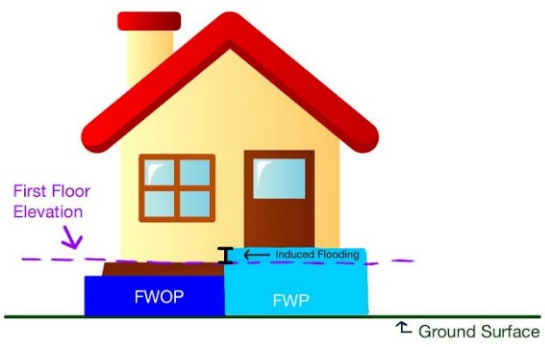
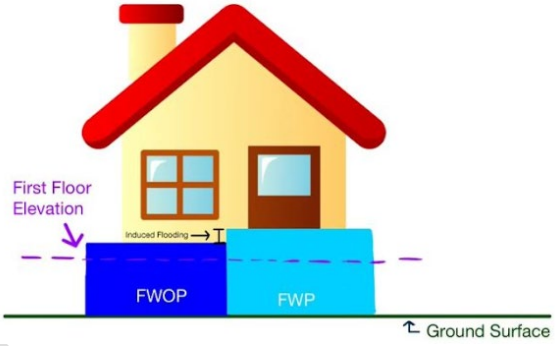
For this study, *induced flooding* was determined to be an increase in water depth relative to the structure's first-floor elevation (FFE) due to the implementation of a project alternative. The FFE was determined to be equivalent to the structure's foundation height and/or the lowest point of entry for water to reasonably enter the structure during a flood event. FFEs were determined for each structure using NSI 2.0, topographic maps, and a Google Earth Windshield survey. Based on the data collected and local knowledge of the area, an assumption was made that these homes do not have basements or backdoor walkouts. Flood event inducement levels could change if these homes were determined to have basements.

To determine a baseline level of flooding during a 1% and 0.2% AEP flood event, water depth was extracted from the HEC-RAS models at the location of each structure in the existing condition. This process was repeated for each alternative, the depth of the water during a 1% and 0.2% AEP flood event was modeled as if the alternative had been constructed, and the water depth (from the model) was extracted at each known structure. This gave the water depth at a structure during a potential flood event "as is", and the water depth at a structure during a flood event for each of the proposed alternatives.

For induced flooding to occur, the FWP water depth during a flood event would need to be higher than both the FFE and the FWOP. No flooding would be induced if the FWOP and FWP depths were below the FFE. If the FWOP depth is below the FFE, but the FWOP is above the FFE, the amount of induced flooding would be the difference between the FWP depth and the FFE. If the FWOP water depth is above the FFE and

the FWP water depth is greater than the FWOP water depth, then flooding will be induced. Table 7 provides an explanation on induced flooding. Any alternatives that induced flooding were modified until the alternative induced no flooding or were screened from further consideration.

Table 7. Induced flooding explanation.

	FWOP < FFE	***FWOP > FFE***
FWP > FFE	***Induced flooding (FWP-FFE)*** 	***Induced flooding (FWP-FWOP)*** 
FWP < FFE	***No Induced flooding[2]*** 	***Reduced flooding[3]*** 

6.2 FWOP Flooding

Without the implementation of a project, the FWOP conditions for flooding are assumed to be the same as the existing conditions (see this Appendix's Section 4.3 Flood event Risk).

6.3 FWP Flooding

The following section shows flood event maps for the subsection of the project area that presented a potential for induced flooding with the implementation of the project

[2] The FWP could be greater than the FWOP in this scenario, however both the FWP and FWOP need to be less than the FFE.

[3] The FWP depth is less than the FWOP depth; therefore, the implementation of a project reduced flood eventing even though the water depth is above the FFE.

alternatives. Induced flooding potential only presented a problem to structures located at the southern entrance of the Robe River Subdivision and properties that border Robe River on River Dr.

On the flood event maps below, circles or polygons represent structures. Circles or polygons coded green signal no induced flooding, yellow circles or polygons signal induced flooding between 0.01 feet to 0.50 feet, and red circles or polygons indicate over 0.50 feet of induced flooding.

*It is important to note this flood event mitigation analysis effort is relative to the structure's first-floor elevation, not the ground surface. Also, induced flooding is the depth above the flood event depth expected during an AEP flood event without a project while also taking into account the structure's FFE. Please reference the existing conditions flood event mapping for more explanation of flood event analysis terminology, Section 4.3 Flood event Risk or Section 6.1 Methodology of this appendix).

6.3.1 Alternative A-1

Modeling for Alternative A-1 showed two structures with induced flooding above 0.50 feet, and one between 0.01-0.50 feet. The left most red circle in Figure 7 is a firehall that serves during emergency events in the local area. This alternative would be inducing flooding to the firehall as well as several other structures. Figure 7 and Figure 8 show modeling for a 1% and 0.2% AEP flood event after the implementation of Alternative A-1.

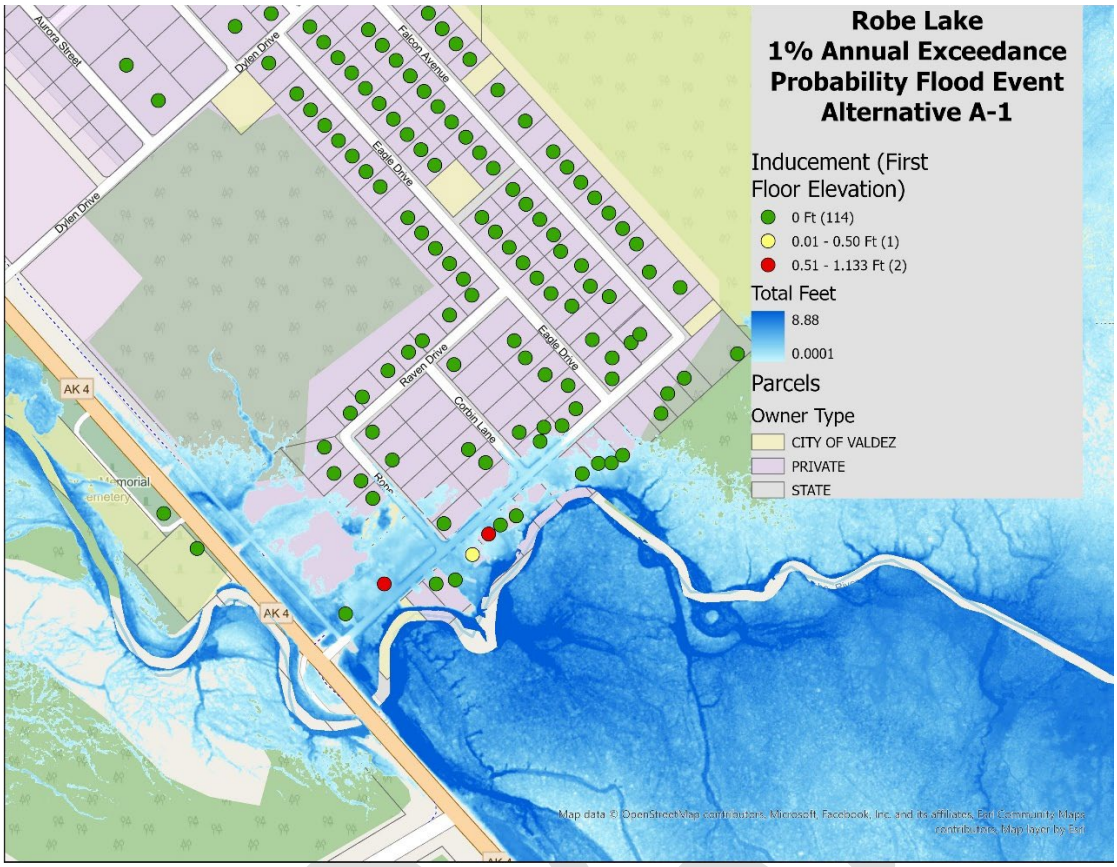


Figure 7. Alternative A-1, 1% Annual Exceedance flood event.

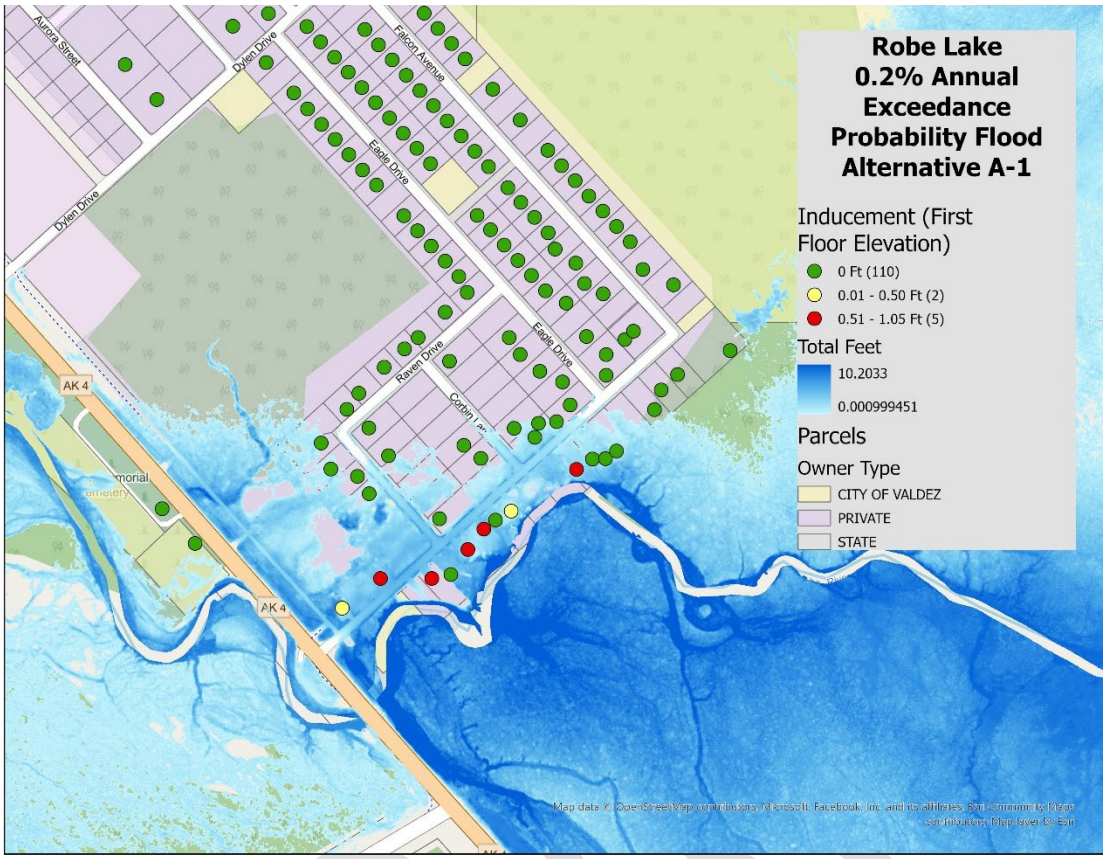


Figure 8. Alternative A-1, 0.2% AEP Flood event.

6.3.2 Alternative A-2

Alternative A-2, which has slightly larger culverts under the Richardson Highway than Alternative A-1, shows less induced flooding than Alternative A-1. However, during a 0.2% AEP flood event, the modeling indicates two structures would still be induced by 0.01-0.50 feet. Figure 9 and Figure 10 show modeling for a 1% and 0.2% AEP flood event after the implementation of Alternative A-2.

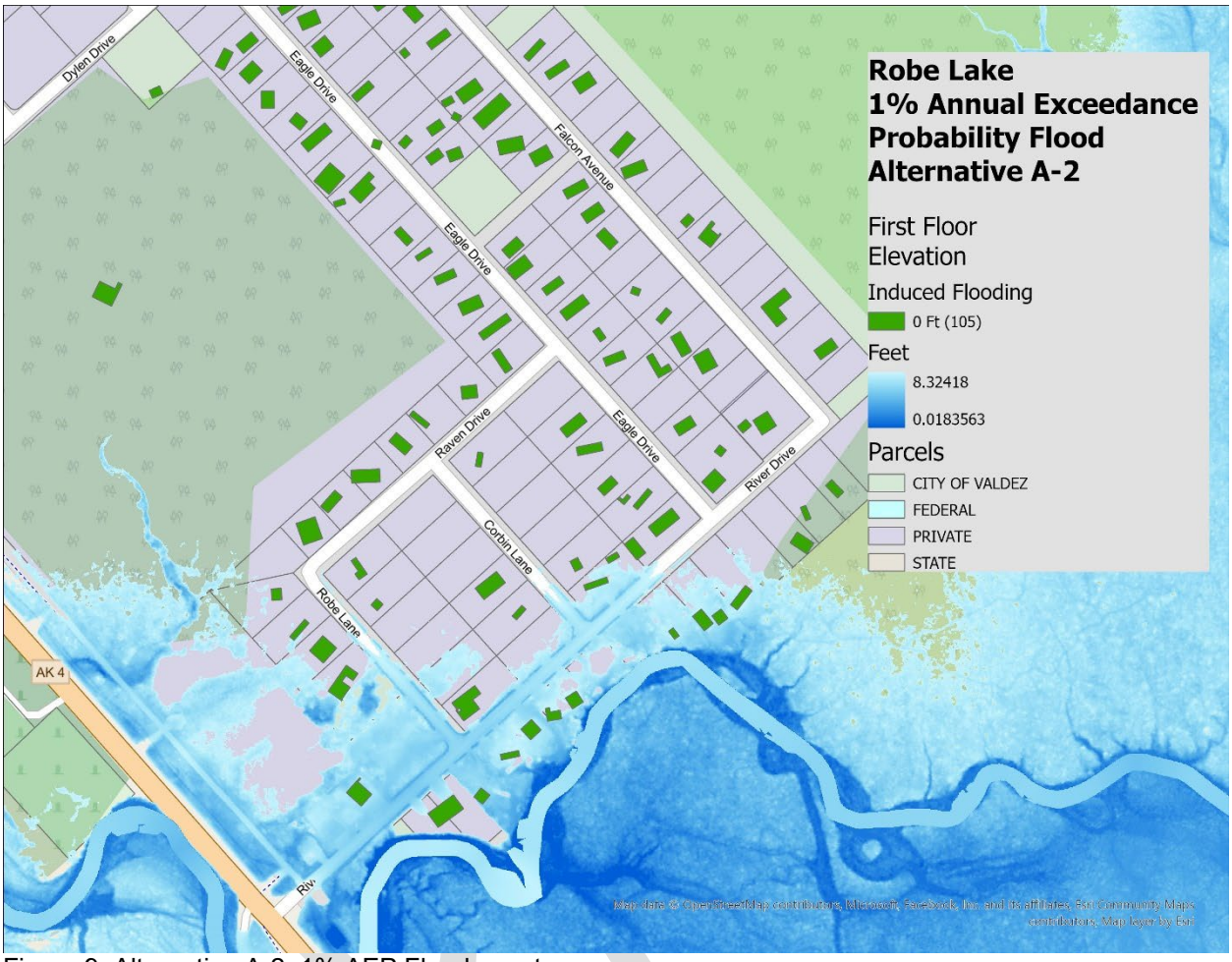


Figure 9. Alternative A-2, 1% AEP Flood event.

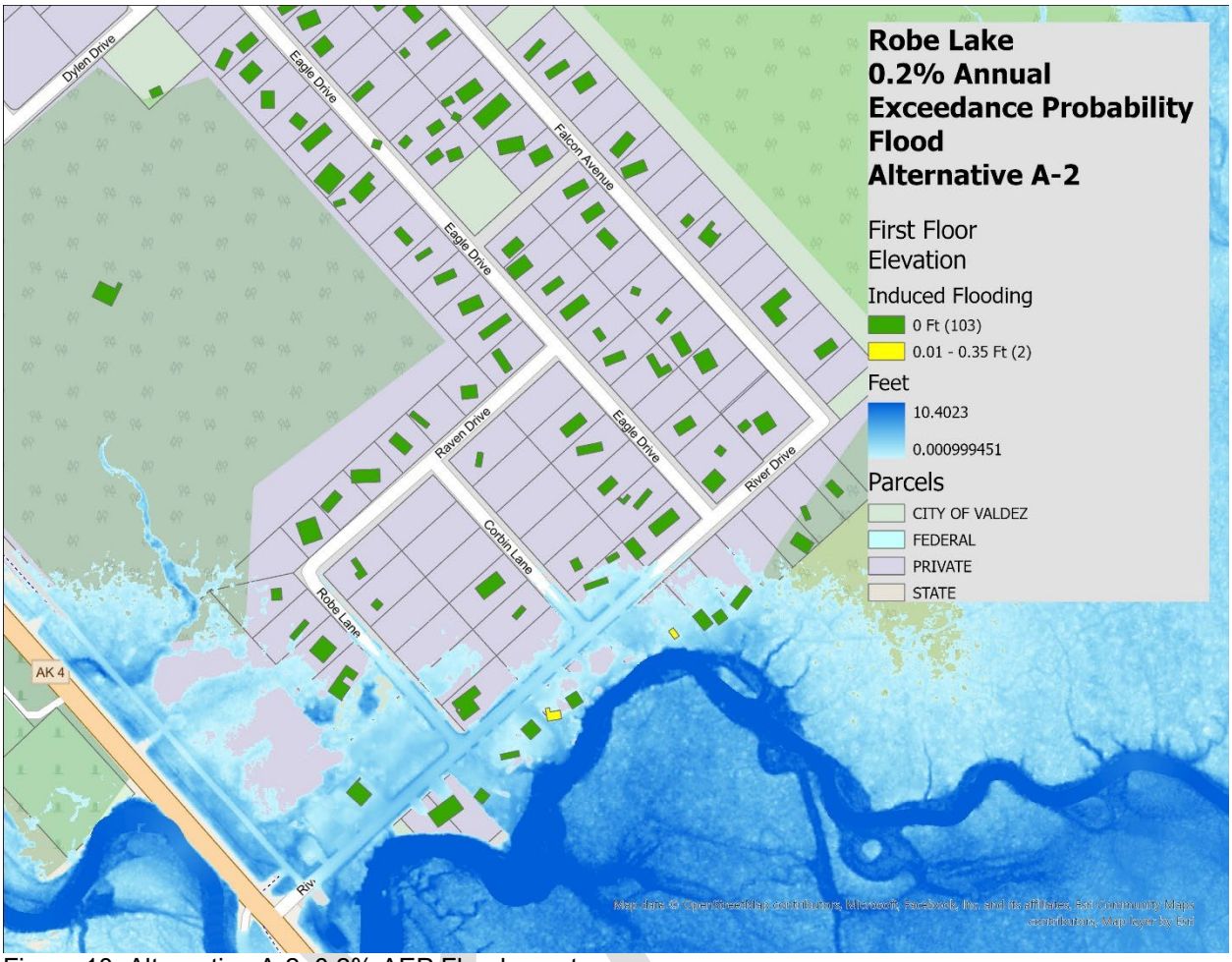


Figure 10. Alternative A-2, 0.2% AEP Flood event.

6.3.3 Alternative A-3

Alternative A-3, which has an extra culvert under the Richardson Highway compared to Alternatives A-1 and Alternative A-2, shows no induced flooding during a 1% or 0.2% AEP flood event shown in Figure 11 and Figure 12.

Figure 11. Alternative A-3, 1% AEP flood event.

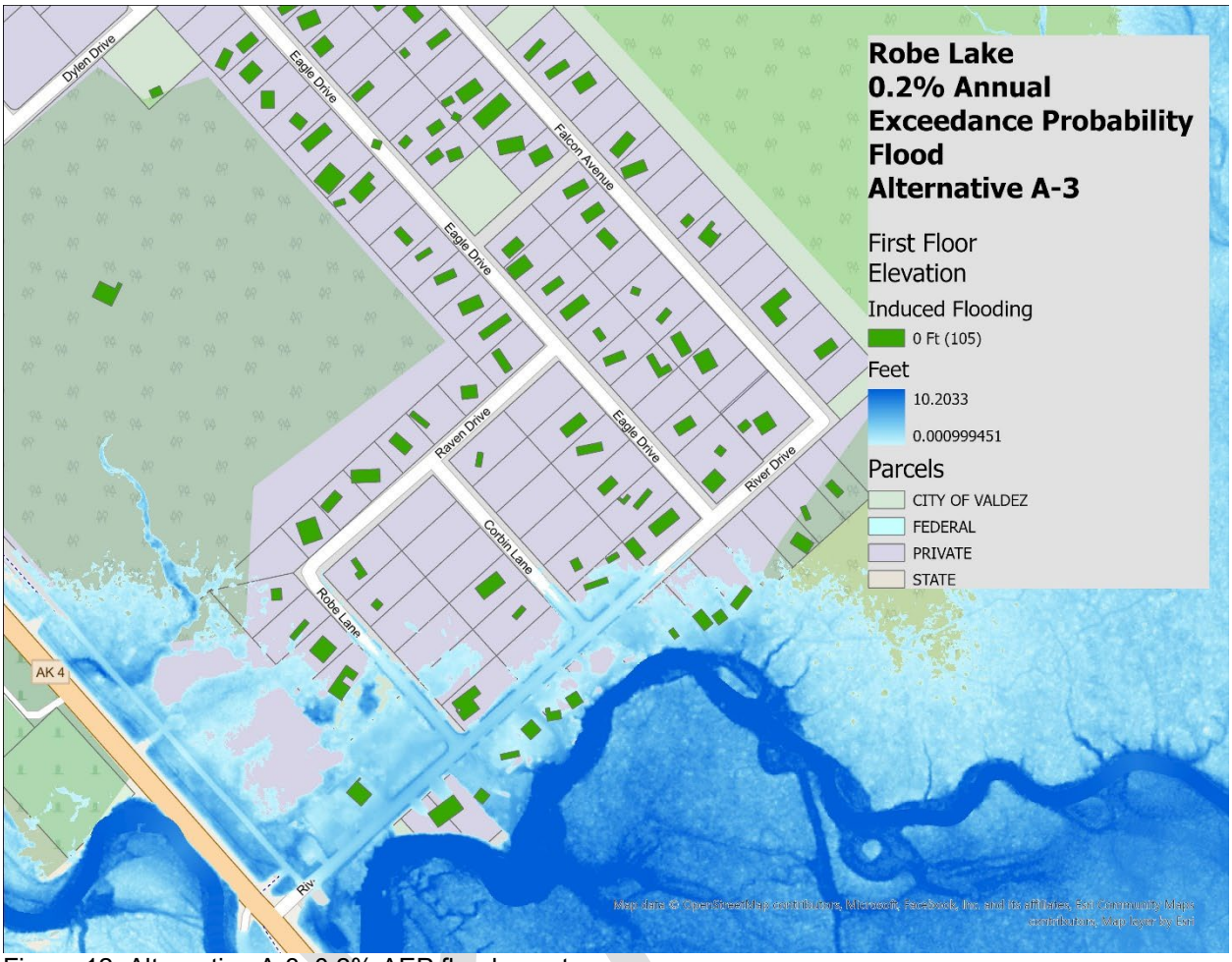


Figure 12. Alternative A-3, 0.2% AEP flood event.

6.3.4 Alternative B-1

Alternative B-1 did not show induced flooding, in fact, it showed a small reduction in flooding during a 1% and 0.2% AEP flood event (Figure 13 and Figure 14). However, Alternative B-1 includes a large 50-foot span AKDOT bridge over the Richardson Highway, making the cost of the project much greater than the other alternatives (also over the federal CAP spending limit, see the IFR-EA for more details).

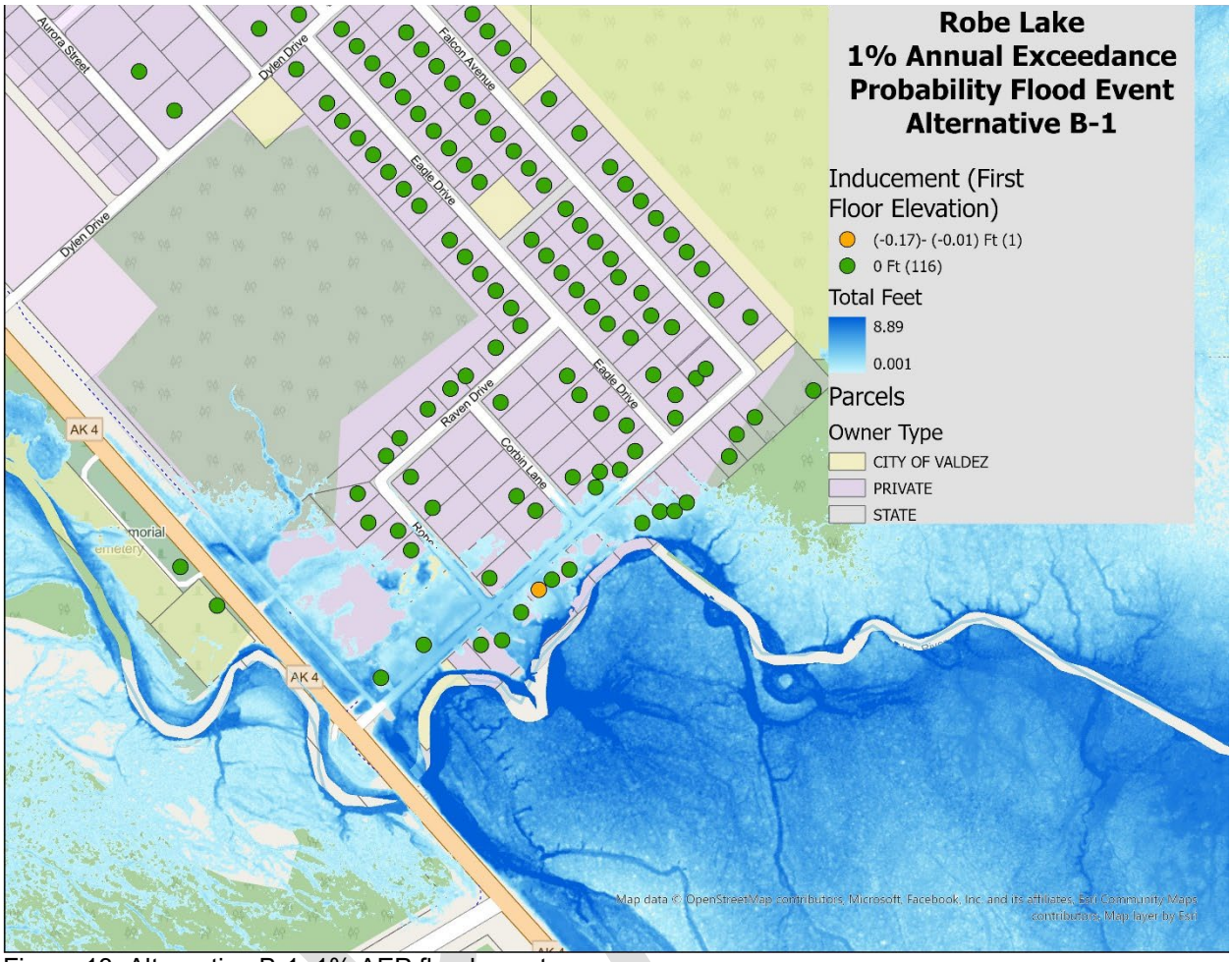


Figure 13. Alternative B-1, 1% AEP flood event.

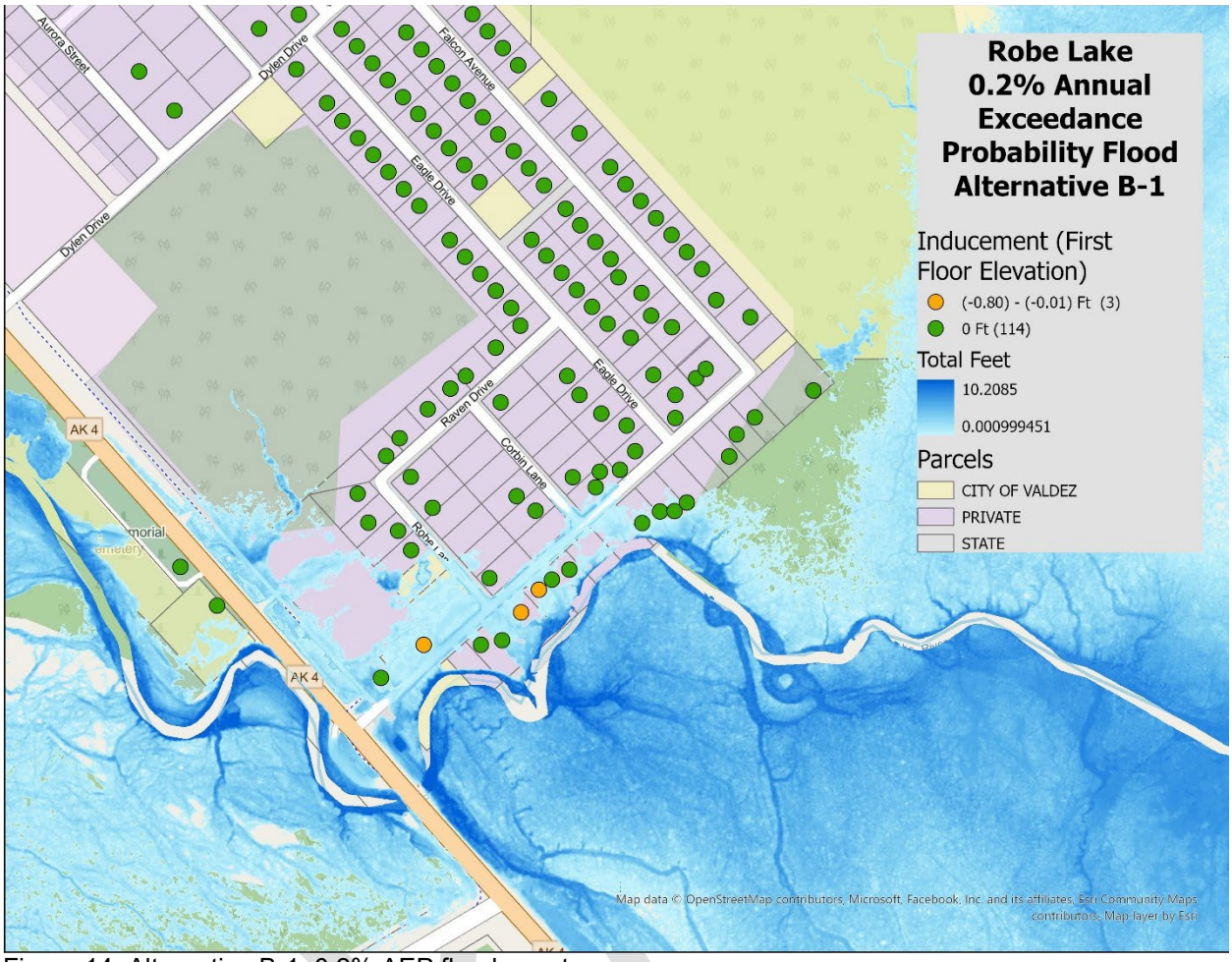


Figure 14. Alternative B-1, 0.2% AEP flood event.

6.3.5 Alternative B-2

Alternative B-2, which includes culverts identical to those in Alternative A-2 but with the included measure of approximately 1.5 miles of dredging of Old Corbin Creek shows induced flooding of two structures during a 0.2% AEP flood event. Figure 15 and Figure 16 show modeling for a 1% and 0.2% AEP flood event after the implementation of Alternative B-2.

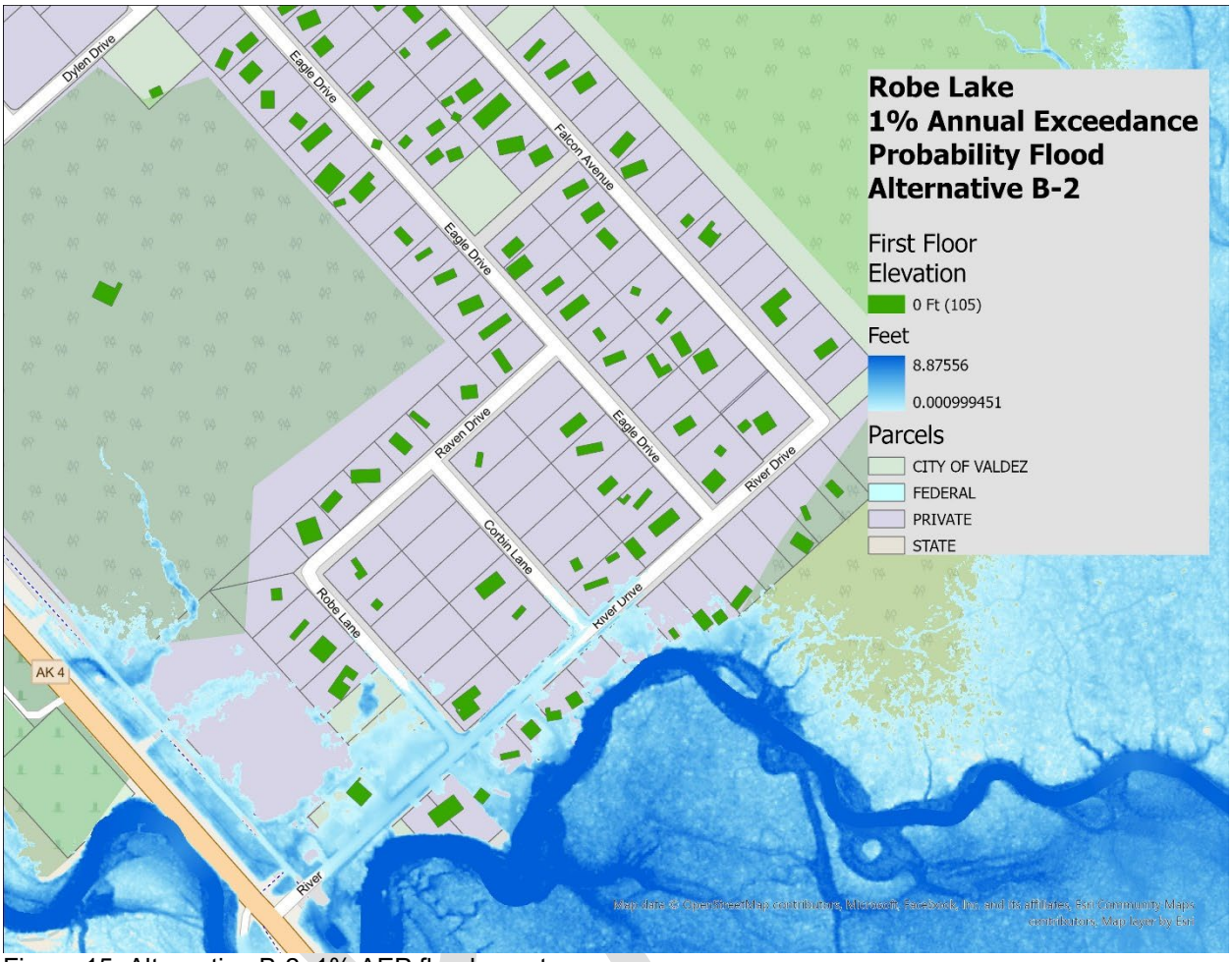


Figure 15. Alternative B-2, 1% AEP flood event.

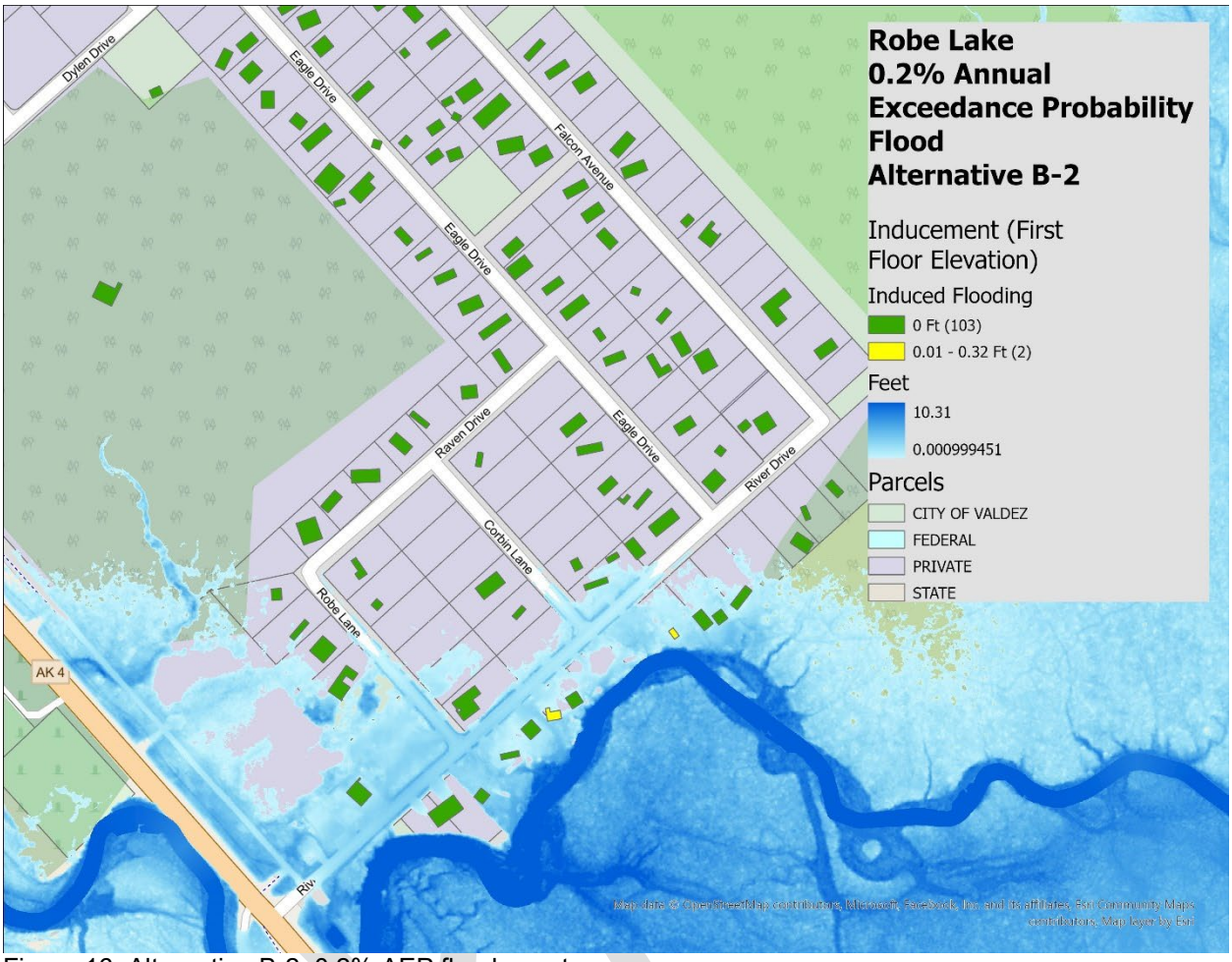


Figure 16. Alternative B-2, 0.2% AEP flood event.

6.3.6 Alternative B-3

Alternative B-3 showed no induced flooding during the 1% and 0.2% AEP flood event in the Robe River subdivision (Figure 17 and Figure 18) during modeling efforts.

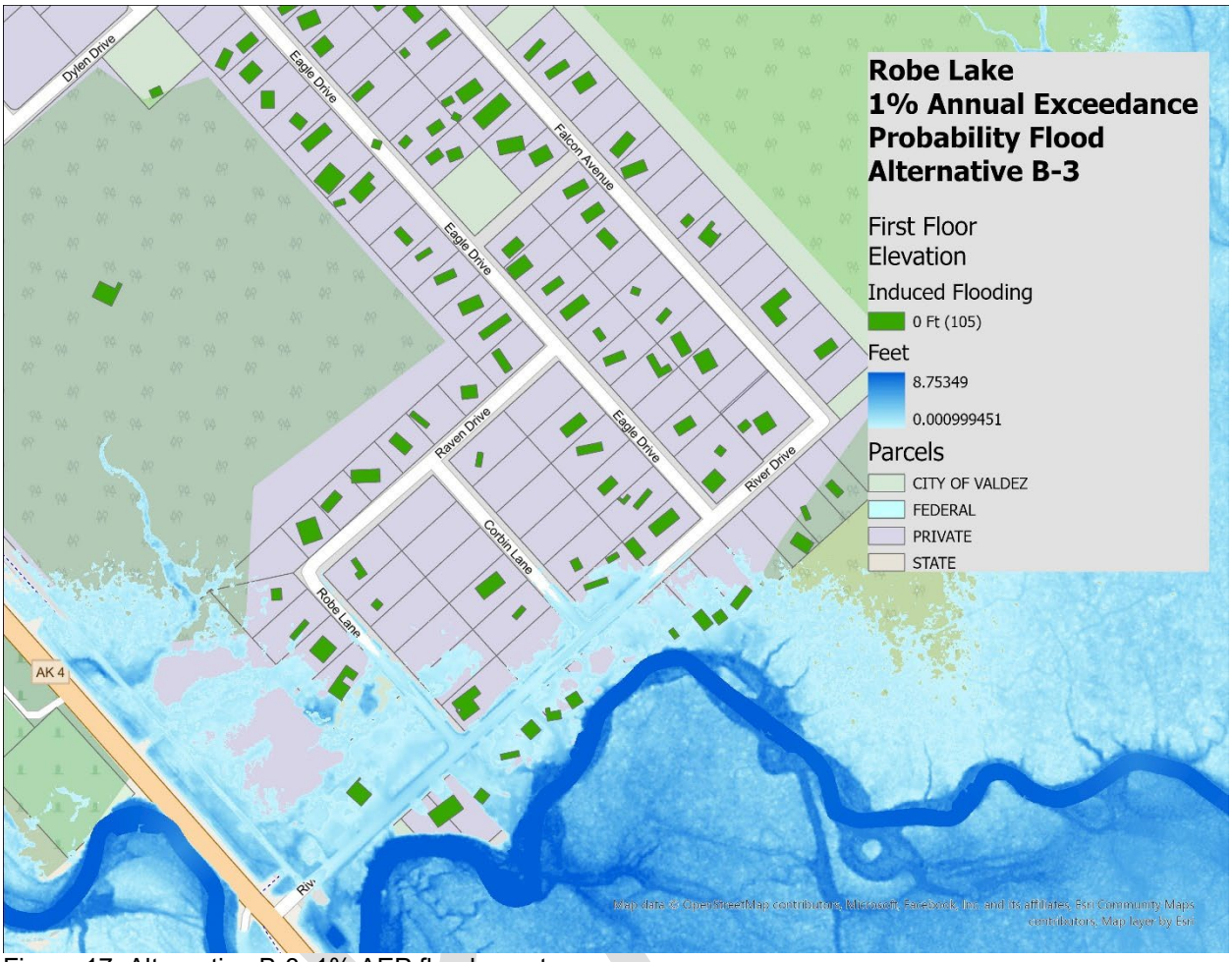


Figure 17. Alternative B-3, 1% AEP flood event.

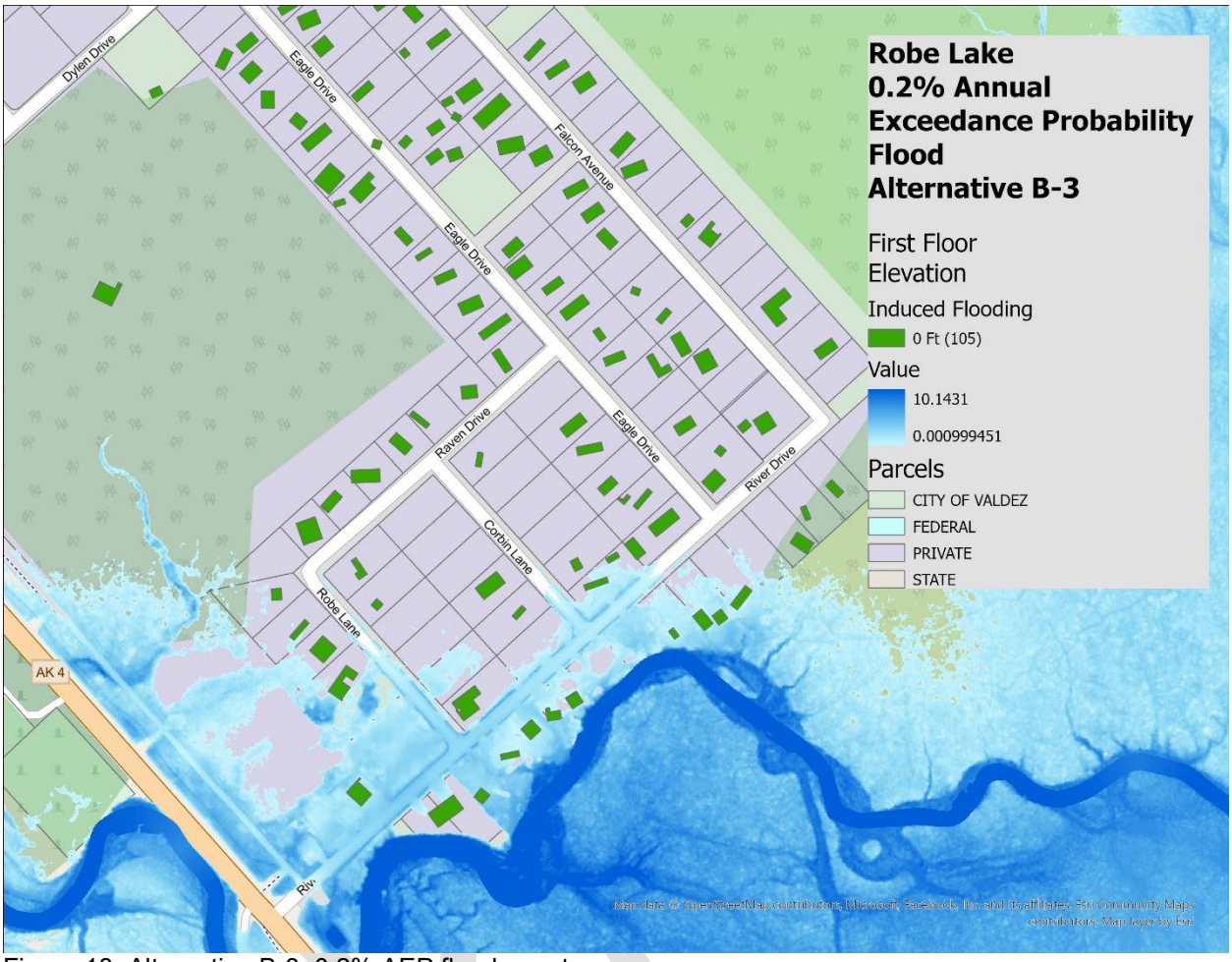


Figure 18. Alternative B-3, 0.2% AEP flood event.

6.3.7 Alternative C

Alternative C, which includes a weir to divert water flow into Old Corbin Creek, shows multiple structures (including the Firehall) with induced flooding during a 1% and 0.2 % AEP flood event (Figure 19 and Figure 20).

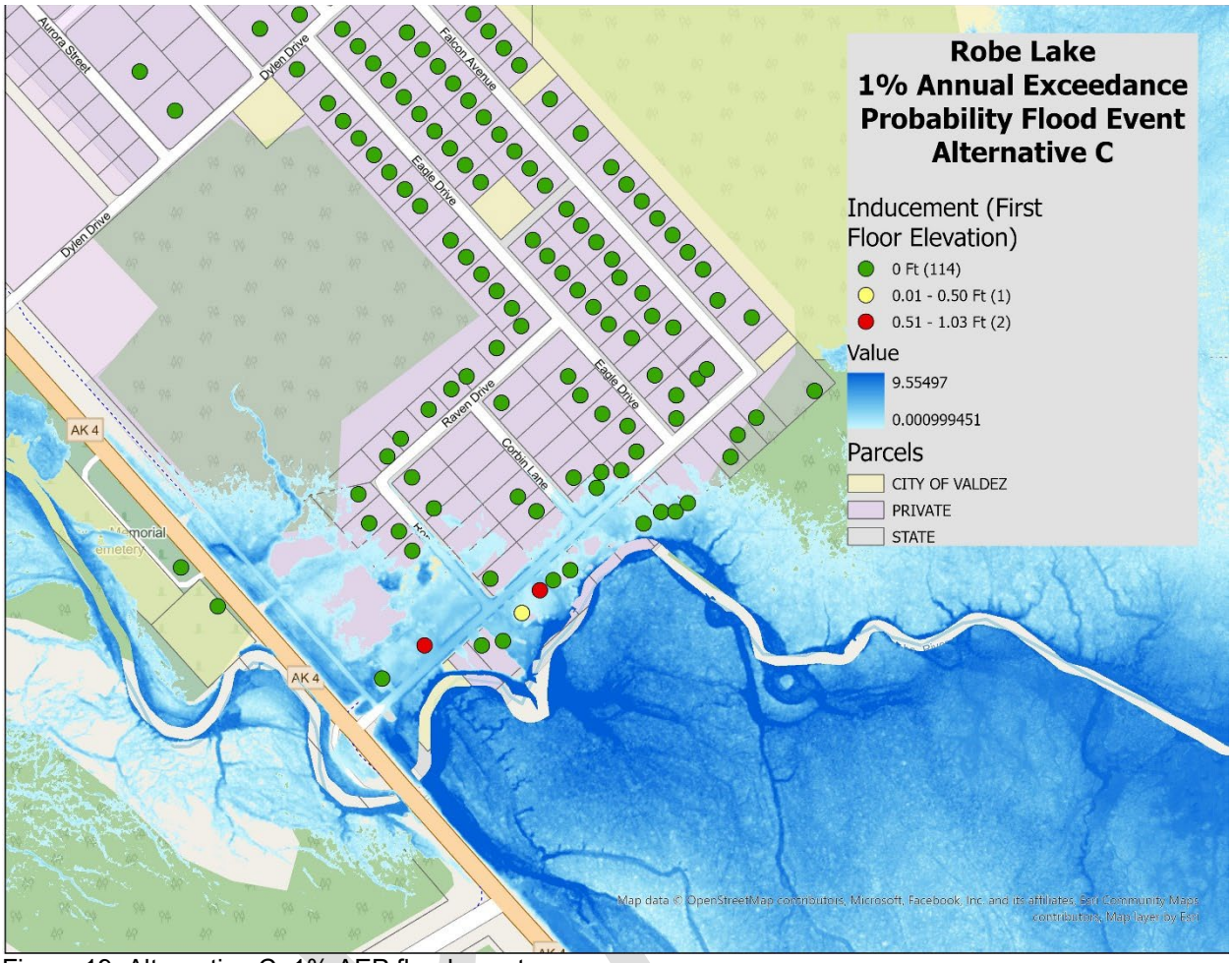


Figure 19. Alternative C, 1% AEP flood event.

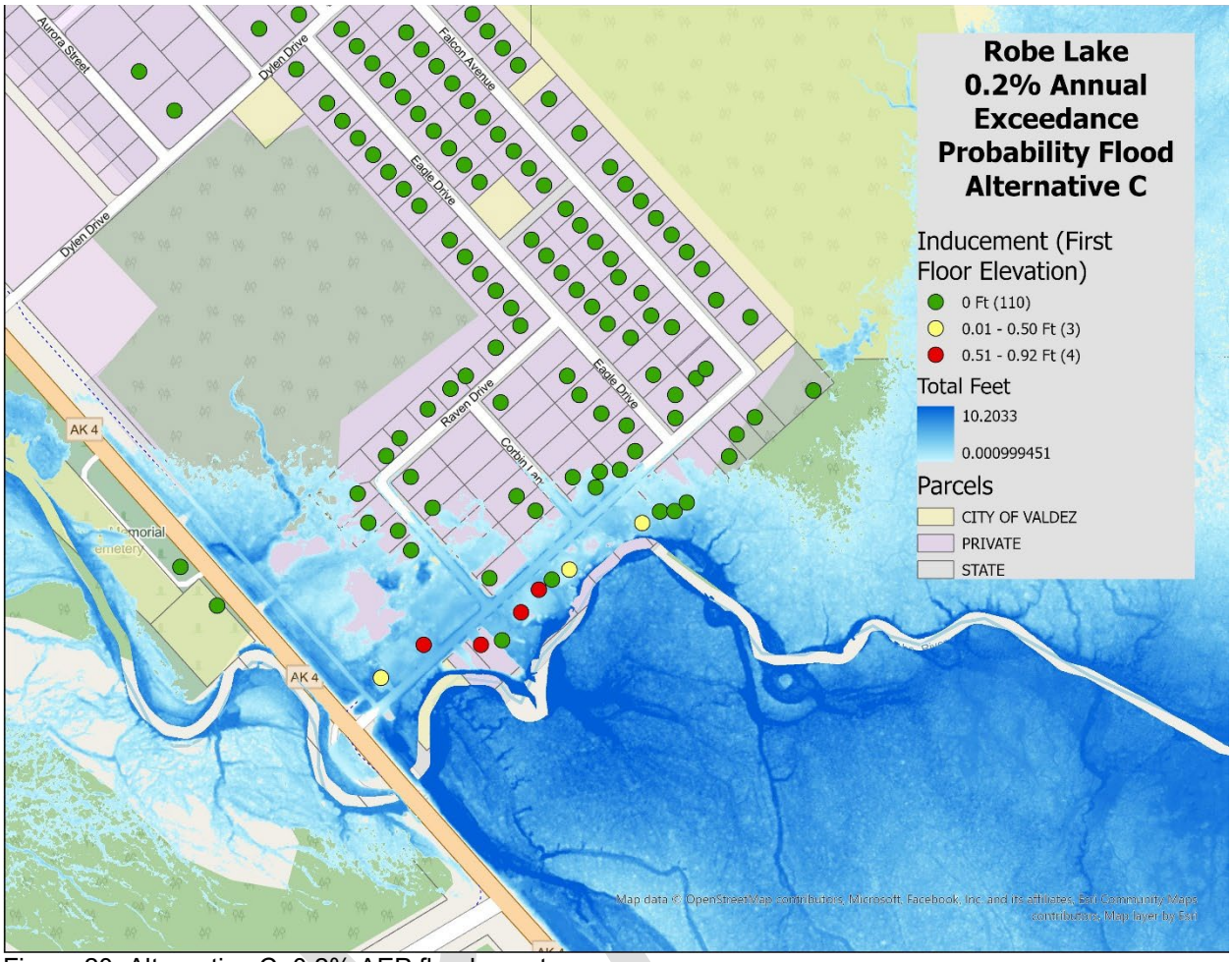


Figure 20. Alternative C, 0.2% AEP flood event.

6.3.8 Alternative D

Alternative C, which includes diverting water flow into Brownie Creek, shows multiple structures (including the Firehall) with induced flooding during a 1% and 0.2% AEP flood

event (Figure 21 and Figure 22).

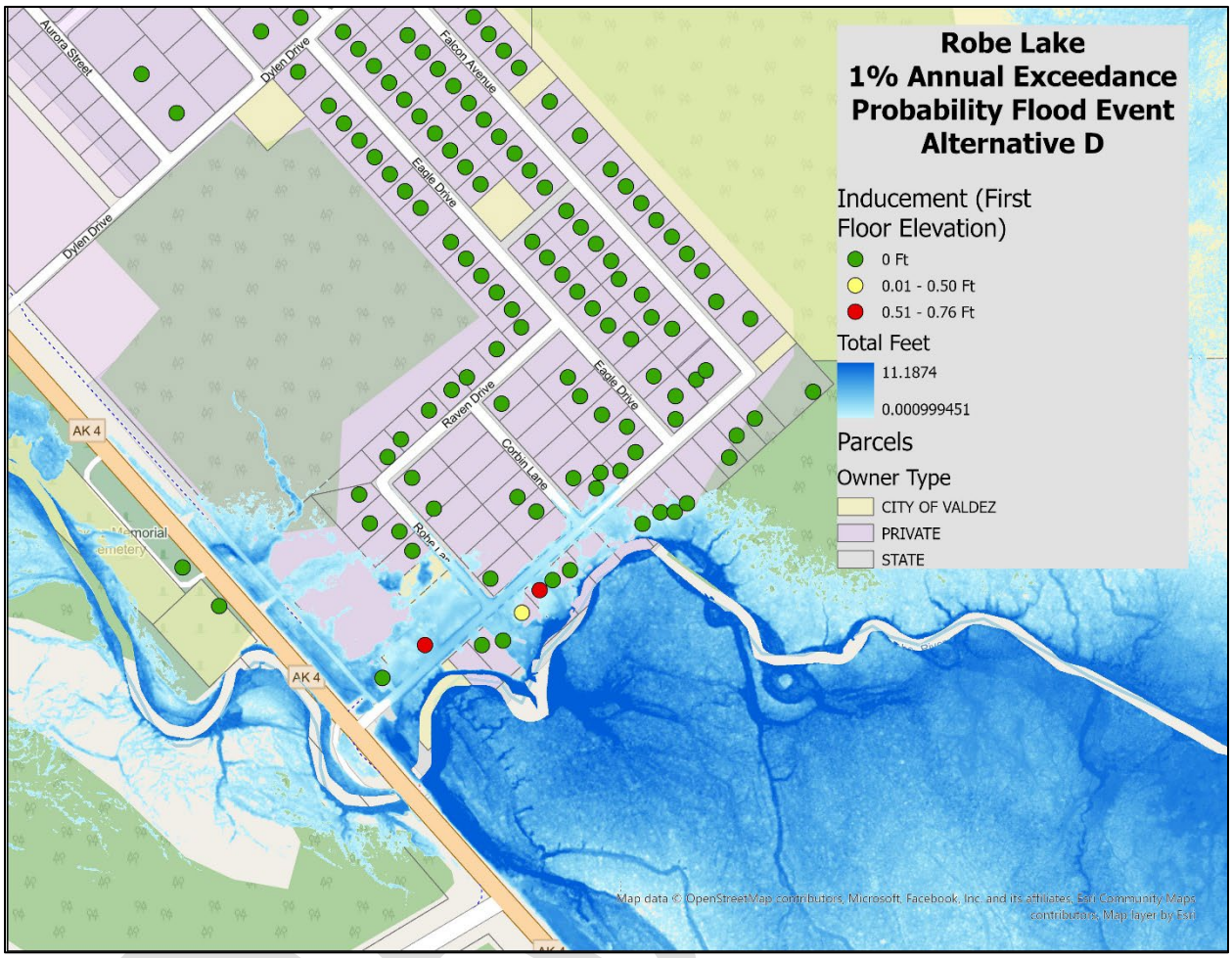


Figure 21. Alternative D, 1% Annual Exceedance flood event.

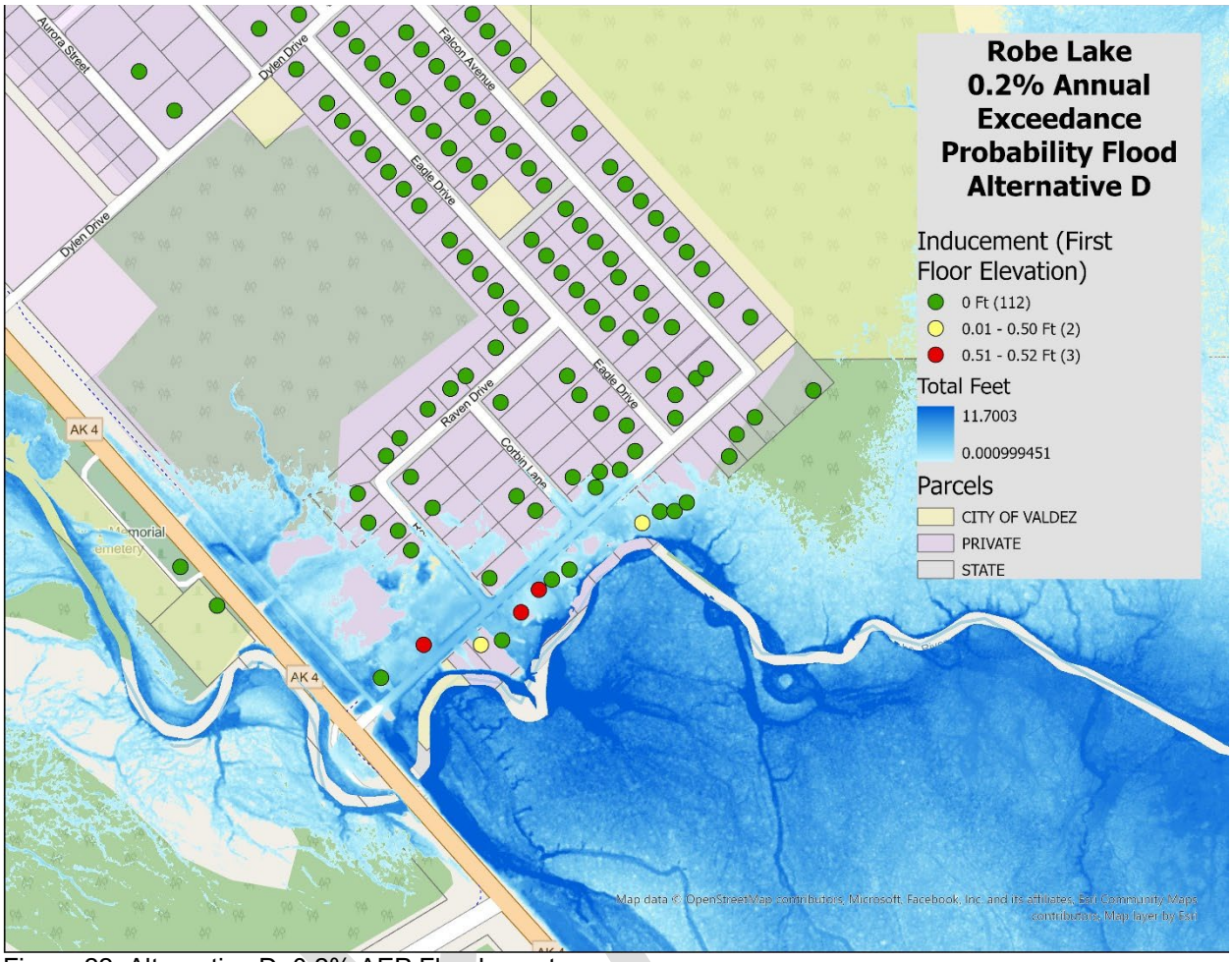


Figure 22. Alternative D, 0.2% AEP Flood event.

6.4 Other Considerations

When rerouting Corbin Creek into either Old Corbin Creek or Brownie Creek, any structures north of the project's diversion dike structure could leave structures without access to water from Corbin Creek. The City of Valdez parcel and tax database showed no structures north of the planned diversion dike structure. This consideration was not carried further as an EQ concern.

6.5 Flood event Risk Analysis Summary

The primary benefits of this project involve restoring the environment; however, a considerable effort was undertaken after evidence that many of the original alternatives induced flooding in the Robe River subdivision. The USACE performed an iterative process to develop modified alternatives that showed no induced flooding. The USACE developed three alternatives that did not induced flooding before conducting the CE/ICA analysis. Two alternatives show no induced flooding (Alternatives A-3, B-3); while Alternative B-1 showed a reduction in flooding. Table 8 shows a list of the alternatives, if they induced flooding, and if the alternative was carried through the CE/ICA.

Table 8. Final Flood event Risk Analysis Summary.

NUMBER OF INDUCED STRUCTURES						
	1% AEP Flood event		0.2% AEP Flood event		Induced Flooding	Carried Through to CE/ICA?
	0.01-0.50 ft	> 0.50 ft	0.01-0.50 ft	> 0.50 ft		
Alternative A-1	1	2	2	5	Yes	No
Alternative A-2	0	0	2	0	Yes	No
Alternative A-3	0	0	0	0	No	Yes
Alternative B-1	0	0	0	0	No	Yes
Alternative B-2	0	0	2	0	Yes	No
Alternative B-3	0	0	0	0	No	Yes
Alternative C	1	2	3	4	Yes	No
Alternative D	1	2	2	3	Yes	No
Alternative F	0	0	0	0	No	Yes

At the end of this process, three alternatives were carried forward to the CE/ICA. These alternatives were Alternative A-3, Alternative B-1, and Alternative B-3.

7.0 NER plan

The following section discusses how the NER plan was selected.

7.1 Ecosystem Benefits (Improved Habitat Units)

To determine the benefits of an environmental restoration plan, FWP environmental outputs are compared to FWOP. The difference between the two represents the benefits of project implementation for each alternative. FWOP and FWP benefits are expressed as improved acres of habitat or habitat units (HU). The USACE Alaska District held a habitat modeling workshop on February 7th, 2023 to implement the *General Salmonid Habitat Model*. During the workshop, USACE Alaska District collaborated with other agencies to determine initial baseline and forecast parameter inputs. The goal of the workshop was to evaluate the restoration alternatives with respect to changes in habitat suitability indices given the parameter input. Each alternative was evaluated against each parameter, for both the tributary and watershed calculators. The results of this workshop were used to infer changes in habitat suitability for the CE/ICA. The Environmental Appendix provides documentation on the *General Salmonid Habitat Model*. The AAHUs are expressed in acres and were calculated using the Annualizer Tool in the Institute for Water Resources Planning Suite II.

7.1.1 FWOP AAHUs

Using a mechanical weed harvester, the VFDA actively mitigates macrophyte growth in the lake. If the weed harvesting operation were discontinued, the habitat quality in Robe Lake would exponentially decline. However, the VFDA has purchased a new weed harvester and will likely continue to harvest. The *General Salmonid Habitat Model* suggests that with the continued current level of macrophyte mitigation (throughout the 50-year period of analysis), the average annual FWOP suitable HUs is about 320 acres

in Robe Lake, 13 acres in Old Corbin Creek, and about 9 acres in Brownie Creek; which annualizes to an average of 342 AAHUs (Table 9).

Table 9. Average annual habitat units (AAHUs); FWOP conditions.

	FWOP AAHUs (acres)
Robe Lake	*320*
Old Corbin Creek	*13*
Brownie Creek	*9*
TOTAL Habitat Units	342

7.1.2 FWP AAHUs

For the most comprehensive comparison of alternatives, AAHUs restored were computed for Alternative A-3, Alternative B-1, Alternative B-3, Alternative C, and Alternative D. Alternative C and Alternative D were screened from further consideration due to engineering concerns and the possibility of induced flooding in the Robe River Subdivision during a flood event. Table 10 shows a summary of the average annual number of improved habitat acres over the 50 years after the completion of the construction of alternatives. Figure 23 is a bar chart of the AAHUs difference between the FWOP and the FWP HUs used as the input for the CE/ICA.

Table 10. AAHU's listed by alternative.

	Robe Lake	Old Corbin Creek	Brownie Creek	Average AAHUs	Change from FWOP	Ranked Order
Alternative A-3	552.17	16.04	8.70	558.45	235.08	4
Alternative B-1	608.52	16.48	8.70	633.70	291.87	1
Alternative B-3	590.62	16.53	8.70	615.85	274.03	2
Alternative C	517.74	15.40	8.70	541.83	200.01	5
Alternative D	556.85	13.13	8.44	578.42	236.60	3
Alternative F	319.99	13.13	8.70	341.82	0.00	-

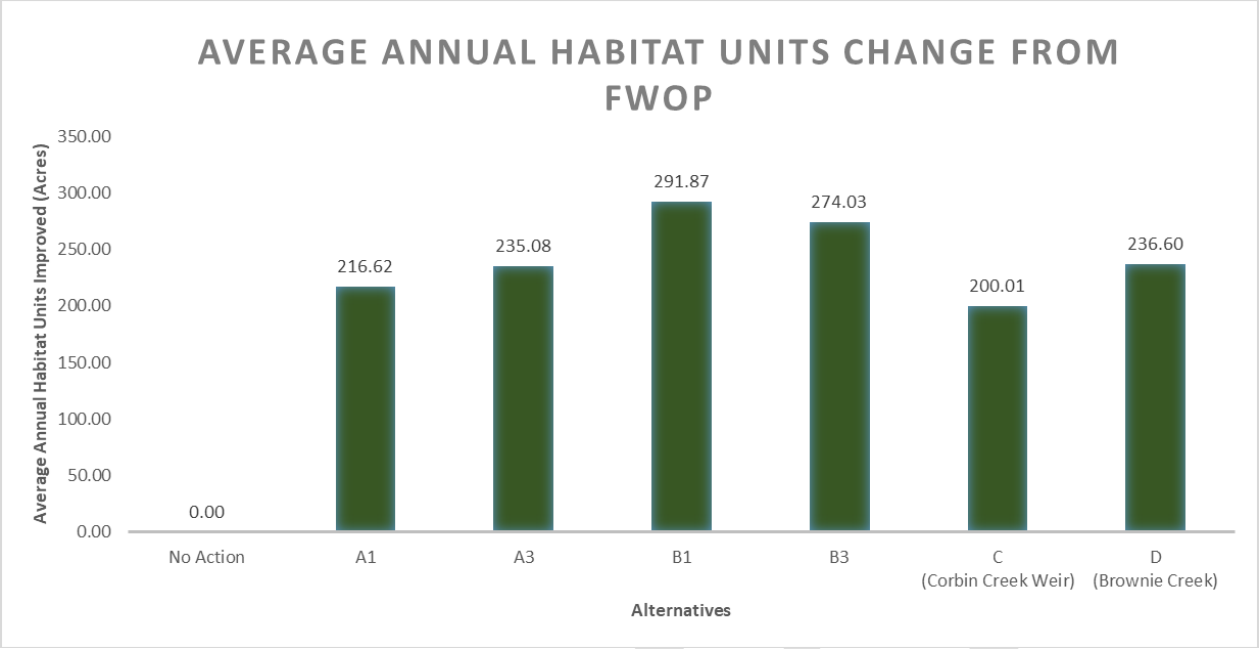


Figure 23. Annualized habitat units.

Figure 24 below shows the AAHU's as a function of time. The steep slope from 2026-2031 for each of the alternatives indicates that the majority of the benefits should be realized within the first five years after the project's construction, with a minor annual increase in benefits over the next 45 years.

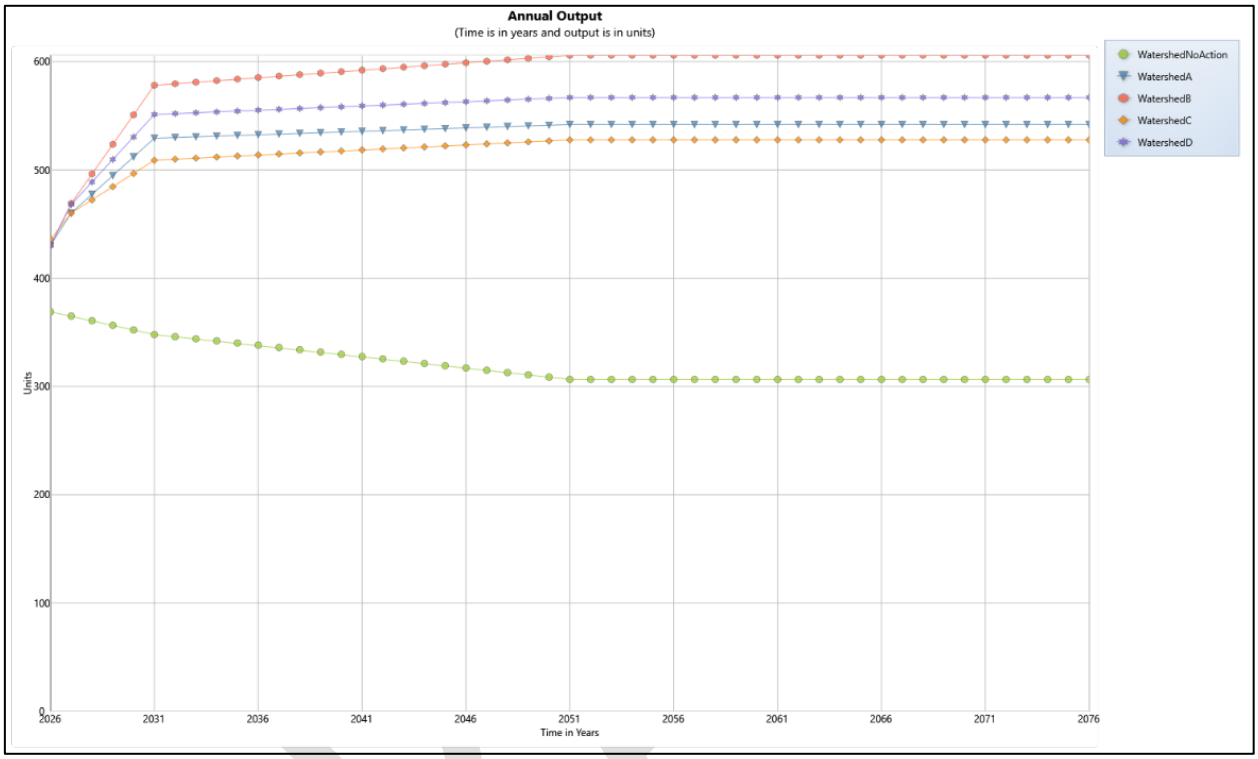


Figure 24. Total habitat units over the 50-year period of analysis.

7.2 Costs

As noted in the Planning Guidance Notebook, the cost-effectiveness analysis evaluates a plan's output level against its cost. The subsequent incremental cost analysis evaluates a variety of alternatives of different scales to arrive at a "Best Buy" option. Best Buy plans are considered the most efficient, providing the greatest output increase for the least cost increase. These analyses help inform whether the next unit of benefit is "worth it." The costs variable for a CE/ICA refers to each alternative's average annual economic costs (AAEQ). These include project first costs, interest during construction, and operation and maintenance costs. Throughout the analysis, the costs are amortized using the federal discount rate for FY23. Alternatives were screened out (alternatives: A-1, A-2, B-1, B-2) due to their potential to induce flooding during a 1% and 0.2% AEP flood event; costs were only totaled for the three viable alternatives to be carried forward into the CE/ICA.

7.2.1 FWOP Cost

As discussed in the existing conditions, the excessive macrophyte growth in Robe Lake has led to the VFDA regularly harvesting excess overgrowth. From FY21-FY23, the city

budgeted an average of $31,506 annually for weed harvesting operations and machine maintenance and purchased a new weed harvester for $289,355 with an expected service life of 25 years. The city would need to purchase one additional weed harvester during the period of analysis of this project (50 years). After annualizing and discounting, the costs are approximately $37,000 annually.

Since this cost is included in the FWOP condition, the saved costs (operations, maintenance, and future purchase of an additional weed harvester) are subtracted from the FWP OMRRR costs. Discussed further in the following sections.

7.2.2 FWP Cost

The USACE Alaska District cost engineers developed Rough Order of Magnitude (ROM) cost estimates for the alternatives. The Cost Engineering Appendix details the procedures and assumptions used to calculate the estimates. Cost risk contingencies were included to account for uncertain items. Project costs were developed without escalation and are in 2023 dollars.

Pre-Engineering Design (PED) is expected to occur over a 12-month period. Contracting and construction is expected to occur over 18 months consisting of one physical construction season, roughly seven months in duration, with construction complete by the end of calendar year 2026. These assumptions inform the interest during construction calculations.

Costs are discounted/indexed to a base year (2026) and amortized to compare the AAHUs using FY2023 discount rate of 2.5. As such, the project's first costs in the Cost Engineering Appendix differ slightly from those in the CE/ICA. The CE/ICA analysis costs include the project's initial cost compounded to the base year using the current discount rate, interest during construction (IDC), and estimated OMRRR costs. The economic project costs by alternative for the CE/ICA analysis are shown in Table 11.

Table 11. Alternative cost estimates (present value).

	Project First Costs	Interest During Construction	Operations & Maintenance*	Total Economic Cost	Average Annual Economic Cost	Annual Cost per Habitat Unit
Alternative A-3	$7,657,000	$197,000	$102,000	$7,956,500	$281,000	$1,200
Alternative B-1	$21,680,000	$460,000	$871,000	$23,012,000	$811,000	$2,800
Alternative B-3	$13,261,000	$411,000	$871,000	$14,543,000	$513,000	$1,900
Alternative F	$0	$0	$0	$0	$0	$0

* The ecosystem restoration benefits (AAHUs) FWOP conditions were derived assuming that macrophyte harvesting would likely continue without a project.

The ecosystem restoration benefits (AAHUs) FWOP conditions were derived assuming that macrophyte harvesting would likely continue without a project. The cost associated with weed harvesting would cease once the benefits were realized. The *General Salmonid Habitat Model* suggests that the majority of the benefits (for each alternative) would be realized after five years. Weed harvesting operations would be expected to continue for the first five years after construction. Therefore, there would be a NED benefit from the saved cost of weed harvesting and the purchase of an additional weed harvester needed in the FWOP but not in a FWP (see this Appendix's Section 8.0 National Economic Development (NED)). The saved cost of weed harvesting was subtracted from the OMRRR costs associated with implementing a project.

7.3 Plan Selection

7.3.1 Methodology

The environmental benefits and costs presented in the previous section were the inputs for a CE/ICA—the analysis aimed to evaluate the alternatives' effectiveness and efficiency at producing environmental outputs. Guidance on conducting CE/ICA is in IWR Report #95-R-1, USACE, May 1995. The product of a CE/ICA is the identification of a set of Best Buy plans. Best Buy plans are the alternatives that provide the greatest increase in environmental output for the least increase in cost. Initially, all cost-effective alternatives (a cost-effective alternative is one where no other alternative can achieve the same level of output at a lower cost or greater level of output at the same or less cost) are arrayed by increasing output to clearly show changes in cost (i.e., increments of cost) relative to changes in output (i.e., increments of output) of each cost-effective alternative plan compared to the future without-project condition. The plan with the lowest incremental costs per output unit is considered the first best buy plan.

After the first best buy plan is identified, all larger cost-effective plans are compared to the first best buy plan in terms of increases in (increments of) cost and increases in (increments of) output. The alternative plan with the lowest incremental cost per unit of output (for all cost-effective plans larger than the first best buy plan) is the second best buy plan. This process is continued until all the best buy alternative plans are identified. This is done using USACE's Institute of Water Resources Planning Suite 2.0 CE/ICA module.

7.3.2 Cost-Effectiveness

Evaluation of the best buys from the initial analysis identified an array of best buy alternatives for comparison over the entire watershed. The PDT compared the best buys from the project area to determine whether the incremental environmental benefits justified the incremental costs. Based on this comparison, a single best buy alternative was selected from the project area, methodology for plan selection is discussed in Section NER Plan. Table 12 shows the results of the first step in the CE/ICA, identifying best buy plans. Alternatives A-3, B-1, B-3, and F (no action) were all best buy plans.

Table 12. CE/ICA results summary.

Alternative	Average Annual NED Cost ($1000)	AAHUs (Acres)	Cost-Effective
Alternative A-3	281	235	Best Buy
Alternative B-1	811	292	Best Buy
Alternative B-3	513	274	Best Buy
Alternative F	0	0	Best Buy

7.3.3 Incremental Cost Analysis

Alternatives A-3, B-3, and B-1 were all compared incrementally after they were determined as best buy plans. It is essential to note that Alternative B-3 is an incrementally larger version of Alternative A-3. Alternative B-3 includes all the same measures as Alternative A-3 with the addition of 1.5 miles of dredging of Old Corbin Creek. **Alternative B-1 is not an incrementally "larger" version of Alternative A-3 or Alternative B-3 since Alternative B-1 includes a DOT bridge over the Richardson Highway instead of culverts as in Alternative A-3 and Alternative B-3**. The bridge and the culverts are substitutes for each other and provide different restoration benefits, so they are not incrementally larger versions of the same plan. Figure 25 shows the Incremental Cost Analysis box plot with the result of the incremental analysis.

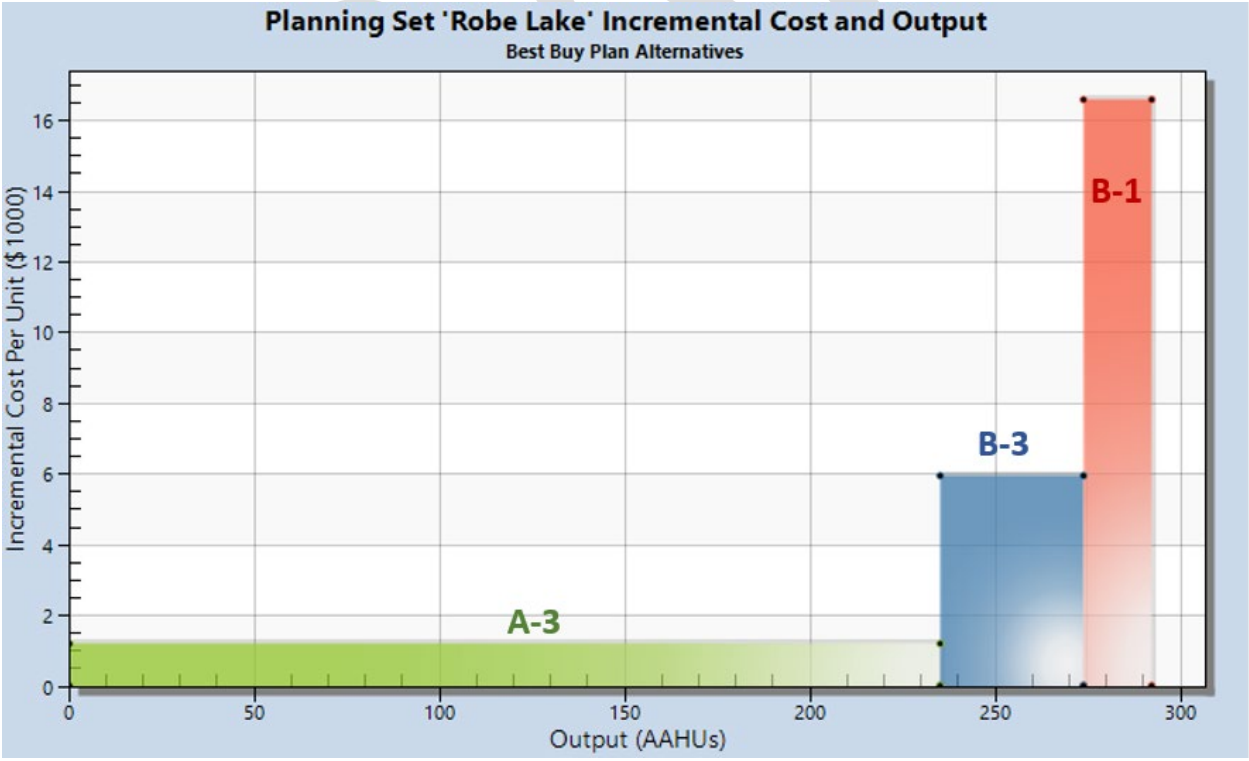


Figure 25. Incremental cost analysis box plot of best buy plans.

Table 13 and Table 14 show the incremental increase in AAHUs from Alternative A-3 to

Alternative B-3, and Alternative B-1 to Alternative B-3 (respectively). From Alternative A-3 to Alternative B-3 (Table 13), there is an increase of 39 acres of annual habitat units restored. These additional acres of improved habitat incur at a price of around $6,000 each annually, whereas the base 235 acres are $1,200 each annually. Although this is a large increase in the price of an improved habitat unit, the USACE believes that this increase is economically justified, discussed in the following section. From Alternative B-1 to Alternative B-3 (Table 14) there are only 18 extra annual habitat units improved. Each of these acres would cost $16,700 which the USACE determined to be too high relative to the increase and value in number of restored habitat units.

Table 13. Incremental benefit and cost summary of Alternative A-3 to Alternative B-3.

	Alternative A-3	Alternative B-3	Incremental Increase from A-3 to B-3
Average Annual Habitat Units	235	274	39
Average Annual Economic Cost	$281,000	$513,000	$232,000
Annual Cost per Habitat Unit	$1,200	$1,900	$700
Annual Cost for additional Habitat Units	-	-	$6,000

Table 14. Incremental benefit and cost summary of Alternative B-1 to Alternative B-3.

	Alternative B-3	Alternative B-1	Incremental Increase from B-1 to B-3
Average Annual Habitat Units	274	292	18
Average Annual Economic Cost	$513,000	$811,000	$299,000
Annual Cost per Habitat Unit	$1,900	$2,800	$900
Annual Cost for additional Habitat Units	-	-	$16,700

7.3.4 NER Plan

The PDT has determined that Alternative B-3 is the NER plan for this project per USACE policy. Alternative B-3 provides the highest number of AAHUs while remaining under the cost limitations of USACE's CAP program. Alternative B-1 is outside of the limits of the Federal cost share for USACE's CAP program.

The additional habitat units Alternative B-3 provides over Alternative A-3 are critical in the opinion of the USACE. Alternative B-3's extra habitat units are derived from dredging approximately 1.5 miles of Old Corbin Creek. These extra habitat units will provide the most ideal habitat for spawning and rearing salmon since these acres are located within a known anadromous habitat, and not in Robe Lake. The Environmental Appendix contains more information on ideal spawning and rearing habitat for salmonid species.

In addition to the added habitat and enhancement of nature-based features in Old Corbin Creek, the USACE believes that Alternative B-3 is more likely to realize the benefits within the period modeled by the *General Salmonid Habitat Model*. The controlled water flow into Robe Lake, due to dredging of approximately 1.5 miles of Old

Corbin Creek, will mitigate any uncertainty of the diverted water flow not reaching the intended destination. Alternative A-3 does not channel the water into Robe Lake. Alternative A-3 only redirects the flow of Corbin Creek into Old Corbin Creek with no additional management measures, leaving water to flow without mitigation or improvements. The channelization of Old Corbin Creek through dredging of approximately 1.5 miles will also decrease the likelihood of water pooling near the proposed 450-foot gravel berm during a flood event. See the Hydraulics and Hydrology Appendix for more information about the water flow during a flood event.

8.0 National Economic Development (NED)

This project generates a national economic benefit since it will likely eliminate the need for the current mechanical weed harvesting operations performed by the VFDA. The *General Salmonid Habitat Model* suggests that the majority of the ecosystem benefits will be realized at the five-year point after the project's construction completion for all of the alternatives considered. So, for this project, the VFDA will save the cost of weed harvesting for the remainder of the analysis period, or 45 years. This cost includes the yearly OMRRR of the weed harvester and the purchase of one additional weed harvester after the service life of the current harvester lapses. Table 15 shows the saved costs for each weed harvesting alternative at the FY23 price level, which are considered an NED benefit of the proposed project.

Table 15. Saved cost of weed harvesting operations.

	Saved Cost of Mechanical Weed Harvesting
Total Cost	$907,180
Average Annual Economic Cost	$31,985

9.0 Environmental Quality

For each alternative plan, positive and negative EQ benefits must be analyzed consistently with current guidance. The benefit assessment can be quantitative or qualitative and, if appropriate, monetized. The analysis must distinguish between national and regional benefits while ensuring benefits are not accounted for more than once. For this project, environmental restoration benefits will be captured for the CE/ICA using the General Salmonid Habitat Model, and any other secondary environmental benefits will be captured in the EQ section.

9.1 Environmental Impacts

USACE biologists investigated project effects on threatened and endangered species, avian species, essential fish habitat, special aquatic sites, climate, and noise and air quality. It is expected that no or minimal impact would occur to any threatened and endangered species, avian species, and special aquatic sites due to implementation of any of the proposed project alternatives. For detailed information please see the

Environmental Appendix.

Environmental benefits, other than the benefits accounted for in the CE/ICA analysis, would occur to the essential fish habitat, climate and on noise and air quality.

9.1.1 Effects on Essential Fish Habitat

Currently Valdez Glacier Stream, and its current tributary (Corbin Creek) are not listed as anadromous waters; however, with a diversion of Corbin Creek into Old Corbin Creek, known anadromous habitat will be beneficially impacted as it will provide improved habitat and rearing grounds for all types of aquatic species in Robe Lake such as trout and macroinvertebrates.

9.1.2 Effects on Noise and Air Quality

Alternatives A-D aim to reduce the water temperature in Robe Lake which in turn will reduce the macrophyte growth. Currently, the VFDA uses a mechanical weed harvester to help control the macrophyte growth in the lake. The proposed alternatives will reduce the need for mechanical intervention once the benefits of the implemented alternative are realized which is projected to be about five years (See Figure 24). Air pollution and noise in the project area will be reduced in the project area after the use of the weed harvester is no longer needed.

Air quality and airborne noise higher than ambient levels within the project area may be affected during the construction period from the use of construction equipment, vehicles, and generators. USACE assesses that any increase in pollutant emissions and airborne noise caused by the project would be transient, highly localized, and would dissipate entirely at the completion of the project. The magnitude of effects on air quality and airborne noise would be minor.

9.1.3 Effects on Climate

Burning of fossil fuels via the weed harvester in the project area will be reduced after the use of the weed harvester is no longer needed, which is expected to be after 5 years of project construction completion. Any other activities due to project implementation would be too limited in physical scope of duration to have any discernable effect on climate.

9.2 Effects on Cultural Resources

Three cultural resources have been identified in the project area: the abandoned low water wooden bridge, the Corbin Creek gravel berm, and the Old Corbin Creek culverts. USACE archeologists have determined these to be cultural resources but not historic properties. The low water wooden bridge would not be impacted by any of the alternatives. The Corbin Creek gravel berm and the Old Corbin Creek culverts would be impacted negatively from the implementation of any project alternative as the culverts

and the berm would be removed and replaced during project construction.

The Corbin Creek gravel berm initially used to divert water away from Robe Lake has degraded over time and needs to be replaced in order to function as originally intended. The PDT has determined that the Old Corbin Creek culverts need removal as they are undersized, have been overgrown by vegetation and don't meet the requirements of current fish passage standards. The alternatives proposed recommends the removal and replacement of the Old Corbin Creek culverts with a pedestrian bridge that meets current size requirements and fish passage standards.

9.3 EQ Summary

The primary benefits of this project involve improving the salmonid spawning and rearing habitat in Robe Lake; however, secondary benefits to the environment and to cultural resources were also determined to be significant by USACEs biological and archeological teams. All alternatives show a positive effect for secondary environmental effects, while demolition and replacement of two cultural resources in the project area present as a negative effect. It is importance to note that the cultural resources are not historical properties.

Table 16. EQ determination summary

	Secondary Environmental Effects	Cultural Resources*	EQ
Alternative A-1	Positive	Negative	Positive
Alternative A-2	Positive	Negative	Positive
Alternative A-3	Positive	Negative	Positive
Alternative B-1	Positive	Negative	Positive
Alternative B-2	Positive	Negative	Positive
Alternative B-3	Positive	Negative	Positive
Alternative C	Positive	Negative	Positive
Alternative D	Positive	Negative	Positive
Alternative E	Neutral	Neutral	Neutral
Alternative F	Neutral	Neutral	Neutral

*Cultural resources effected by the project alternatives are not historic properties, however degradation or demolition of a manmade structure 50 years old or older suggests a negative impact to cultural resources.

10.0 Regional Economic Impacts (RED)

The RED account measures changes in the distribution of regional economic activity that would result from each alternative. Evaluations of regional effects are measured using a nationally consistent income, employment, output, and population projection. These impacts occur from the construction of the project and from the contribution to a regional economy from the functioning of the project.

The USACE Regional Economic System (RECONS) is an economic model designed to estimate regional, state, and national contributions of Federal spending associated with

Civil Works and American Recovery and Reinvestment Act (ARRA) Projects. It also provides a means for estimating the forward linked benefits (stemming from effects) associated with non-Federal expenditures sustained, enabled, or generated by USACE projects. Contributions are measured in terms of economic output, jobs, earnings, and/or value-added. RECONS includes three categories of economic impacts:

- **Direct effects** are defined as expenditures made by USACE. In the impact area in which the project is located, direct effects represent the portion of expenditures that flows to material and service providers in the impact area. For employment and earnings measures, the direct effect represents the jobs associated with the work activity (e.g., onsite construction jobs).
- **Indirect effects** include the backward-linked suppliers for any goods and services used by the directly affected activities.
- **Induced effects** on the region occur from household expenditures associated with direct- and indirect-affected workers spending their income within the impact area. Economic impact measures reported are many jobs, employment earnings output (sales), and value-added (gross domestic product).

RECONS reports indirect and induced effects collectively as secondary effects. The tool was used to perform the RED analysis for the Robe Lake Ecosystem Restoration Project. For purposes of this analysis, the Valdez-Cordova Census Area is considered the local impact area, with the state of Alaska and the USA also differentiated.

10.1 RED Alternative A-3

Table 16 gives the RED values for Alternative A-3. The expenditures associated with All Work Activities, with Ability to Customize Impact Area and Work Activity at Valdez-Cordova Census Area (AK) are estimated to be $6,278,000. Of this total expenditure, $5,123,995 will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $6,278,000 support a total of 76.9 full-time equivalent jobs, $4,901,799 in labor income, $3,115,984 in the gross regional product, and $7,052,936 in economic output in the local impact area. More broadly, these expenditures support 162.4 full-time equivalent jobs, $10,764,824 in labor income, $11,108,787 in the gross regional product, and $20,037,152 in economic output in the nation.

Table 17. RED values for Alternative A-3.

Area	Local Capture	Output	Jobs*	Labor Income	Value Added
Local					
Direct Impact		$5,124,275	67	$4,419,493	$2,038,481
Secondary Impact		$1,929,047	10	$482,575	$1,077,674

Total Impact	$5,124,275	$7,053,322	77	$4,902,067	$3,116,155
State					
Direct Impact		$5,667,961	80.2	$5,697,277	$2,979,028
Secondary Impact		$5,862,735	28.6	$1,885,340	$3,427,611
Total Impact	$5,667,961	$11,530,696	108.9	$7,582,618	$6,406,639
US					
Direct Impact		$6,275,233	102.9	$6,492,024	$3,696,853
Secondary Impact		$13,763,016	59.6	$4,273,389	$7,412,542
Total Impact	$6,275,233	$20,038,249	162.4	$10,765,413	$11,109,395

*Jobs are presented in full-time equivalence (FTE).

10.2 RED Alternative B-1

Table 17 gives the RED values for Alternative B-1. The expenditures associated with All Work Activities, with Ability to Customize Impact Area and Work Activity at Valdez-Cordova Census Area (AK) are estimated to be $21,014,000. Of this total expenditure, $17,151,262 will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $21,014,000 support a total of 257.6 full-time equivalent jobs, $16,407,520 in labor income, $10,429,960 in the gross regional product, and $23,607,901 in economic output in the local impact area. More broadly, these expenditures support 543.6 full-time equivalent jobs, $36,032,495 in labor income, $37,183,825 in the gross regional product, and $67,069,244 in economic output in the nation.

Table 18. RED values for Alternative B-1.

Area	Local Capture	Output	Jobs*	Labor Income	Value Added
Local					
Direct Impact		$17,151,621	224.1	$14,792,623	$6,823,062
Secondary Impact		$6,456,775	33.5	$1,615,241	$3,607,117
Total Impact	$17,151,621	$23,608,396	257.6	$16,407,863	$10,430,179
State					
Direct Impact		$18,971,411	268.6	$19,069,535	$9,971,198
Secondary Impact		$19,623,342	95.9	$6,310,482	$11,472,665
Total Impact	$18,971,411	$38,594,753	364.4	$25,380,016	$21,443,862
US					
Direct Impact		$21,004,027	344.2	$21,729,656	$12,373,851
Secondary Impact		$46,066,621	199.4	$14,303,593	$24,810,753
Total Impact	$21,004,027	$67,070,649	543.6	$36,033,250	$37,184,603

*Jobs are presented in full-time equivalence (FTE).

10.3 RED Alternative B-3

Table 18 gives the RED values for Alternative B-3. The expenditures associated with All Work Activities, with Ability to Customize Impact Area and Work Activity at Valdez-Cordova Census Area (AK) are estimated to be $12,167,000. Of this total expenditure, $9,930,494 will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $12,167,000 support a total of 149.1 full-time equivalent jobs, $9,499,871 in labor income, $6,038,894 in the gross regional product, and $13,668,856 in economic output in the local impact area. More broadly, these expenditures support 314.8 full-time equivalent jobs, $20,862,633 in labor income, $21,529,247 in the gross regional product, and $38,832,754 in economic output in the nation.

Table 19. RED values for Alternative B-3.

Area	Local Capture	Output	Jobs*	Labor Income	Value Added
Local					
Direct Impact		$9,930,744	129.7	$8,564,890	$3,950,535
Secondary Impact		$3,738,456	19.4	$935,220	$2,088,511
Total Impact	$9,930,744	$13,669,200	149.1	$9,500,110	$6,039,046
State					
Direct Impact		$10,984,398	155.5	$11,041,211	$5,773,297
Secondary Impact		$11,361,864	55.5	$3,653,752	$6,642,643
Total Impact	$10,984,398	$22,346,261	211	$14,694,963	$12,415,940
US					
Direct Impact		$12,161,277	199.3	$12,581,414	$7,164,427
Secondary Impact		$26,672,454	115.4	$8,281,743	$14,365,361
Total Impact	$12,161,277	$38,833,731	314.8	$20,863,158	$21,529,788

*Jobs are presented in full-time equivalence (FTE).

10.4 RED Alternatives Summary

Table 19Table 19 shows a summary of the RED benefits of this project. All alternatives (not including no action) will provide regional economic development. Projects with higher construction costs will provide more regional benefit, however, any alternative will have a positive effect on the economy regionally.

Table 20. RED national summary by alternative.

	Local Capture	Output	Jobs*	Labor Income	Value Added
Alternative A-3	$6,275,233	$20,038,249	162	$10,765,413	$11,109,395
Alternative B-1	$21,004,027	$67,070,649	544	$36,033,250	$37,184,603
Alternative B-3	$12,161,277	$38,833,731	315	$20,863,158	$21,529,788

* Jobs are presented in full-time equivalence (FTE).

11.0 Other Social Effects

Prior to the construction of the gravel berm that diverted Corbin Creek in the 1950s, the water flow from Corbin Creek into Robe Lake was navigable via boat, and conditions were good for recreational boating and swimming on Robe Lake. However, it was assessed that during the summer months, the extensive overgrowth of macrophytes made the lake unfit for recreational use, including swimming, boating, fishing, or operating float planes (Koenings et al., 1987). Site visits to Robe Lake confirm that recreation still occurs on the lake, even with the excessive macrophyte growth.

Robe Lake is the largest freshwater lake in the Valdez area. In addition to providing spawning and rearing habitat for salmonid species, Robe Lake also offers wildlife viewing and recreational opportunities for both Valdez residents and visitors (Interfluve et al., 2021). Controlling the overgrowth of macrophytes within Robe Lake increase opportunities for recreation, including increased accessibility for motorboats, kayaks, canoes, and paddle boards.

Many residents still use Robe Lake as a recreational area; moreover, all three alternatives would return Robe Lake to a more ideal recreation area for residents and tourists. Many tourists and Alaskan locals enjoy visiting salmon spawning and rearing areas for wildlife viewing opportunities. Other opportunities may include sport fishing or limited levels of subsistence use. The Environmental Appendix provides more information about subsistence and sport fishing at Robe Lake.

12.0 Risk, Uncertainty and Sensitivity

12.1 Elodea Establishment in Robe Lake

The USACE biological team has determined that the risk of *Elodea* becoming established within Robe Lake is relatively low. The risk is overall relatively low given the distance between Robe Lake and Eyak Lake (in Cordova, has an established *Elodea* population). Likewise, the potential transport between these two lakes is most likely limited to float planes since Cordova is off the road system – resulting in a decreased

risk of establishment. However, the FWOP condition has a higher risk of an invasive becoming established in Robe Lake (given the current degraded environmental state), than the FWP condition.

If *Elodea* were to become established, the impact to FWP condition is anticipated to be minimal since the preferred alternative already aims to reduce the overgrowth of native macrophytes (introducing cold, turbid, glacial flow). The projected outcome of implementing the preferred alternative would also reduce the risk of *Elodea* becoming established in the FWP condition. Therefore, any benefits from the project are anticipated to still be achieved.

12.2 Flood event Mitigation

The flood event mitigation analysis was based on HEC-RAS modeling produced by USACE Hydraulics and Hydrology engineers. The model has been reviewed through a targeted ATR process, but there is some uncertainty that the water during flood events might not flow as predicted. Precautions were taken to model the scenarios as accurately as possible. The Hydraulics and Hydrology Appendix provides more information on the HEC-RAS flood event modeling.

12.3 Benefit Realization

Realizing the benefits of this ecosystem restoration project (through habitat units restored) may present a degree of uncertainty due to uncontrollable environmental factors. A final determination was made that dredging of approximately 1.5 miles of Old Corbin Creek (as outlined in Alternative B-3) would be less risky with regard to not realizing benefits than a non-dredging alternative (i.e., Alternative A-3) since the channelization of the redirected flow will facilitate water flow into Robe Lake, and cool down the lake, which is a major factor in the growth of the aquatic vegetation.

12.4 Cost Reductions

The NED benefits are based on reducing the need for weed harvesting. Since the VFDA has recently (in 2023) bought a new weed harvester with a 25-year service life, they may choose to continue harvesting past the projected five years used in this analysis. If the VFDA decides to continue to weed harvest for the past five years after the project's construction completion, the NED benefits would not be as high as presented in this Economic Appendix.

13.0 Four Economic Account Summary

This Economics Appendix presented the economic analysis of three alternatives for providing ecosystem restoration improvements at Robe Lake, in Valdez Alaska. The alternatives were evaluated using the four accounts established in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies: National Economic Development, Regional Economic Development, Environmental Quality, and Other Social Effects. The results from the analysis of each of the four economic accounts, including the CE/ICA analysis, are summarized in Table 1.

13.1 Comprehensive Documentation of Benefits Policy Directive Requirements

Consistent with the 5 January 2021 Policy Directive on Comprehensive Documentation of Benefits in Decision Document, each study must include, at a minimum, the following plans in the final array of alternatives for evaluation:

1. The “No Action” alternative.
2. A plan that maximizes net total benefits across all benefit categories.
3. A plan that maximizes net benefits consistent with the study purpose.
4. For flood event-risk management studies, a non-structural plan, which includes modified flood event plain management practices, elevation, relocation, buyout/acquisition, dry flood event proofing and wet flood event proofing.
5. A locally preferred plan, if requested by a non-Federal partner, if not one of the aforementioned plans.

For Robe Lake, a “No Action” alternative is included (Alternative F), so the first requirement is met. Additionally, Alternative B-3 (the recommended plan), meets the criteria for both item two and item three in the guidance. The fourth and fifth criteria do not currently apply as this is not a flood event-risk management study and the non-Federal sponsors have expressed support for Alternative B-3.