TETRA TECH

Memorandum

Clallam County, WA
FY-2022 FEMA HMGP Application, Benefit-Cost Analysis

DUNGENESS OFF-CHANNEL RESERVOIR PROJECT

BCA METHODOLOGY MEMORANDUM

Revised November 2022

Clallam County, Washington is submitting a FY-2022, Hazard Mitigation Grant Program (HMGP) project grant application to the Washington Emergency Management Division (WAEMD) and FEMA Region X for consideration of funding under the HMGP. The scope of this project is to mitigate current and future drought risk through the construction of a Dungeness River Off-channel Reservoir that will support/ enhance groundwater recharge efforts of the County and provide numerous ecosystem and social benefits to the Citizens of Clallam County and the State of WA as a whole. See ***Attachment A*** and more complete description of this project and/or visit: https://vimeo.com/203968263 .

To determine if this project was technically feasible and cost-effective, the Clallam County contracted Tetra Tech, Inc. to perform the "benefit-cost analysis" (BCA) for this project, using best available data and science to measure the "cost-effectiveness" (the net benefits of the project will equal or exceed the cost of the project) of the project for HMGP grant eligibility. This memorandum has been prepared to show the findings of this analysis, and to document the BCA pursuant to FEMA requirements for Hazard Mitigation Assistance (HMA) grant applications.

I. PROJECT OVERVIEW

Clallam County is requesting funding to support construction of an off-channel reservoir in the Dungeness basin near Sequim, WA in eastern Clallam County. With future significant projected decrease in snowpack and a change from a snow and rain dominated climate to a solely rain dominated climate, the Dungeness Reservoir will replace snowpack storage with manmade storage over an infiltration zone to enable reliable and vital water supplies in the Dungeness basin for farms, people, and fish. The nature-based solution is for water to be diverted from the mainstem Dungeness via the HID diversion at river mile 10.7 into climate-resilient reservoir storage in winter/spring when river flows are high. In Aug.-Sept. of each year, eastside Dungeness farmers will use the stored water instead of diverting 15-26 cfs from the river during its critical low flow period. The water no longer diverted from the river will be protected instream utilizing the state's Trust Water Rights program. The County is also currently working with the eastside Dungeness food producers and water conveyance districts to formalize a legal agreement. Please note that while Irrigators are key stakeholders in this project, this is not an irrigation project. The irrigators are key to this project because they will be relinquishing their water rights to support the use and application of the off-channel reservoir. The streamflow restored by the Reservoir will result in weighted usable habitat area (WUA) increases of up to 35% for ESA listed fish and other wildlife.

Multi-Objective Project

This is considered to be a multi-objective project meaning the net benefits of this project will mitigate the impacts from multiple hazards within Clallam County. The overarching theme for this project is to "*capture*

and store water when you have it, to use it when you don't"! As will be noted below, Clallam County is transitioning from a snow dominant watershed to a rain dominant watershed. This transition means that water is no longer being stored for late season use in the upper watershed of the county as snow as has been the case in the past. Since it is not being stored, the valuable resource, water, flows through the County as rainfall to its ultimate destination, the Strait of Juan de Fuca. This lack of storage means the opportunity to replenish the aquifers of the County is lost, which ultimately impacts water supply for the residents of Clallam County.

Additionally, the reduction in water storage as snow in the upper watersheds of the County impact stream flows of the Dungeness River, which results in adverse environmental impacts to the ecosystems of the River. The maintenance of normative flows in the Dungeness Rivers is mission critical to supporting the critical habits of four listed endangered species protected by both State and Federal law.

So, the multiple objectives of this project include the mitigation of impacts from prolonged drought, and at the same time, mitigation of the adverse environmental impacts that are being caused by a changing climate. It is important to note that FEMA's Hazard Mitigation Assistance (HMA) program does not preclude projects from funding where 100% of the net benefits of the project are environmental benefits. That is not to say that all of the net benefits of the Dungeness Off-Channel Reservoir Project are environmental. While the preponderance of the benefits of this project are environmental, there are direct benefits to the people, property, and economy of Clallam County by assuring a stable and consistent water supply.

Problem to be Mitigated

This project has been designed specifically to address and mitigate multiple hazards with an emphasis on "nature-based solutions" for the communities in the Dungeness Valley and the environment. This nature-based solution will reduce risks from climate change impacts such as drought, changing weather patterns, and flooding from increased storm events; provide a secure climate-resilient water supply for local agriculture and drinking water;, and restore river habitat for multiple ESA-listed species. For this BCA Analysis, the loss mitigated by this project is the loss of stormwater and snowmelt runoff that is not captured during high-flow events that flow out to the Strait of Juan de Fuca. The capture and storage of this runoff on top of the infiltration zone of the shallow aquifer of the Dungeness Valley will mitigate the impacts to this region from drought impacts which are anticipated to increase with the impacts from climate change. However, there are numerous other benefits to this project that should be considered as "qualitative" benefits that are not quantified. This analysis should be reviewed as a "lower-bound" analysis, meaning that not all benefits of the project are being quantified. The reasoning for this lower-bound approach is that several of these additional benefits are difficult to quantify in terms suitable for FEMA benefit-cost analysis protocol. These additional impacts and benefits are described below.

Current and projected climate change impacts are compounding freshwater availability and stream flow challenges in the Dungeness – the driest area in the Puget Sound region as it is located in the rain shadow of the Olympic Mountains. The average annual rainfall in the City of Sequim, which is adjacent to the reservoir location, is only 16 inches. It is projected that total spring and summer season (Apr-Sept) streamflow in the Puget Sound region (including the Dungeness) will decrease by 24–31% on average relative to the 1970–1999 streamflow by the end of the century (Weinheimer et al. 2017; Mauger et al. 2015), and river and stream temperatures in Puget Sound will increase by 2.2–2.5°C by the 2080s relative to temperatures during 1970–1999, based on a moderate greenhouse gas scenario (Weinheimer et al. 2017; Isaak et al. 2012; Mauger et al. 2015). The need for climate resiliency in the Dungeness basin has been strongly emphasized and supported in local and regional climate change reports and adaptation strategies. According to the Climate Change Preparedness Plan for the North Olympic Peninsula, increasing regional capacity for water storage is a Top 10 adaptation strategy for building local ecosystem resilience with a specified key action step to "create water

storage and usage options at all scales (recharge, mitigation, food production)" (P. IV and P.50). Furthermore, a Top 10 adaptation strategy for building local water supply resilience is to "continue to study ways to enhance water storage and groundwater recharge." Drought in the Dungeness has already made its impact felt in 4 of the past 8 years providing the region with empirical evidence on potential future conditions including the plummeting of Dungeness River flows to 56 cfs. in Aug. 2015, far below the minimum target flow (105 cfs) as well as the regulatory instream flow recommendation (180 cfs).

Finally, in addition to providing climate-resiliency to the Dungeness Valley, the Dungeness Reservoir is a project that is climate resilient itself. According to the University of Washington (UW) Climate Impacts Group's Puget Sound State of Knowledge Report, it is anticipated the Dungeness basin will move from a transient watershed (snow/rain mix) to a rain-dominant watershed with peak stream flows shifting to 25-40 days earlier by the 2080s compared to 1970-1999 (p.A-3). The Reservoir demonstrates climate resiliency and its ability to persist over time in that it will remain fully operational and functional – able to divert and store high flow water – despite projected shifts in type of precipitation from snow/rain mix to rain and despite shifts in the timing of precipitation and high-flows. The residual hazards after project implementation include the unknown impacts that climate change may bring to the Dungeness basin in regard to drought, storm events and other impacts. While there are projections for climate change impacts in regard to temperature, precipitation, water availability and other factors, climate change may manifest in ways not yet fully apparent. This is all the more reason to take steps in building resiliency for people and the environment in the Dungeness Basin.

Project Benefit Area (PBA)

While it could easily be argued that all citizens of Clallam County and beyond would benefit from the outcomes of this project, there is a clearly definable Project Benefit Area (PBA) that can be identified for this project, the East Dungeness River Watershed. Like most of Clallam County, this area of the County relies heavily on ground water from a shallow aquifer for its potable water supply serviced by a combination of public and private wells. As stated above, a principal objective for this project is to capture and store surface water runoff on the infiltration zone for multiple objectives use including but not limited to shallow aquifer recharge and maintaining normative flows on the Dungeness River.

To estimate the population within this PBA, 2020 US Census data was utilized. The total population of Clallam County in 2020 was 77,155 and all of these people benefit from a healthy and climate resilient watershed and Dungeness River, a more climate-resilient local agricultural economy and food system, and/or improved recreational opportunities. The number of people that live down-gradient of the Reservoir is 11,812 (15.3% of the Clallam County total population) based on 2020 Census block data and these people will likely benefit most from the project. The Dungeness Reservoir will benefit low income and minority populations. According to the US Census Bureau, the median household income of Clallam County from 2016-2020 (in 2020 dollars) was $55,090. This income is significantly lower than the Washington state ($78,687) and US ($65,712) median income. Additionally, income data retrieved from the American Community Survey indicates that within 2 miles down gradient of the Reservoir, there are about 2,512 people with a weighted median income of $44,405.13 – significantly below even the median household income of the County as a whole. See ***Attachment B*** for the Census profile for Clallam County.

As noted above, groundwater is the primary source for potable water in this region. According to the Clallam County Water Resources Program, there are 1,048 private wells that are being serviced by four infiltration basins withing the off-channel reservoir service area. These wells and infiltration basins make up the infiltration zone that will be serviced as needed by the off-channel reservoir. See ***Attachment C*** for a map of the PBA that shows well and infiltration basin locations.

Analysis Approach

The City of Sequim, WA applied an alternative approach to measuring the net benefits of its aquifer storage and recovery (ASR) project from the FEMA ASR methodology contained in version 6.0 of the FEMA Benefit-Cost Calculator (BCC). The justification for the alternative approach was the lack of complete and creditable information to be able to run the ASR methodology. To get the level of detailed information needed to run the FEMA ASR methodology would require expensive analyses beyond those needed to engineer and design the project. This alternative approach was developed by Earth Economics (EE), the FEMA vendor contractor that has developed several BCA applications for FEMA, most notable of which is the "environmental benefits calculator". The premise behind the EE approach was simple in context in that the loss trying to be avoided by the action was the water supply that was not being captured or stored on the infiltration zone within the basin that flowed into the Strait of Juan de Fuca during high flow events. The benefits of the project would be the capture of that water supply for future use. While this philosophy is not that much different than that of FEMA's ASR methodology, the approach to measuring these impacts is vastly different. It is important to note that the capture and storage of the water supply in a multi-use facility allows for distribution of this water supply to areas of need (infiltration zone and/or the Dungeness River) when needed water supplies are taxed (drought conditions). This is not necessarily the case in the existing system in that water supply can only be dispersed when the flows are high, which does not typically occur when the system is taxed. Therefore, that surplus is lost.

Clallam County has chosen to follow this same approach for the following reasons:

- Like Sequim, the County does not have available the detailed information needed to run the ASR module as that data was identified as part of the engineering/ design for the project.

- Precedent was established by both FEMA Region X and WAEMD in accepting this alternative approach in the funding of the City of Sequim project. It is very important to note that the EE alternative approach was not developed in a vacuum. EE consulted with both FEMA Region X and WAEMD in the development of that approach and there was consensus amongst all involved that the approach was a solid, defensible representation of the cost-effectiveness of the project.

- This Clallam County project is complex, with many of the net benefits of the project falling outside of FEMA standard values and approaches to measuring net benefits. Many of the ecosystem service and future condition benefits of this project are not measurable under current FEMA guidelines. While some may argue that this simplified ASR approach overstates net benefits, others could argue that you need to overstate some benefits to account for the understatement of others. Like the City of Sequim, EE, WAEMD and FEMA Region X, Clallam County feels that following this approach is logical, based on best available data and science, creditable and most importantly, defensible.

II. THE BENEFIT COST ANALYSIS

The following sections will document the Data entries into the BCC, version 6.0 for each component of the aggregate BCA, structure loss and utility Interruption.

A. Project Configuration

The project configuration selected for this analysis was "*Flood Diversion and Storage*". Per FEMA's "Supplemental Guidance For Conducting a Benefit-Cost Analysis (BCA) for a Floodwater Diversion and Storage Project", this mitigation action type was deemed appropriate based on the following:

> "*Managing floodwaters through diversion, storage, and infiltration* ***also can replenish water supply aquifers through groundwater recharge****, which can increase the baseflow and enhance usable water supply to mitigate the effects of drought*".

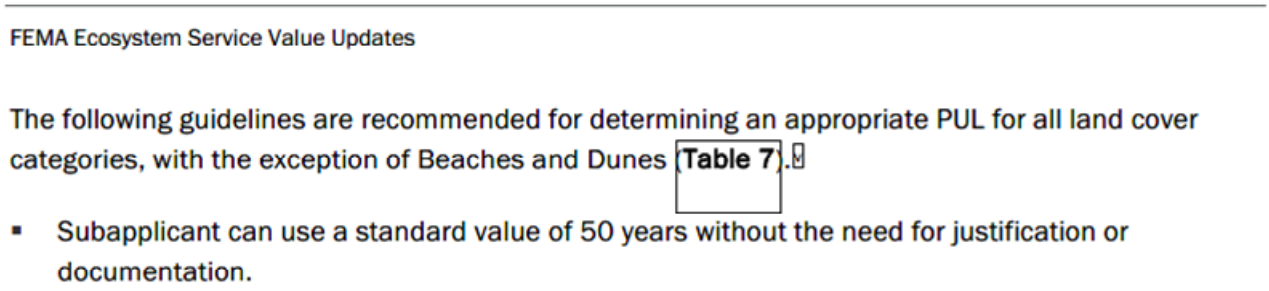
While focus of this project is the mitigation of drought impacts in the PBA, there may be some flood control benefits realized by this project that are not fully known at this point since no analyses have been performed. The off-channel reservoir has not been designed as a flood control facility. However, the design and use of the project best aligns with this mitigation category, and it allows for the inclusion of environmental benefits, which is a large aspect of this project.

- ***Property Structure Type***: Other
- ***Hazard Type***: Riverine Flood
- ***Mitigation Action Type***: Flood Diversion and Storage
- ***Damage and Frequency Relationship based on***: Professional Expected Damages

Cost Estimation

Project Useful Life

Since the major component of this project involves the conversion of land cover at the proposed project site from a degraded habitat condition, to and enhanced created habitat condition that includes FEMA recognized ecosystem service land covers, the project useful life assigned is 50-years based on FEMA guidance published in its June 2022, *FEMA Ecosystem Service Value Updates*[1], see Figure 1.



FEMA Ecosystem Service Value Updates

The following guidelines are recommended for determining an appropriate PUL for all land cover categories, with the exception of Beaches and Dunes (**Table 7**).

- Subapplicant can use a standard value of 50 years without the need for justification or documentation.

Figure 1. FEMA Recommended Project Useful Life Values

[1] FEMA Ecosystem Service Value Updates, June 2022.
https://www.fema.gov/sites/default/files/documents/fema_ecosystem-service-value-updates_2022.pdf

Initial Project Costs

The total cost for this project as determined by 30% engineering and design is $29,954,689. Please note that these costs do not include "pre-award" costs incurred by the County that will not be associated with the implementation of the project but are inclusive of all management costs. See ***Attachment D*** for detailed cost breakdown.

Annual Maintenance Costs

The maintenance costs reflected were provided to Clallam County by its engineering subcontractor Anchor QEA. The cost for maintenance is estimated at $182,500/ year based in input for the engineering/design of the project. The breakdown of these costs is: $100,000/year for the maintenance of the reservoir per the design operations and maintenance specifications and $82,500/year for parks and facilities maintenance (1/2 FTE at 32,500/yr. plus $50,000/yr. for a low-end park with trails and 1 restroom facility maintenance). For the reservoir maintenance costs, O&M costs were estimated based on the cost of operating storage facilities of similar size, and they include salary and benefits for a government employee at a rate of 1/4 full-time equivalency, administrative costs, transportation costs, supplies, maintenance, repairs, and contracted labor costs.

Drought Recurrence Interval

According to the US Drought Monitor (https://www.drought.gov/states/washington/county/clallam), Clallam County has experienced conditions of "Abnormally Dry" (D0) precipitation or higher 23 times from 1967 to 2017 (see figure 2). The Standardized Precipitation Index (SPI) is an index to characterize meteorological drought on a range of timescales, ranging from 1 to 72 months. The SPI is the number of standard deviations that observed cumulative precipitation deviates from the climatological average. NOAA's National Centers for Environmental Information produce the 9-month SPI values on a monthly basis, going back to 1895. Using these historic statistics, this correlates to a recurrence interval (RI) of 82 years, with a 1.2% annual chance of occurring in any given year. As noted above, it is anticipated that this probability will increases as the Clallam County region continues its transition from a snow and rain dominated climate to a solely rain dominated climate.

Professional Expected Damages Before Mitigation

As stated earlier in this memorandum, the basis for loss in this analysis is the loss of water supply from the Dungeness River when the river has flows that are above in-stream flow rules established by Washington State regulation. The instream flow rule establishes a quantity of water to remain in river during the year. Flows above the in-stream flow rule would be those available for allocation based on available supply. For this analysis, the damages expected before mitigation would be the flows above the in-stream flow rules plus those flows allocated for usage due to assigned water rights (i.e., irrigation and domestic water supply). So, any flow above the in-stream flow rule and water rights allocation that flows to the Strait of Juan de Fuca is considered a loss.

The basis for this analysis is a model of the project run by Washington Water Trust (WWT) that quantifies the availability of water resources to fill the proposed reservoir. Washington Water Trust was founded in 1998 – the brainchild of two non-profit organizations, American Rivers and the Center for Environmental Law and Policy – to pioneer a new way of restoring water to Washington's rivers and

streams (https://www.washingtonwatertrust.org/). The model developed for this project, used the software R Studio, an integrated development environment for R, a programming language for statistical

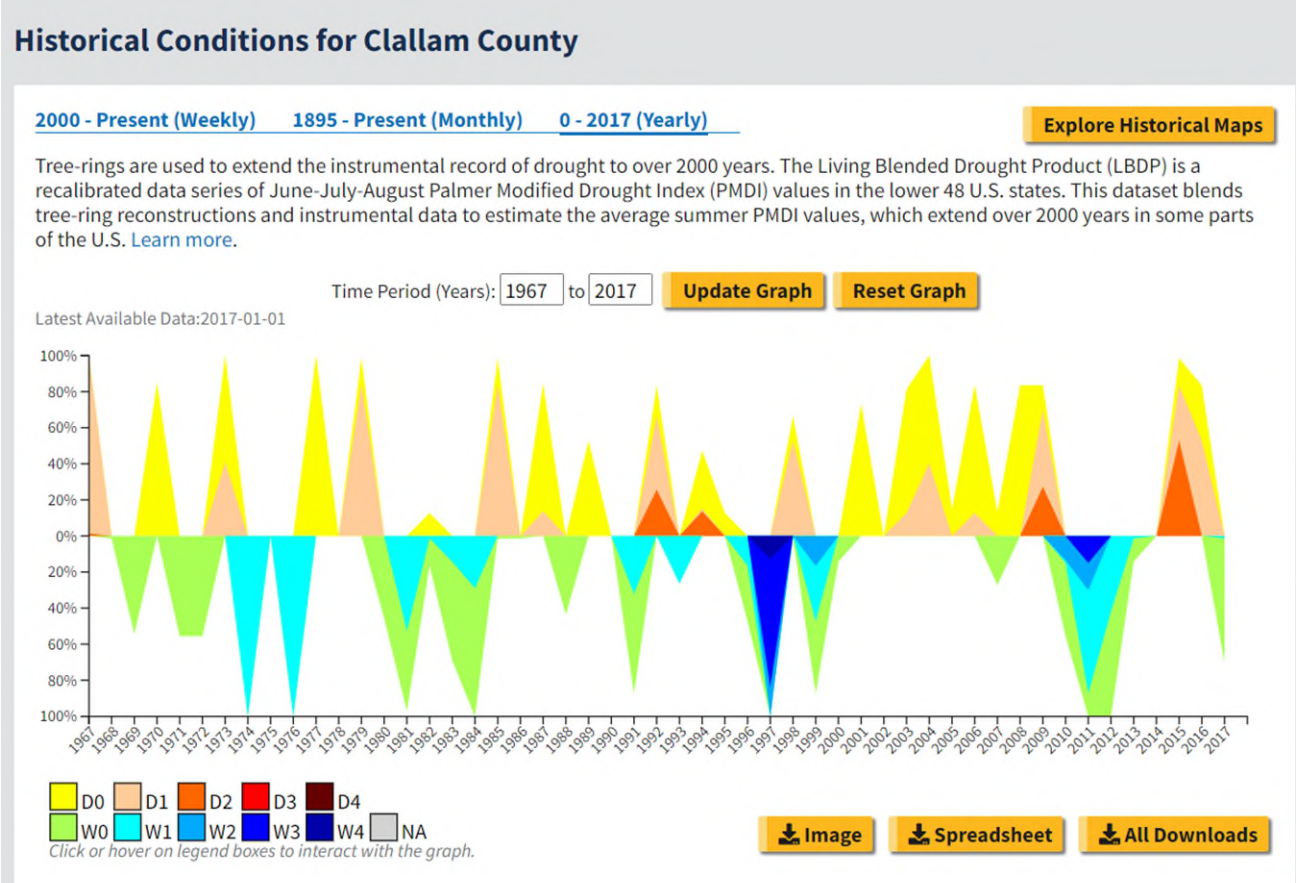


Figure 2. Historic Drought Conditions in Clallam County (1922 to 2022)

computing and graphics. It was critical for the success of this model that the statistical software used could manipulate large datasets, incorporate limiting factors, have the datasets interact, and produce dependable and high-quality data outputs – all qualities offered by R Studio.

This model uses historic Dungeness River Stream flows (2000 to 2021) and identifies supplies available above in-stream flow + water right allocation to fill the proposed reservoir at 2 infill flow scenarios, 15 cfs. and 25 cfs. This time frame includes drought years where restrictions on water uses were applied by the WA dep't. of Ecology and County. The WWT report identifies probabilities of the 22-year time frame that there would be sufficient inflows to fill the proposed reservoir and concluded that the 25cfs scenario increases the dependability of the reservoir as a secure water source. See ***Attachment E*** for the complete copy of the WWT report.

As shown in Figure 3, the 25cfs scenario was utilized to estimate the pre-project damages for the analysis. The average maximum allocation water for the 22-year time frame (2000 to 2021) was 2,585 afy, which would equate to 842,324,835 gallons of water supply that would flow into the Strait of Juan de Fuca.

Unit = AFY	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
15 cfs Diversion: Total accumulation of max allocation water	1447.85	155.1839	1667.796	1349.784	943.999	626.7248	1880.621	1716.488	1122.182	487.1934	1862.677	1782.812	1537.191	1425.476	952.0655	1093.061	2574.043	1830.889	1530.198	1024.844	1270.331	1163.997
25 cfs Diversion: Total accumulation of max allocation water	2790.527	319.4094	3167.532	2560.681	1753.209	1160.306	3656.272	3361.784	2332.585	998.1172	3616.145	3424.364	3150.403	2852.242	1901.38	1877.694	4671.891	3547.141	2931.304	1980.318	2513.028	2295.271

Highlighted year = dry year leasing

Red box = reservoir did not reach one fill

Figure 3. Maximum Allocation Water (MAW) for both the 15 cfs and 25 cfs diversion scenarios.

FEMA documentation shows that there is a value of $3,455 per 1 million gallons of water for which there is an avoided cost of building infrastructure of alternative public drinking water supplies[2]. This value is associated with the avoided costs associated with compromised potable water supplies. Appling this value to the volume of water lost equates to $2,910,147 estimated losses.

While the off-channel reservoir will provide measurable benefits annually, the recurrence interval (RI) assigned to this analysis was the 158-year RI determined for historic drought occurrence, because it will be during droughts when to primary use of the multi-use facility will be diversion to infiltration basins for groundwater recharge. This is considered to be a lower-bound assumption since a more frequent RI is justified based on how the off-channel reservoir will be operated. This represents a loss occurrence to recharge ground water supplies that are needed when low-flow and/or drought years do occur within the project area. The Professional Expected Damages Before Mitigation identified for this project are shown in Figure 3.

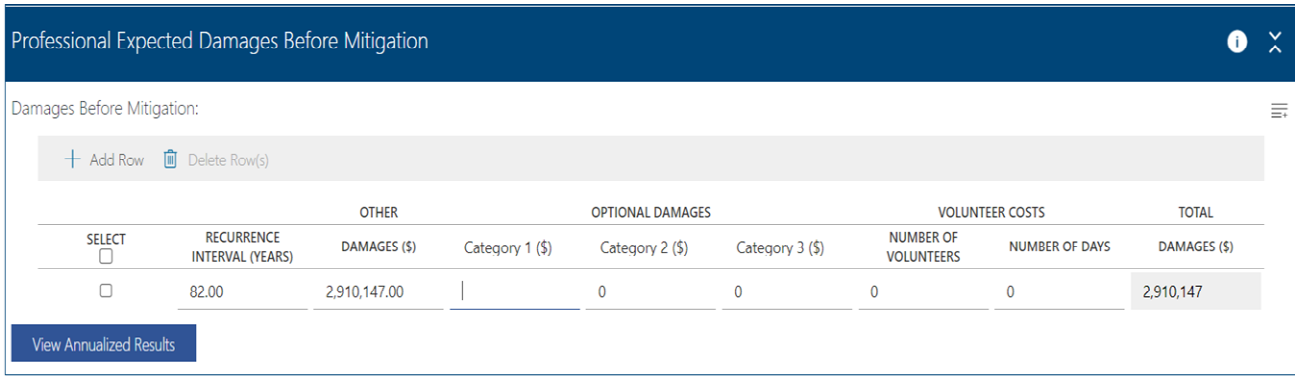


Figure 3. Professional Expected Damages Before Mitigation

[2] Per FEMA "*Supplemental Guidance for Conducting a Benefit-Cost Analysis (BCA) for a Floodwater Diversion and Storage Project*" section 6.4 (https://www.fema.gov/sites/default/files/documents/fema_supp_bca_guidance_floodwater_div_storage.pdf). Also, in FEMA's "*Innovative Drought and Flood Mitigation Projects*", section 2.3.2, dated January 25, 2017. (https://www.fema.gov/sites/default/files/documents/fema_innovative-drought-flood-mitigation-projects.pdf)

Professional Expected Damages After Mitigation

To estimate the post-project damages for the project, the analyst subtracted the capacity of the reservoir (1,500 AF) per the design and engineering for the project from the maximum allocation water value utilized for the pre-project condition used above. Please note that this analysis assumes 1 complete fill of the reservoir per year. While the WWT analysis identified 3 out of 22 years that there was not sufficient flow available to complete fill the reservoir, there were 19 out of 22 years where there were sufficient flows to fill the reservoir beyond capacity. Taking this into account, the analysts determined that a 1 complete fill assumption was logical and defensible.

- 1,500 AF = 488,776,500 gallons
- 488.8 million gallons x $3455/1 Million Gallons = $1,688,804= avoided losses
- $2,910,147 - $1,688,804 = $1,221,343 = Post Project Damages.

The Professional Expected Damages After Mitigation identified for this project are shown in figure 4.

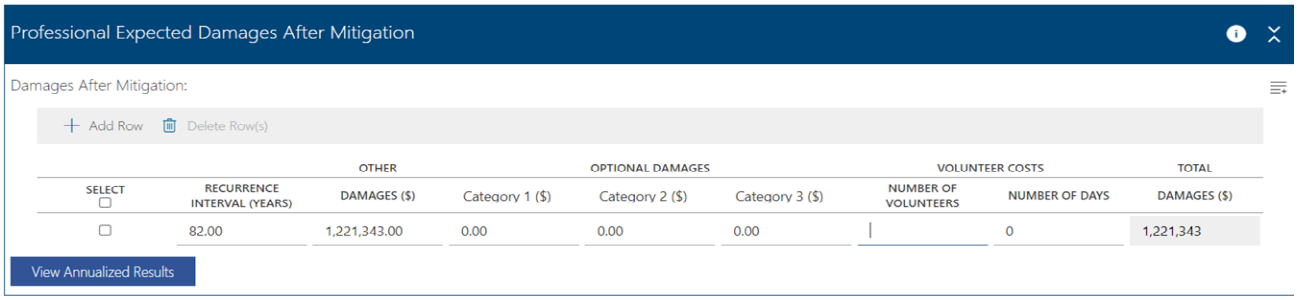


Figure 4. Professional Expected Damages after Mitigation

Standard Benefits - Ecosystem Services

In June of 2022, FEMA released its Ecosystem Service Value Updates that updates FEMA's policies and directives for recognizing the benefits provided by nature-based solutions as part of hazard mitigation projects. Section 5 of this report provides step-by-step guidance on how to apply the ecosystem service values in FEMA's BCA Toolkit for a mitigation action or project. This report provides guidance on how to define the land cover category (or categories) associated with the mitigation project, including definitions for each category that has associated dollar values. The 1st step identified in this report states, the sub-applicant should identify the land cover category (or categories) that will be restored, ***created***, enhanced, or protected as a result of the project. What this statement acknowledges is that ecosystem services can be created by a mitigation action on a site that may have had no real ecosystem service benefits and/or has degraded ecosystem service benefits, prior to the mitigation action. Furthermore, this guidance emphasizes that, for any mitigation project, the area of each land cover category that is counted in the BCA Toolkit must be part of the footprint of the project, where the land cover category is being restored, created, enhanced, or protected. This is an important facet for the justification for including ecosystem service benefits in the Dungeness Off-Channel Reservoir project.

The primary benefits of this off-channel reservoir project are the ecosystem services provided by the project. These services range from maintaining "normative flow" in the Dungeness River, aquifer storage and recovery, to the creation of critical habitat and the social recreational benefits of green open space. While the proposed location for the new reservoir is currently in a vacant state, the land is currently zoned

to allow for future development. Thus, another testament to how this project will mitigate future conditions by the conversion of developable land to open space uses. The current site is zoned as "Commercial Forest" which has the following allowed uses pursuant to Clallam County Zoning Code 33.070.020 (https://clallam.county.codes/CCC/33.07.020):

- Agricultural activities
- Communication relay facilities
- Industrial land uses
- Mineral extraction
- Primitive campgrounds
- RV parks in the western half of the Straits Regional Comprehensive Planning Area
- Single-family dwellings
- Timber harvesting
- Timber labor camps

While the land use designation for the site, "Commercial Forrest" implies some sort of land use restriction that strives to preserve the ecosystem service benefits for "Forests" like those identified for the BCA Calculator, this is not the case. As stated in the Clallam County code, "*the purpose of the Commercial Forest zone is to protect large forest land parcels from encroachment of uses which threaten effective forest management practices*". These practices include the activities noted above (including timber harvesting) which do not preserve the ecosystem service benefits for "forests" identified by FEMA. Therefore, this site is considered to be a degraded habitat that provides no existing baseline ecosystem service benefits being provided by the site in its pre-project condition. The fact that the parcel could be developed to include land uses that could degrade ecosystem services benefits for the reach needs to be emphasized. This is a key issue that will be addressed by the Off-Channel Reservoir project in that it will functionally change land-cover and land uses of the site to those that provide ecosystem service benefits in perpetuity. The regulated land use of the site will be changed from one that allows for to development, to one that limits all development of the site to those associated with parks and open space uses. Land cover will be changed at the site to covers recognized by FEMA as providing ecosystem services. So, in essence, the project goes from a pre-project baseline of zero ecosystem service benefits, to a post project condition that will provide inland wetland, riparian, and rural green open space ecosystem service benefits, that will be guaranteed in perpetuity via deed restriction.

Section 5.2, page 22 of the "FEMA Ecosystem Service Value Updates" document also states; "*In the context of a FEMA BCA, the ecosystem service values can be realized through an increase in the health or functionality of an ecosystem in the "After-Mitigation" scenario relative to the "Before-Mitigation" (No Action) scenario. Therefore, ecosystem service values could be generated through restoration, creation, enhancement or protection (of areas at risk of degradation in a No Action scenario)*". So, since the off-channel reservoir project will result in a land use change that will eliminate any future degradation of the reach in perpetuity, the project clearly meets this requirement.

Lastly, section 5.2, page 22 of the "FEMA Ecosystem Service Updates" document also provides some examples of ecosystem services that meet what has been defined above. One example cited is as follows:

> *Another example would be the acquisition of a parcel that does not contain structures, followed by restoration, creation, or enhancement of ecosystems on that parcel for the purpose of reducing the risk of a hazard such as flood or wildfire. It should be emphasized that, per the 2015 FEMA HMA Guidance document, projects "with the sole purpose of open space acquisition of unimproved land" are an ineligible activity, However, if acquisition of an existing unimproved parcel is part of a*

broader, eligible mitigation action, it may be eligible. For example, the sub-applicant may be proposing a Floodplain and Stream Restoration, Flood Diversion and Storage, or Hazardous Fuels Reduction project that involves acquisition of an open space parcel containing a degraded forested area. If the sub-applicant could show that 1) Acquisition is required in order to make the project feasible and effective (i.e., other options such as easements or landowner agreements have been considered but ruled out); AND 2) Restoration, creation and/or enhancement of forested areas on that parcel would result in a quantifiable risk reduction benefit (as demonstrated through modeling and/or the BCA Toolkit), then such an action may be quantified and considered for ecosystem service benefits in the BCA. Examples could include: 1) Acquisition and restoration of a forested area to increase the floodwater storage potential on the land, thereby reducing flood risk to downstream people and property; or 2) Acquisition and enhancement of a forested area through hazardous fuels reduction activities, thereby reducing the potential risk and severity of a wildfire to adjacent people and property. However, because such approaches are relatively new from a FEMA HMA perspective, the sub-applicant should always seek guidance and clarification on this matter from their FEMA regional office and State Hazard Mitigation Officer.

This scenario would directly apply to the Dungeness Off-Channel reservoir project. The "broader eligible mitigation action" is aquifer storage and recovery. Active recharge is not occurring at the reservoir site itself. It will occur offsite when water from the reservoir is conveyed through a system of water conveyance canals to established infiltration basins that have been created to replenish the ground water supply in the project area. The water needs to be captured and stored so that this recharge can occur. The obvious source for that water is the Dungeness River. So, land acquisition is needed adjacent to the Dungeness River to create a capture and storage point that has access to the water conveyance system. This so happens to be the site selected by the County for this project. This site is currently vacant and is zoned for future land uses that could degrade ecosystem services at the site. Creation of the project will actually change the land cover and uses to those that will provide ecosystem service benefits as well as cultural and social benefits in perpetuity. The example above notes that this approach to recognizing ecosystem services is "relatively new from a FEMA HMA perspective" , and my not be well understood by the traditional BCA technical review protocol. However, this is the direction FEMA is promoting with its guidance like the "FEMA Ecosystem Service Value Updates" and FEMA should be open to acceptance of projects like the Dungeness Off-Channel Reservoir Project.

The "Ecosystem Services" information tab in version 6.0 of the FEMA Benefit Cost Calculator states; "*Ecosystem service benefits accrue when land use is changed or enhanced by a mitigation activity to provide a higher level of natural benefits. Because natural systems are largely self-maintaining and tend to become more economically valuable over time, including ecosystem services provides a more complete accounting of a project's benefits"*. This guidance does not caveat any parameters required for determining land cover change. So, in essence, a mitigation project that results in an enhancement of eligible ground cover changes, should be allowed to count ecosystem services benefits. FEMA has established values for various land covers that have been determined to provide ecosystem service benefits as shown in Table 1 below.

Table 1. Ecosystem Service Categories/Values

Category	Value ($/Acre)
Urban Green Open Space	$15,541
Rural Green Open Space	$10,632
Riparian	$37,199
Coastal Wetlands	$8,955

Category	Value ($/Acre)
Inland Wetlands	$8,171
Forests	$12,589
Coral Reefs	$7,120
Shellfish Reefs	$2,757
Beaches and Dunes	$300,649

So, if a project changes the land cover from a category of less or no value to a recognized category or one of a higher value, that is an enhancement of the ecosystem services.

This project will create 396 acres of land that will maximize these benefits amongst others. The Ecosystem Services calculator utilizes areas calculations and assigned standard values per acre to estimate net benefit based on nine ecosystem service categories.

The total acreage for the project site is 396 acres broken down as follows:

- 319 acres for the reservoir site that is inclusive of 62.4 acres that will be utilized for the actual reservoir.
- 77 acres for a park that will provide the public access to the site for recreational purposes.

See ***Attachment F*** for site maps and area calculations.

Based on these areas, the analyst applied the following allocations and justifications to calculate the ecosystem benefits for the project:

- In the post-project state, the service area for the reservoir itself will be 62.4 acres at maximum capacity. Once created, the reservoir itself would likely meet the US EPA classifications for either Riverine-Lower Perineal wetlands or Riverine-Intermittent wetlands (see ***Attachment G***). Therefore, the analyst applied the 62.4 acres (15.8% of the project site) to the inland wetland land cover category.

- The analyst assumed that those areas immediately adjacent to the body itself, would qualify as "riparian" under the Ecosystem Services calculator. To confirm this, the analyst applied the definition of "Riparian Buffer Zone "from the "Biological Opinion" for FEMA Region X (see ***Attachment H***). To calculate this area, the Analyst applied a 50-foot buffer to the perimeter of the reservoir, which amounts to 15.3 acres (3.9% of the project area) immediately adjacent to these areas categorized as wetlands. This is considered to be a very conservative value as the Biological Opinion for FEMA Region X suggests riparian zone buffers up to 250 feet.

- The balance of the project area (318.3 acres) would qualify as "Urban Green Open Space". This equates to 80.3% of the project site.

The ecosystem service values entered into the BCC are shown in figure 5 below.

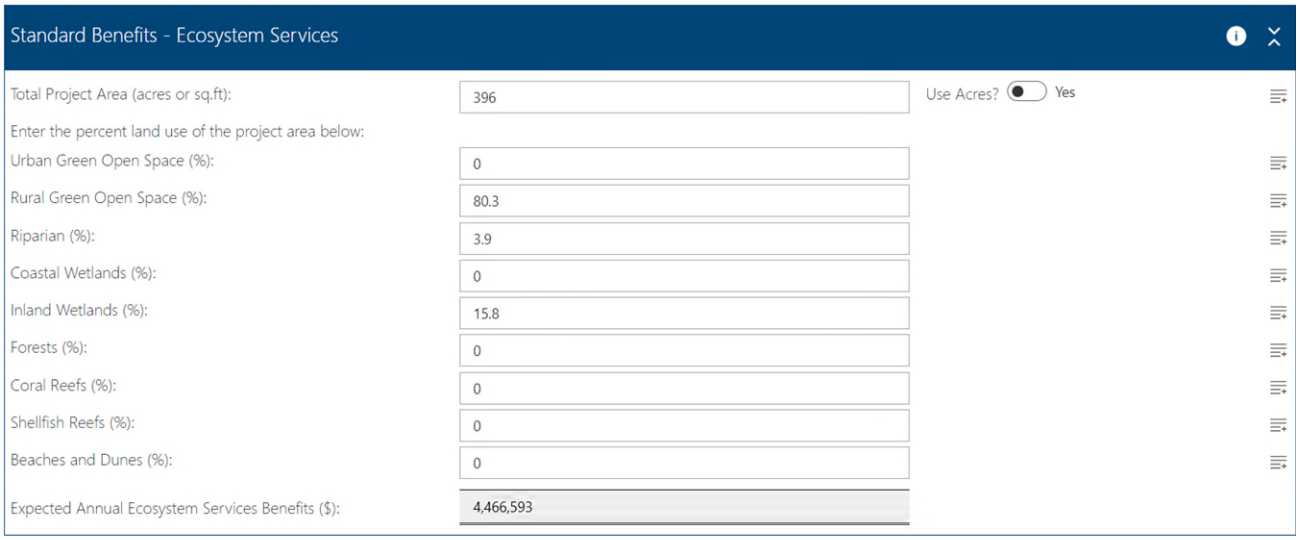


Figure 5. Ecosystem Service Land Cover Percentages

III. The Final BCR

The final BCR for this project is **1.91** as depicted Figure 6 below. The Final BCA report can be viewed in ***Attachment I***.

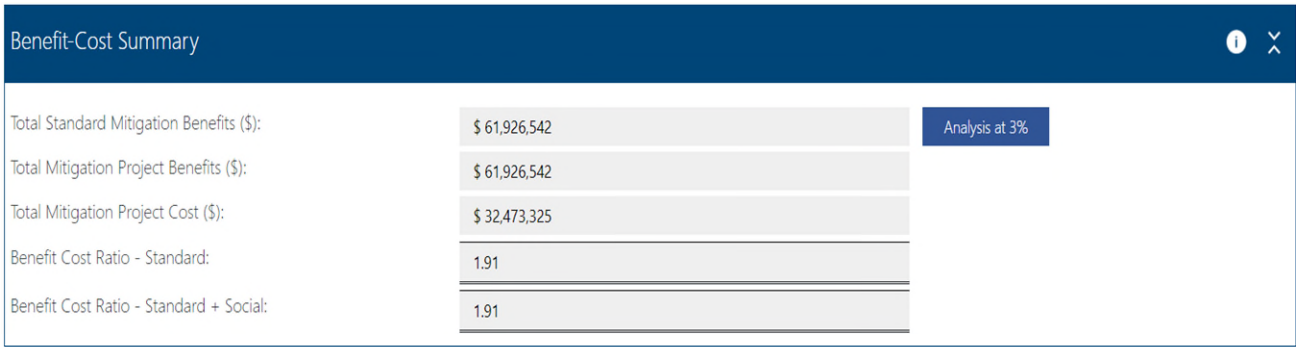


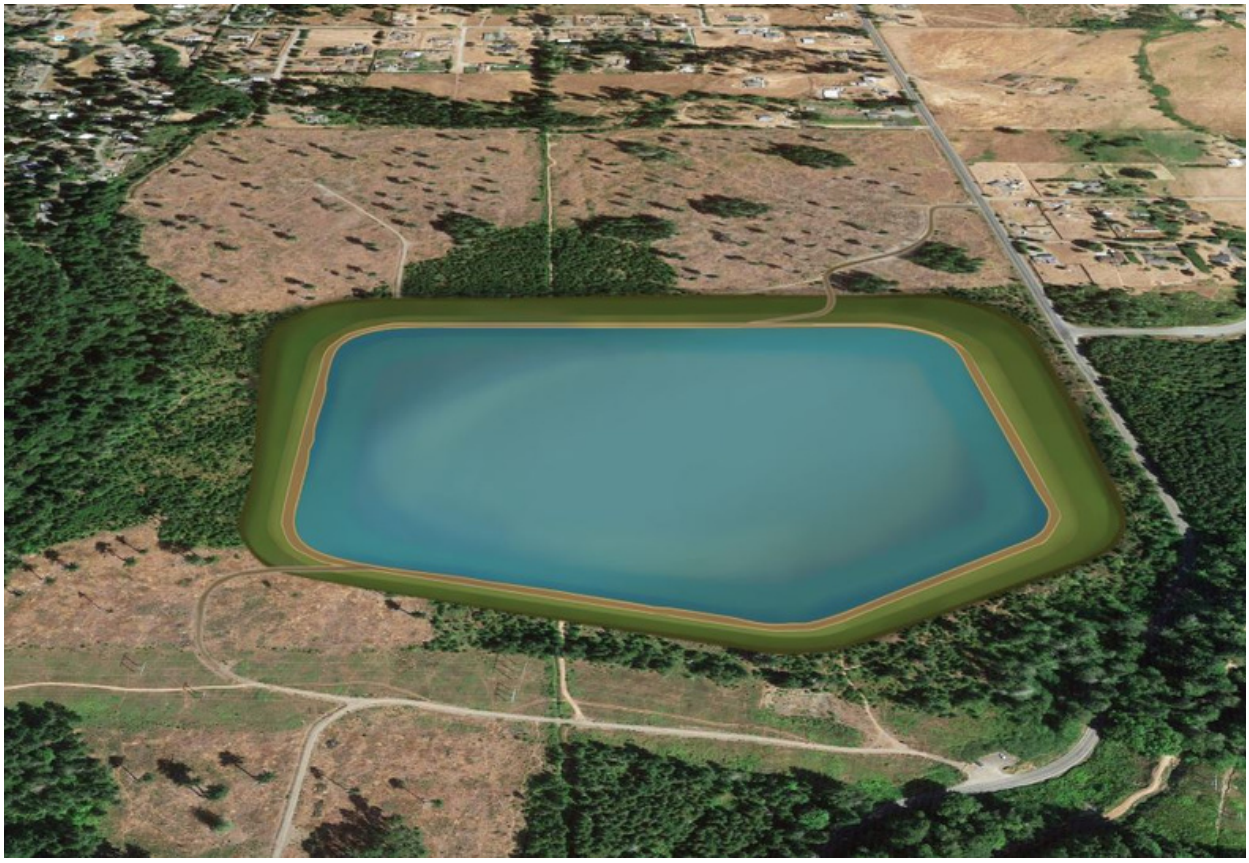
Figure 6. Final Benefit Cost Ratio (BCR)

ATTACHMENT A

Project Description/Background

DUNGENESS STREAMFLOW RESTORATION OFF-CHANNEL RESERVOIR

PROVIDING DROUGHT RESILIENCY AND RIVER RESTORATION IN THE DUNGENESS RIVER BASIN



PROJECT SPONSOR: CLALLAM COUNTY

PARTNERS:

- CITY OF SEQUIM
- CLALLAM CONSERVATION DISTRICT
- DUNGENESS WATER USERS ASSOCIATION
- JAMESTOWN S'KLALLAM TRIBE
- WASHINGTON DEPT. OF ECOLOGY
- WASHINGTON DEPT. OF FISH & WILDLIFE
- WASHINGTON WATER TRUST

PROJECT DESCRIPTION

The Dungeness River basin, located in the rain shadow of the Olympic Mountains on the northeast corner of Washington's Olympic Peninsula, is the driest and most climate vulnerable area in western Washington. The Dungeness River is important to local communities for water supply, and is also ecologically and culturally important as it is home to four ESA-listed native fish species, Puget Sound Chinook, Hood Canal Summer Chum, Puget Sound Steelhead, and bull trout, whose numbers have decreased significantly over the past 150 years.

Fed by rain and the Olympic Mountains snowpack, flows in the Dungeness River decline over the spring and summer often reaching critically low levels in late summer when communities and fish need water the most. Water right holders can withdraw as much as 50% of river flows during this time reducing the amount of habitat available to fish and contributing to dangerously high water temperatures and fish passage challenges. In addition, the Dungeness watershed is increasingly susceptible to drought. Eight of the last twenty years – including four of the past eight years – in the Dungeness have been drought or dry years, and it is projected that by the 2080s the average snowpack in Washington will decline by 56% to 70%, and summer stream flows will decrease by 34% to 44% on average across the state putting freshwater supplies and the communities and fish that depend upon them at risk.

The solution to the freshwater supply challenges facing communities, farms and fish is the Dungeness Streamflow Restoration Off-Channel Reservoir. Water will be collected and stored in an off-stream reservoir during winter and spring when flows are plentiful. This stored water will be used later in the year in place of water withdrawn directly from the river when flows are at their lowest. The result will be increased groundwater levels in the heavily tapped shallow aquifer, a stable, drought-resistant and climate-resilient water supply for the local food system and communities, and 15 - 26 cfs of streamflow restored to the Dungeness River resulting in weighted usable habitat area increases of up to 35% for ESA-listed fish species.

COMMUNITY BENEFITS

Aquifer Recharge - Stored water from the reservoir can be used for aquifer recharge to increase groundwater levels in the heavily tapped shallow aquifer as well as augment flows in local streams, and generate additional mitigation credits for the Dungeness Water Exchange (a local water bank).

Drought-Resilient & Climate-Resilient Water Supply - Decreasing water supplies for both people and the environment is the biggest climate concern for eastern Clallam County. Drought conditions have been present in the area in four of the past eight years. This project will use water storage to provide a reliable climate-resilient water supply for drinking water supply/aquifer stability and the local food system over time.

Streamflow Restoration - The project will restore between 15 - 26 cfs of flow in the Dungeness River alleviating low streamflows and fish passage issues, restoring habitat, and reducing water temperature for ESA-listed salmon, steelhead and bull trout.

Recreation - The project site is currently owned by the WA Department of Natural Resources and will be owned and managed by Clallam County as a new public park with hiking, biking, wildlife viewing, and river access opportunities. The park will provide aesthetic benefits for improved mental health and physical well-being.

RECOVERY & MANAGEMENT PLANS:

The following recovery and management plans support Dungeness streamflow restoration:

- Puget Sound Partnership Action Agenda: Highest Priority Near-Term Action (#2018-0169)
- Elwha-Dungeness Watershed Plan
- Climate Change Preparedness Plan for the North Olympic Peninsula
- 2016 State of our Watersheds: A Report by the Treaty Tribes in Western Washington
- Puget Sound Salmon Recovery Plan
- Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Recovery Plan
- ESA Recovery Plan for the Puget Sound Steelhead DPS
- Recovery Plan for the Coterminous United States Population of Bull Trout

BY THE NUMBERS

Reservoir size	Reservoir capacity	Size of new county park
41.6 acres	**1,600 acre feet**	**396 acres**

Flow restoration benefit	One-month irrigation supply annually for	ESA-listed fish species benefitting
15-26 cfs**	**3,200 acres**	**4 species*****

**Represents up to a 47% increase in flow which dropped to 56 cfs in 2015. Restored flow will be protected by Trust Water/MOA agreement from other diverters.

***Puget Sound Chinook, Hood Canal Summer Chum, Puget Sound Steelhead & Bull Trout

PROJECT TIMELINE

PHASE	DATE
PHASE 01 LAND TRANSFER & ASSESSMENTS	JAN 2020 - JUN 2023
PHASE 02 DESIGN, RELATED OUTREACH & PERMITTING	JUN 2021 - SEPT 2023
PHASE 03 CONSTRUCTION & RELATED OUTREACH	OCT 2023 - DEC 2025

PROJECT BUDGET OF $30 MILLION

ATTACHMENT B

Census Profile for Clallam County, WA

County

Clallam County, Washington

Clallam County, Washington has 1,738.7 square miles of land area and is the 20th largest county in Washington by total area. Clallam County, Washington is bordered by San Juan County, Washington and Jefferson County, Washington.

// United States / Washington / Clallam County, Washington

Display Sources

Populations and People
Total Population
77,155
P1 | *2020 Decennial Census*

Income and Poverty
Median Household Income
$62,695
S1901 | *2021 American Community Survey 1-Year Estimates*

Education
Bachelor's Degree or Higher
26.6%
S1501 | *2021 American Community Survey 1-Year Estimates*

Employment
Employment Rate
45.1%
DP03 | *2021 American Community Survey 1-Year Estimates*

Housing
Total Housing Units
37,930
H1 | *2020 Decennial Census*

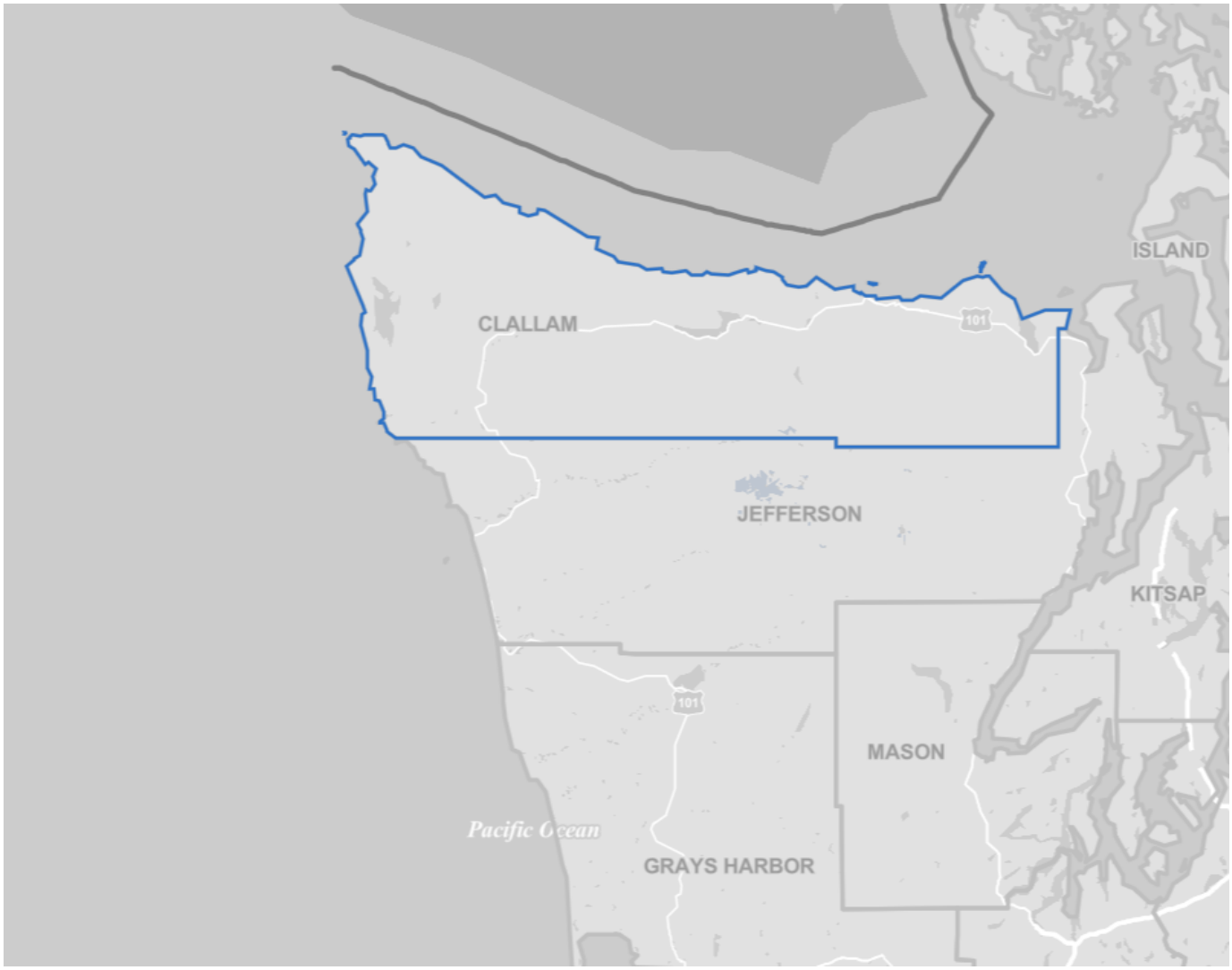
Health
Without Health Care Coverage
7.3%
S2701 | *2021 American Community Survey 1-Year Estimates*

Business and Economy
Total Employer Establishments
2,050
CB2000CBP | *2020 Economic Surveys Business Patterns*

Families and Living Arrangements
Total Households
34,773
DP02 | *2021 American Community Survey 1-Year Estimates*

Race and Ethnicity
Hispanic or Latino (of any race)
4,732
P2 | *2020 Decennial Census*

Clallam County, Washington Reference Map



Source: U.S. Census Bureau

Populations and People

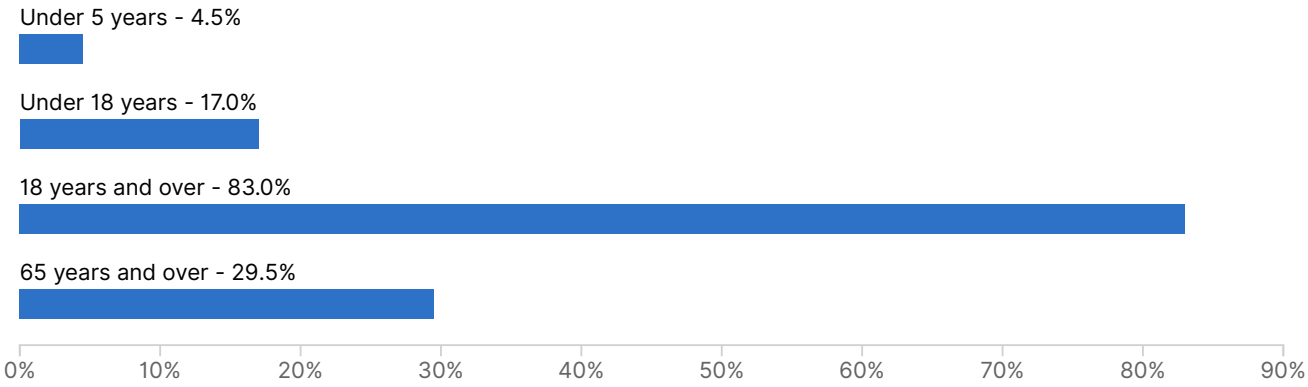
Age and Sex

51.5 +/- 0.9
Median Age in Clallam County, Washington

38.2 +/- 0.1
Median Age in Washington

S0101 | *2021 American Community Survey 1-Year Estimates*

Population by Age Range
in Clallam County, Washington



DP05 | *2020 ACS 5-Year Estimates Data Profiles*

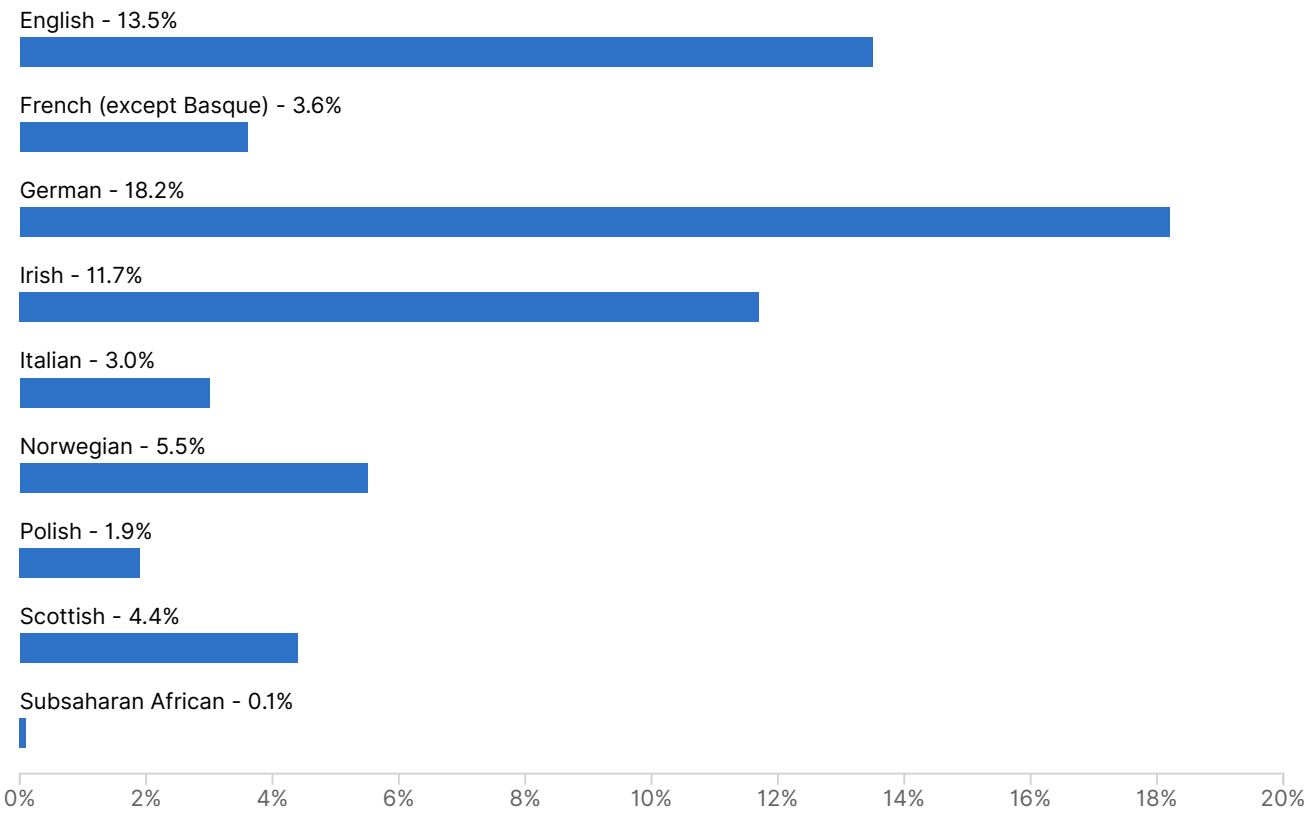
Ancestry

2.8% +/- 1.1%
Italian Ancestry in Clallam County, Washington

3.1% +/- 0.1%
Italian Ancestry in Washington

DP02 | *2021 American Community Survey 1-Year Estimates*

Ancestry
in Clallam County, Washington



DP02 | *2020 ACS 5-Year Estimates Data Profiles*

Language Spoken at Home

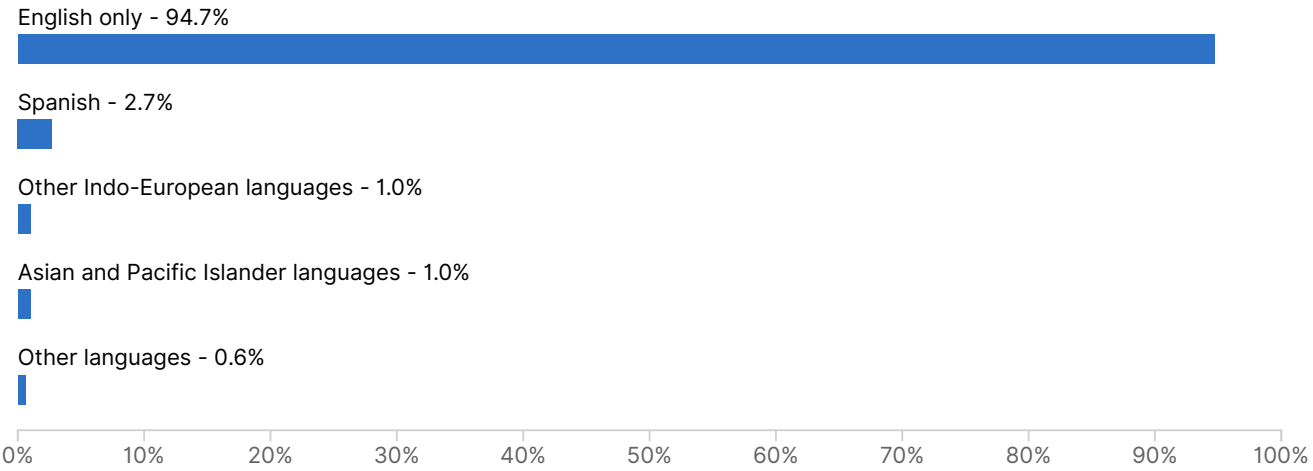
N +/- N
Language Other Than English Spoken at Home in Clallam County, Washington

20.8% +/- 0.3%
Language Other Than English Spoken at Home in Washington

S1601 | *2021 American Community Survey 1-Year Estimates*

S1601 | 2021 American Community Survey 1-Year Estimates

Types of Language Spoken at Home
in Clallam County, Washington



DP02 | 2020 ACS 5-Year Estimates Data Profiles

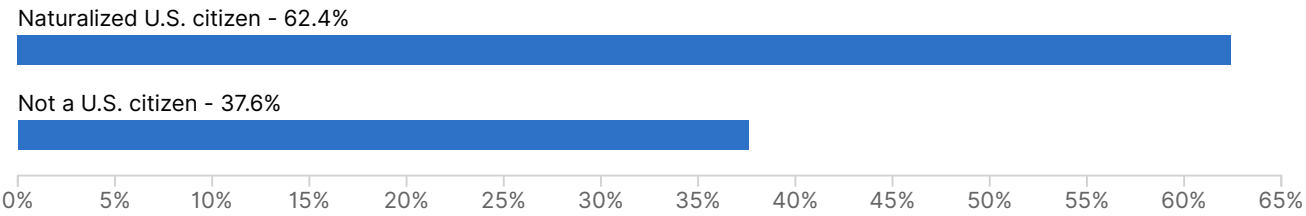
Native and Foreign Born

4.5% +/- 1.3%
Foreign Born population in Clallam County, Washington

14.8% +/- 0.2%
Foreign Born population in Washington

DP02 | 2021 American Community Survey 1-Year Estimates

Foreign Born Population
in Clallam County, Washington



DP02 | 2020 ACS 5-Year Estimates Data Profiles

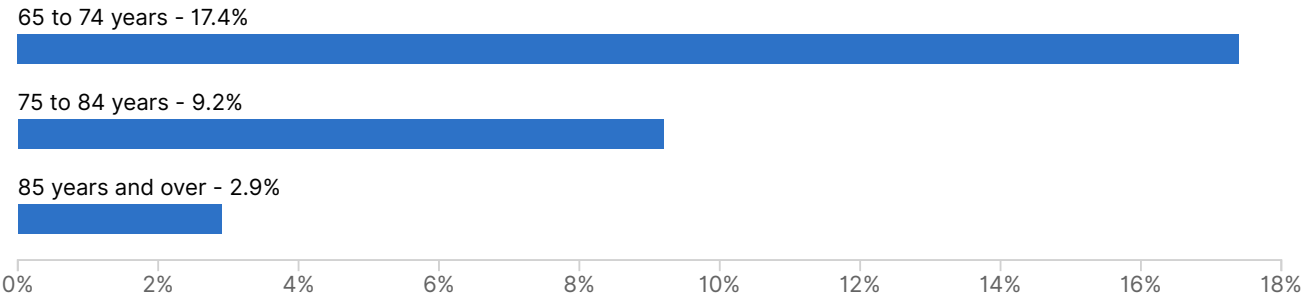
Older Population

31.4% +/- 0.7%
65 Years and Older in Clallam County, Washington

16.2% +/- 0.1%
65 Years and Older in Washington

DP05 | 2021 American Community Survey 1-Year Estimates

Older Population by Age
in Clallam County, Washington



DP05 | *2020 ACS 5-Year Estimates Data Profiles*

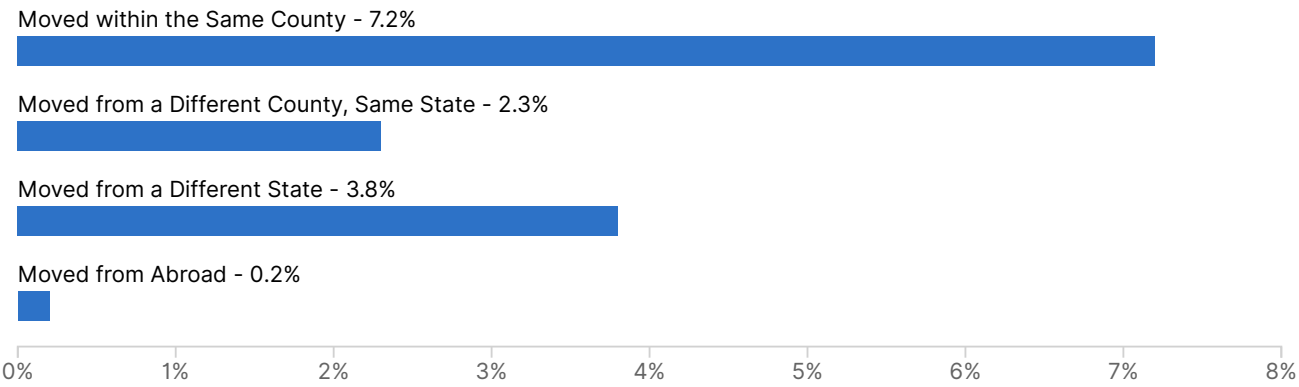
Residential Mobility

4.2% +/- 2.0%
Moved From a Different State in the Last Year in Clallam County, Washington

2.9% +/- 0.2%
Moved From a Different State in the Last Year in Washington

S0701 | *2021 American Community Survey 1-Year Estimates*

Residential Mobility in the Last Year
in Clallam County, Washington



S0701 | *2020 ACS 5-Year Estimates Subject Tables*

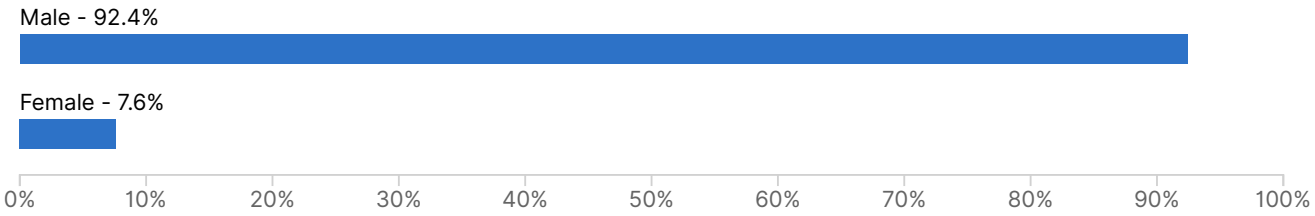
Veterans

13.6% +/- 2.0%
Veterans in Clallam County, Washington

8.2% +/- 0.2%
Veterans in Washington

S2101 | *2021 American Community Survey 1-Year Estimates*

Veterans by Sex
in Clallam County, Washington



S2101 | *2020 ACS 5-Year Estimates Subject Tables*

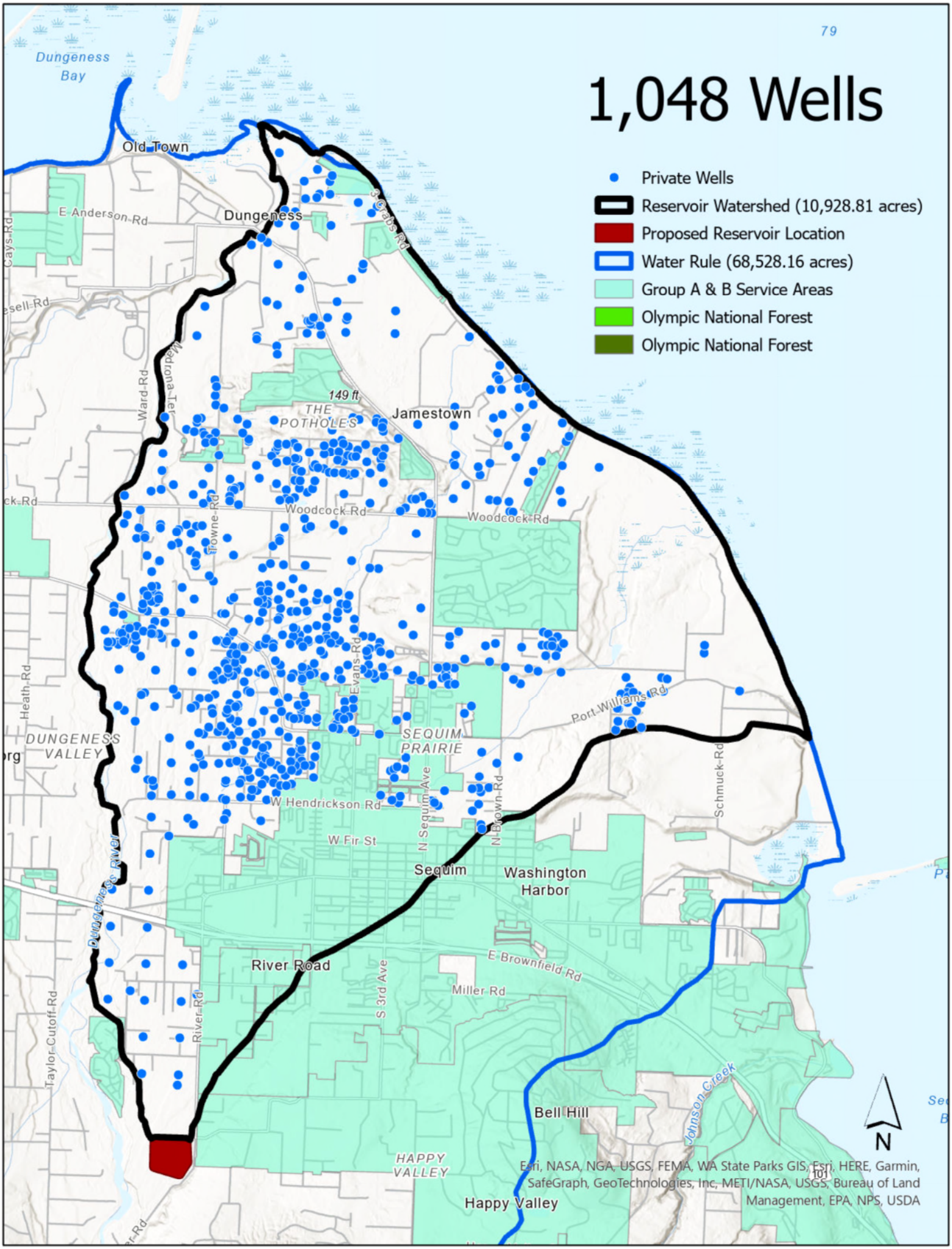
Nearby Counties

San Juan County, Washington

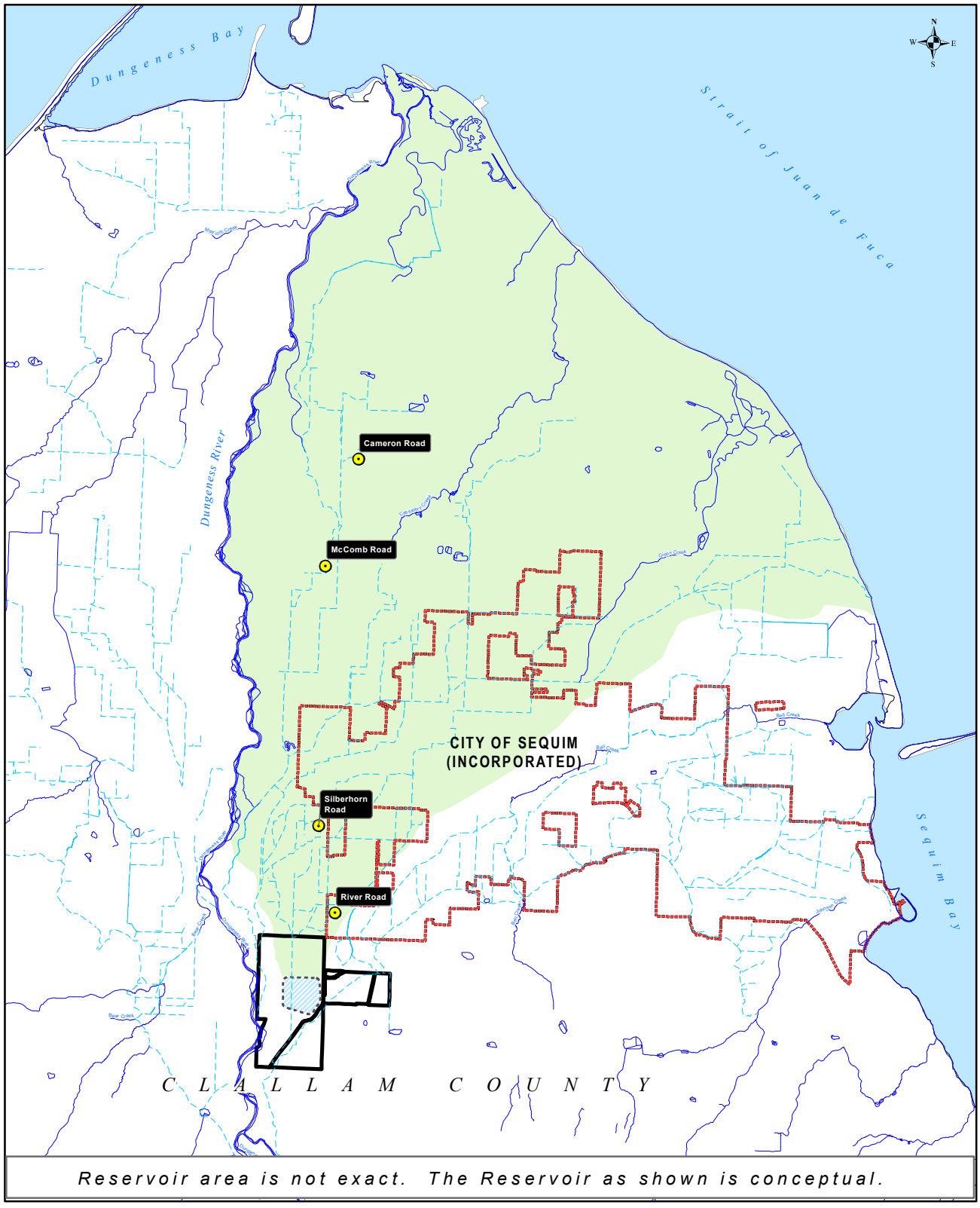
Jefferson County, Washington

ATTACHMENT C

PBA Map


1,048 Wells
Private Wells
Reservoir Watershed (10,928.81 acres)
Proposed Reservoir Location
Water Rule (68,528.16 acres)
Group A & B Service Areas
Olympic National Forest
Olympic National Forest
Dungeness Bay
Old Town
Dungeness
E Anderson Rd
3 Crabs Rd
Ward Rd
Marina Ter
149 ft
THE POTHOLES
Jamestown
Woodcock Rd
Towne Rd
Evans Rd
Port Williams Rd
Heath Rd
DUNGENESS VALLEY
SEQUIM PRAIRIE
W Hendrickson Rd
N Sequim Ave
N Brown Rd
Schmuck Rd
W Fir St
Sequim
Washington Harbor
Dungeness River
River Road
E Brownfield Rd
Miller Rd
S 3rd Ave
River Rd
Taylor Cutoff Rd
Johnson Creek
Bell Hill
HAPPY VALLEY
Happy Valley
N
Esri, NASA, NGA, USGS, FEMA, WA State Parks GIS, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA

Proposed Dungeness Reservoir - Aquifer Recharge Sites



Legend

- Stream
- Water conveyance canals
- City of Sequim
- Downgradient Area Impacted By Project
- Subject Parcels
- Conceptual Reservoir
- Aquifer recharge sites

0 3,500 7,000 14,000 Feet

Date: 11/13/2022 CT

Document Path: J:\GRANTS\RESERVOIR\FEMA BRIC\ResShed_InfiltationSites.mxd

ATTACHMENT D

Project Costs

Dungeness Off-stream Reservoir Project (1-10-22)

Opinion of Probable Cost by Anchor QEA - SUMMARY - FOR FEMA GRANT APPLICATION

Dungeness Reservoir Key Elements:

Cost Item	Reservoir and Appurtenances - Till Cutoff, No Geomembrane Liner, 1,200 Acre-foot Option Cost
Subtotal - Reservoir and Appurtenances	**$20,274,503**
Subtotal - HID Settling Basin	$170,375
Construction Subtotal	**$20,444,878**
Sales Tax (8.5%)	$1,737,815
Construction Total	**$22,182,693**
Construction Management (8% of Construction totall)	$1,774,615
Additional Project Costs. See Table below.	$6,029,380
Total Project Cost	**$29,986,689**
Total Prject Cost, less Pre-award Costs	**$29,954,689**

Additonal Project Costs:

Cost Item	Cost
Land Acquisition and Appraisals	$2,520,000
Engineering Design	$2,465,320
Water Rights, Legal, Planning, and Some Outreach	$145,352
Permitting and Assessment	$233,451
Project Administration and Construction Closeout	$240,380
Project Management Costs	335,877
Pre-award Costs	$32,000
Outreach	$57,000
Total Additional Project Costs	**$6,029,380**

Dungeness Off-stream Reservoir Project (1-10-22)
Opinion of Probable Cost by Anchor QEA - 30% Design - FOR FEMA GRANT APPLICATION
Configuration with Till Cutoff/No Geomembrane Liner - 1,200 Acre-foot Reservoir

RESERVOIR AND APPURTENANCES

Bid Item	Estimated Quantity	Unit	Item	Spec.	Unit	Total	Subtotals	FEMA Cost Category
1	1	LS	Removal of Structures and Obstructions	2-02.5	$7,500	$7,500		*Demolition and Removal*
							$7,500	
2	1	LS	Construction Surveying	1-05.5(4)	$88,000	$88,000		*Site Work*
3	1	LS	Right-of-Way Use, Construction Permit Compliance	1-07.6(4)	$25,000	$25,000		*Site Work*
4	1	LS	Temporary Water Pollution/Erosion Control	1-07.15(4)	$300,000	$300,000		*Site Work*
5	1	LS	Utilities Locate and Protection	1-07.17(1)	$10,000	$10,000		*Site Work*
6	1	FA	Force Account	1-09.6	$100,000	$100,000		*Site Work*
7	1	LS	Temporary Traffic Control	1-10.5	$26,000	$26,000		*Site Work*
8	108	AC	Clearing and Grubbing	2-01.5	$5,000	$540,000		*Site Work*
9	1	LS	Final Cleanup	2-11.5	$22,000	$22,000		*Site Work*
10	174,300	CY	Stripping, Haul, and Stockpile of Topsoil Layer	2-03.5	$4.00	$697,200		*Site Work*
11	63	AC	Revegetation (Planting Seeding, Fertilizing, and Mulching)	8-02.5	$5,000	$315,000		*Site Work*
							$2,123,200	
12	1	LS	Moblization/Demobilization	1-09.7	$1,469,175	$1,469,175		*Construction*
13	40,233	CY	Cutoff Trench Excavation, Haul, and Stockpile	2-03.5	$4.00	$160,932		*Construction*
14	33,100	CY	Overexcavation for Crushed Rock Maintenance Course	2-03.5	$4.00	$132,400		*Construction*
15	1,286,700	CY	Reservoir Excavation, Haul, and Compact in Stockpile	2-03.5	$6.50	$8,363,550		*Construction*
16	20,524	CY	Screening and Placement of On-site Embankment Materials	2-03.5	$6.50	$133,406		*Construction*
17	42,462	CY	Import and Placement of Sand Filter	2-03.5	$40	$1,698,480		*Construction*
18	14,902	CY	Screening and Placement of On-site Embankment Drain Material	2-03.5	$6.50	$96,863		*Construction*
19	77,846	CY	Screening and Placement of Till Cutoff Material	2-03.5	$7.50	$583,845		*Construction*
20	5,900	TN	Bentonite Amendment for Till Cutoff	2-03.5	$90	$531,000		*Construction*
21	33,100	CY	Processing and Placement of Crushed Rock Maintenance Course	2-03.5	$6.50	$215,150		*Construction*
22	174,300	CY	Placement of Onsite Topsoil Material	2-03.5	$4.00	$697,200		*Construction*
23	9,818	CY	Trenching for Pipe Installation, including Shoring	2-03.5	$6.00	$58,908		*Construction*
24	3,925	CY	Placement of Imported Pipe Bedding	2-03.5	$40.00	$157,000		*Construction*
25	3,902	CY	Placement of On-site Trench Backfill	2-03.5	$7.00	$27,314		*Construction*
26	9,800	SY	Geotextile	2-12.5	$3.60	$35,280		*Construction*
27	1,800	CY	Crushed Rock Surfacing	4-04.5	$6.50	$11,700		*Construction*
28	1	LS	Flow Control Structure on HID Canal with Automatic Gates	6-02.5	$51,000	$51,000		*Construction*
29	1	LS	Reservoir Inlet Structure	6-02.5	$18,000	$18,000		*Construction*
30	1	LS	Low Level Outlet Structure	6-02.5	$13,000	$13,000		*Construction*
31	1	LS	Drop Inlet Spillway Structure	6-02.5	$13,000	$13,000		*Construction*
32	1	LS	30-inch Automated Control Gate at Outlet	7-10.5	$26,000	$26,000		*Construction*
33	2,600	LF	36-inch HDPE DR 21 Inlet Pipeline, Control Structure to Reservoir	7-10.5	$230	$598,000		*Construction*
34	4,020	LF	18-inch HDPE Bypass Pipeline, Around Reservoir	7-10.5	$45	$180,900		*Construction*
35	1,420	LF	30-inch HDPE DR 21 Outlet Pipeline, Reservoir to Irrigation System	7-10.5	$160	$227,200		*Construction*
36	1	LS	Items Not Yet Identified	TBD	$2,644,500	$2,644,500		*Construction*
							$18,143,803	

Subtotal		**$20,274,503**
Construction Subtotal		**$20,274,503**
Sales Tax	8.50%	$1,723,333
Construction Total		**$21,997,836**

NOTES:

(1) Design, permitting, construction administration, legal and administrative costs are not included with this estimate.

(2) Opinion of cost updated in October 2021. Actual construction costs will vary based on materials and labor costs at time of construction.

(3) The Subtotals and Construction Total are rounded to the nearest $1,000.

HID INLET FACILITY SETTLING BASIN

Bid Item	Estimated Quantity	Unit	Item	Spec.	Unit	Total
1	0.25	AC	Hydroseed (Seeding, Fertilizing, and Mulching)	8-02.5	$2,500	$625
2	1	LS	Construction Surveying	1-05.5(4)	$2,500	$2,500
3	1	LS	Temporary Water Pollution/Erosion Control	1-07.15(4)	$5,000	$5,000
4	1	LS	Utilities Locate and Protection	1-07.17(1)	$1,000	$1,000
5	1	FA	Force Account	1-09.6	$10,000	$10,000
6	0.25	AC	Clearing and Grubbing	2-01.5	$5,000	$1,250
7	1	LS	Final Cleanup	2-11.5	$2,000	$2,000
8	1	LS	Moblization/Demobilization	1-09.7	$12,000	$12,000
9	1	LS	Reinforced Concrete Settling Basin	6-02.5	$110,000	$110,000
10	1	LS	Items Not Yet Identified	TBD	$26,000	$26,000
			Subtotal			**$170,375**
			Construction Subtotal			**$170,375**
			Sales Tax	8.50%		$14,482
			Construction Total			**$184,857**

NOTES:

(1) Design, permitting, construction administration, legal and administrative costs are not included with this estimate.

(2) Opinion of cost updated in October 2021. Actual construction costs will vary based on materials and labor costs at time of construction.

(3) The Subtotals and Construction Total are rounded to the nearest $1,000.

Site Work
Site Work
Site Work
Site Work
Site Work
Site Work
Site Work

$22,375

Construction
Construction
Construction

$148,000

taxes $1,737,815

Total Construction Categories

demo and removal	$7,500
site work	$2,145,575
construction	$18,291,803
taxes	$1,737,815
total	$22,182,693

ATTACHMENT E

Washington Water Trust (WWT) Report

Memo

TO: Carol Creasey, County Hydrogeologist

FR: Nicole Gutierrez, Washington Water Trust

DT: 9/29/2021

RE: Dungeness Off-channel Reservoir Fill Model Summary Report

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Dungeness Off-channel Reservoir Fill Model Justification

The ability to fill the proposed Dungeness Off-channel Reservoir (Reservoir) has been a question of interest for Dungeness Reservoir Working Group members. This question prompted a quantification and water availability of the water sources for the Reservoir. While the water sources to supply the Reservoir include river water and overland flow, it had not yet been determined the portion of each source which could be reasonably expected in a water year. To address this data gap, Washington Water Trust (WWT) recommended that a model be developed to quantify how much of each potential Reservoir water sources may be available considering various limiting factors, particularly water availability from each source.

The model developed to address this data gap, used the software R Studio, an integrated development environment for R, a programming language for statistical computing and graphics. It was critical for the success of this model that the statistical software used could manipulate large datasets, incorporate limiting factors, have the datasets interact, and produce dependable and high-quality data outputs – all qualities offered by R Studio.

The following report includes an overview of the development and implementation of the modelling code as well as summarized findings.

Model Development and Function

The final output of the Reservoir fill model (RFM) calculates the total cumulative fill of the Reservoir from identified water sources in acre-feet/year (afy) units, also known as the annual quantity (Qa). The instantaneous quantity (Qi) is measured in cubic feet per second (cfs). The three water sources identified are:

- Maximum Allocation Water (River source)[1]: *Max Allocation Water is a portion of interruptible water right above the regulatory instream flow, available for new uses.*
- Water Rights Water (River source): *Senior irrigation district/company water rights associated with the diversions on the east side of the Dungeness River.*
- Overland Flow (Precipitation source): *Storm event water which is not formally captured but does intercept an irrigation ditch, exceed its carrying capacity and pose risk damage to urban infrastructure.*

In order to address the question of how much water could be available to fill the Reservoir and provide results, limiting factors which impact each water sources potential contribution to Reservoir fill, were identified and incorporated into the model. Among the limiting factors identified were:

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[1] WAC 173-518-090

Dungeness instream flow rule: **The instream flow rule establishes a quantity of water to remain in river during the year. Maximum allocation water is only available during times when the Dungeness River is above the instream flow limits, and otherwise is unavailable. Table 1, column 3-Max Allocation (cfs), identifies the total amount of interruptible water available.**

Table 1. Dungeness instream flow rule

Month	*Instream Flow Rule (cfs)*	*Maximum Allocation (cfs)*
Jan - March	575	25
April	475	25
May - July 14	475	35
July 15 - 31	475	0
August - Oct	180	0
Nov 1 - 15	575	0
Nov 16 - Dec	575	25

- *Diversion capacity:* The physical capacity of the existing diversion intake planned to provide river water to the reservoir-Highland Irrigation District (HID), determines the instantaneous rate (Qi) that can be withdrawn from the Dungeness River.
    - For example: If the diversion capacity is 15 cfs, the greatest instantaneous rate that can be withdrawn from the river for Reservoir fill is 15 cfs, despite the maximum allocation limit being 25-35 cfs. In times of high flows, diversion capacity is the limiting factor.
- *Irrigator outtake:* The amount of water that is needed by HID affects the diversion capacity available to serve Reservoir fill. The water available to fill the Reservoir would be *diversion capacity – irrigator outtake*
- *Irrigator water right:* The HID irrigation water right, an eastside irrigation water right, allows for 14 cfs instantaneous flow to be diverted during the irrigation season (4/15-9/15). If the reservoir fill solely relied on this water right, it would be limited to *14 cfs minus irrigator outtake* during the irrigation season.
- *Evaporation rate:* Water which may be lost due to evaporation (8%) at the reservoir site. See Assumptions section for more detail.
- *Reservoir capacity:* Reservoir capacity is assumed to be 1580 acre-feet and it is able to be filled more than once.[2]

The RFM was developed to investigate fill conditions under two different diversion and conveyance capacity scenarios.

1) A 15 cfs scenario which represents the existing diversion for HID, confirmed with the HID President.
2) A 25 cfs scenario, which would align with the max amount of Max Allocation water available during the majority of months.

[2] Anchor QEA. 2016. Executive Summary and Project Proposal: Dungeness Off-stream Reservoir Project. Prepared for Clallam County.

Data and Sources

The data utilized for the model include:

1. *Dungeness River historic flows:* USGS River gauge data, downloaded from USGS 12048000 Dungeness River near Sequim, WA. Years used in the analysis included 1999-2021.

2. *Irrigation outtake:* Calculated using annual outtake reports (diversion quantities) provided by Dungeness Water Users Association (irrigators) for 2006-2019, considering only the districts/companies with eastside of the river diversions, those that could be served by the reservoir. The maximum outtake per month reported for HID, the diversion used to fill the reservoir, was identified and used to represent the water quantity needed by irrigators.

3. *Overland flow:* Determined using the 2021 Wilson Engineering analysis prepared for the City of Sequim. *Task Assignment No. 4: Stormwater Capture and Infiltration RFI and FEMA.*

Assumptions

In order to account for the variation of water availability year to year, a conservative approach was used to determine overland flow, irrigator outtake, and evaporation rate parameters in the model.

- *Irrigator outtake:* The maximum outtake per month for HID was used to represent total irrigator outtake from the diversion to determine Reservoir fill under high irrigator outtake demands.

- *Evaporation rate:* A constant evaporation rate of 8% was applied to the RFM, for evaporation on the reservoir surface. This evaporation estimate that was included in a proposal or follow up to a question in 2016. The rate is based on the following formula:

    - Post fill (pan evaporation * evap coeff) /divided average depth of reservoir (assumes no inflow post fill))[3].

- *Overland flow:* Approximately ***87 acre-feet*** of water would be captured over the course of the Reservoir fill year (Nov 15 – Nov 14), according to the 2021 Wilson Engineering analysis prepared for the City of Sequim. *Task Assignment No. 4: Stormwater Capture and Infiltration RFI and FEMA.* The report offered the total potential capture amount, but not the seasonal distribution of that water. Therefore, the model distributed 0.6397 acre-feet of overland flow water over the course of 136 days, November 16 – March 31.

Please note that rainfall was not incorporated into Reservoir fill estimates. However, this quantity could be expected to contribute approximately 114.7 afy[4].

Output

The Reservoir fill model provides an output in afy units of total cumulative fill of the Reservoir from maximum allocation water, water right water, and overland flow, incorporating the aforementioned limiting factors. The final data is presented in both a table and graph format.

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[3] Information from email correspondence with Mike Haggerty, fisheries - hydrology consultant.

[4] Based on 88 acre reservoir area and 17 inches of rainfall annually. 8% evaporation applied.

Preliminary Results

Tables

The following tables provide the model output from 2000 - 2021. *Total max allocation water + water right water* represents the cumulative fill of river sources while *Total max allocation water + water right water + overland flow* represents cumulative fill from river sources and precipitation. Table 1 represents fill with a 15 cfs diversion and Table 2 represents fill with a 25 cfs diversion. Table 3 represents the maximum allocation water for both infill scenarios. Maximum allocation water is when flows are above the instream flow rule and, during the irrigation season, we subtract for irrigator outtake which impacts conveyance capacity

Table 1: Cumulative fill calculated for 15 cfs diversion (Water Right Water = wrw)

15 CFS Diversion Unit = AFY	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total max allocation water + water right water	1763.2	470.5	1981.1	1665.1	1259.3	942.0	2195.9	2031.8	1437.5	802.5	2178.0	2098.1	1852.5	1740.8	1267.4	1408.4	2889.3	2146.2	1845.5	1340.1	1585.6	1405.8
Total max allocation water + wrw+ overland flow	1843.2	550.5	2061.2	1745.1	1339.3	1022.1	2276.0	2111.8	1517.5	882.5	2258.0	2178.2	1932.5	1820.8	1347.4	1488.4	2969.4	2226.2	1925.5	1420.2	1665.7	1485.8

Highlighted year = dry year leasing Red box = reservoir did not reach one fill

Table 2: Cumulative fill calculated for 25 cfs diversion (Water Right Water = wrw)

25 CFS Diversion Unit = AFY	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total max allocation water + water right water	2951.4	615.0	3301.0	2745.4	1989.2	1436.0	3782.7	3515.5	2470.2	1234.1	3722.7	3556.3	3208.7	2982.0	2100.0	2193.0	4840.3	3675.0	3092.8	2210.1	2677.8	2500.6
Total max allocation water + wrw + overland flow	3031.5	695.0	3381.0	2825.4	2069.3	1516.1	3862.7	3595.5	2550.3	1314.2	3802.7	3636.3	3288.8	3062.1	2180.1	2273.0	4920.4	3755.0	3172.8	2290.1	2757.8	2580.6

Highlighted year = dry year leasing Red box = reservoir did not reach one fill

Table 3: Maximum Allocation Water (MAW) for both the 15 cfs and 25 cfs diversion scenarios.

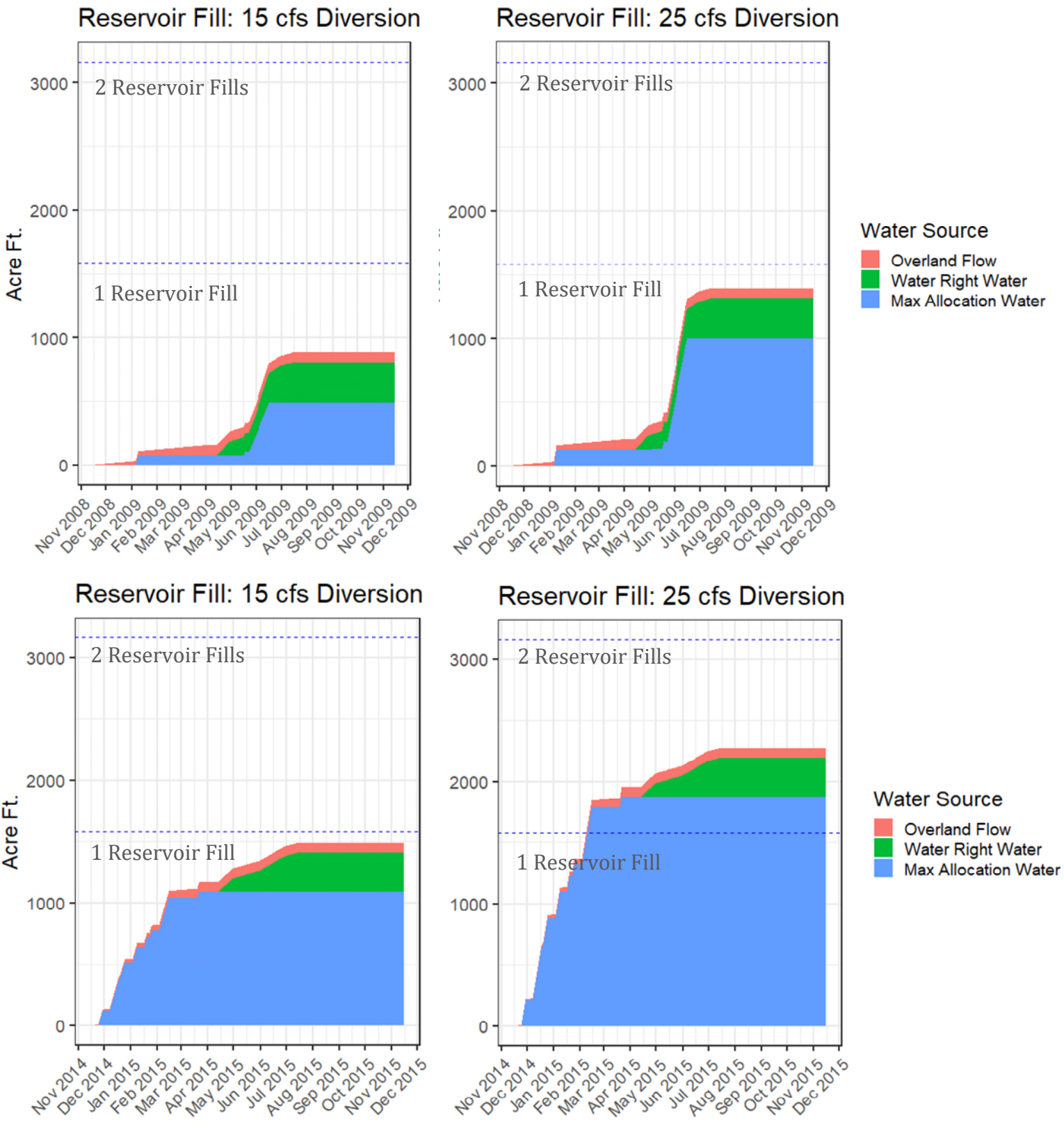
Unit = AFY	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
15 cfs Diversion: Total accumulation of max allocation water	1447.85	155.1839	1667.796	1349.784	943.999	626.7248	1880.621	1716.488	1122.182	487.1934	1862.677	1782.812	1537.191	1425.476	952.0655	1093.061	2574.043	1830.889	1530.198	1024.844	1270.331	1163.997
25 cfs Diversion: Total accumulation of max allocation water	2790.527	319.4094	3167.532	2560.681	1753.209	1160.306	3656.272	3361.784	2332.585	998.1172	3616.145	3424.364	3150.403	2852.242	1901.38	1877.694	4671.891	3547.141	2931.304	1980.318	2513.028	2295.271

Highlighted year = dry year leasing Red box = reservoir did not reach one fill

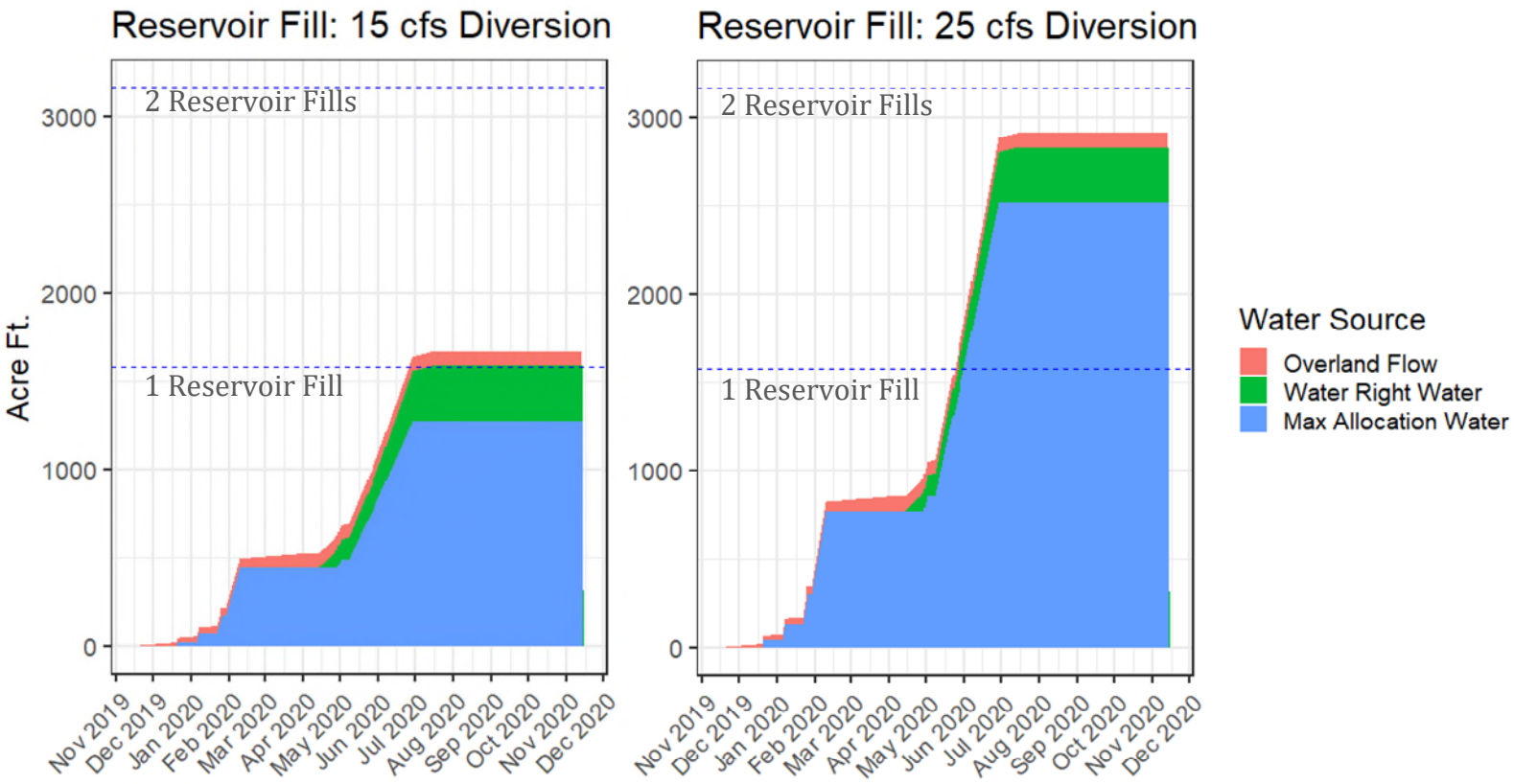
Graphs

Graphs were created to show how fill would be distributed over time from which sources. The two diversion scenarios were plotted. The following graphs represent Reservoir fill year 2009 & 2015 (Drought Years) and 2020.

2009 & 2015 Cumulative Fill – Drought Year



2020 Cumulative Fill – "Normal" Year



Conclusion and Next Steps

The Reservoir fill model was developed as a tool to estimate cumulative fill of the Reservoir based on historical Dungeness River flows and overland flow. The exercise was initiated by a question from Dungeness Reservoir Working Group members, including irrigators, which asked how the reservoir would be filled and with what certainty. Based on modelled results from historical Dungeness River flows from 2000 to 2021, the 1580 acre-foot Dungeness Off-Channel Reservoir design fills at least once most years in both diversion scenarios. However, fill years vary based on diversion scenario:

15 cfs Diversion

- Accumulates >1580 AF 13 out of 22 years
- Accumulates >1000 AF (<1580 AF) 7 out of 22 years
- Accumulates <1000 AF 2 out of 22 years

25 cfs Diversion

- Accumulates >1580 AF 19 out of 22 years
- Accumulates >1000 AF (<1580 AF) 2 out of 22 years
- Accumulates <1000 AF 1 out of 22 years

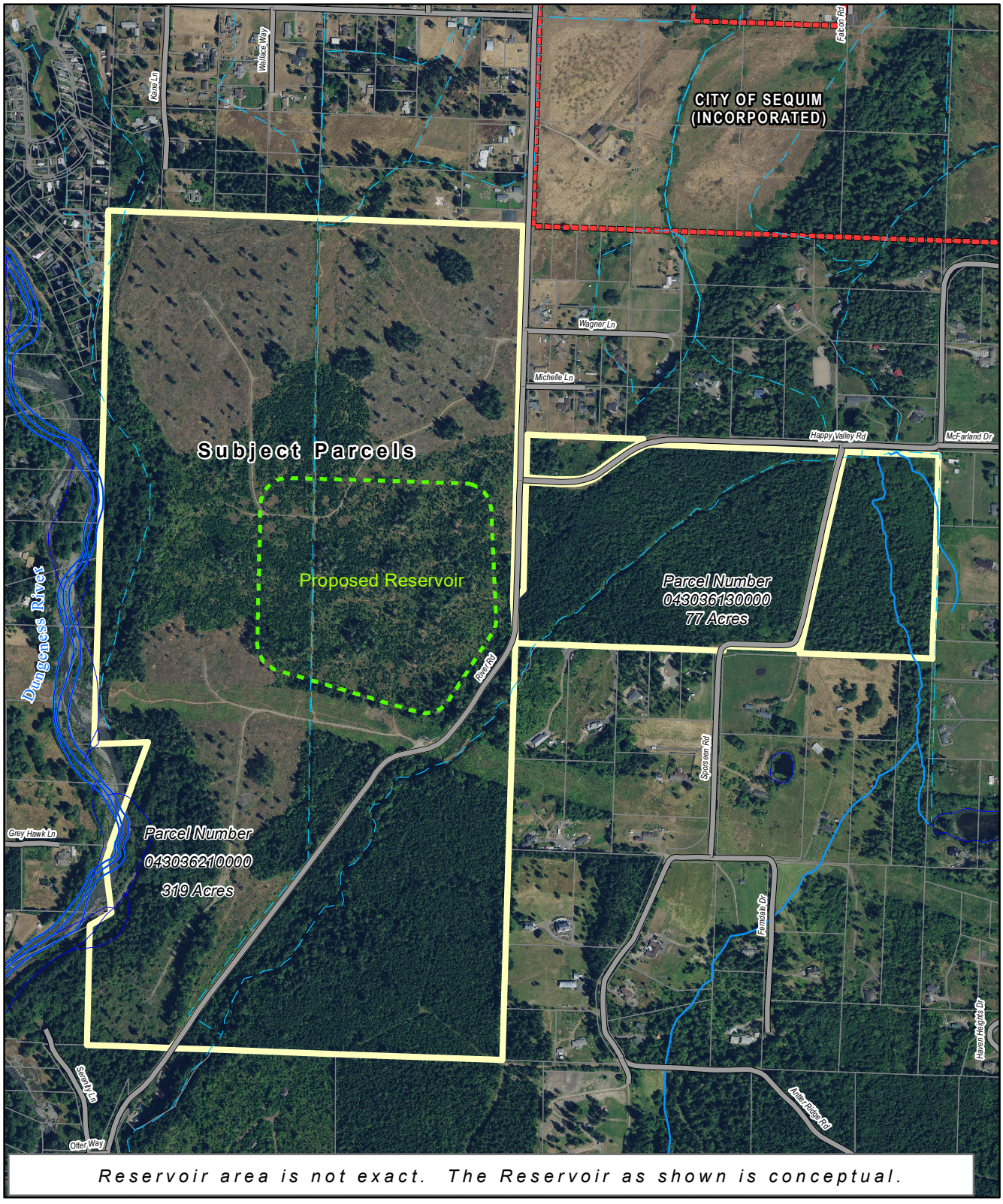
Based on these results, the 25 cfs diversion scenario increases the dependability of the reservoir as a secure water source.

The Reservoir fill model will continue to be refined with the most up-to-date data available. There is also interest from project partners to incorporate Dungeness River flow projections to determine water availability and security into the future. This data is still being pursued.

ATTACHEMENT F

Site Maps and Area Calculations

Proposed Dungeness Reservoir - Aerial Photo[1]



Legend

- Stream
- Water conveyance canals
- Roads
- Subject Parcels
- Proposed Reservoir
- Parcels
- City of Sequim

1- Aerial Photo Date- 2020, Source- Clallam County.

N
W E
S

Map Date: 11/8/2022 CT

0 500 1,000 2,000 Feet

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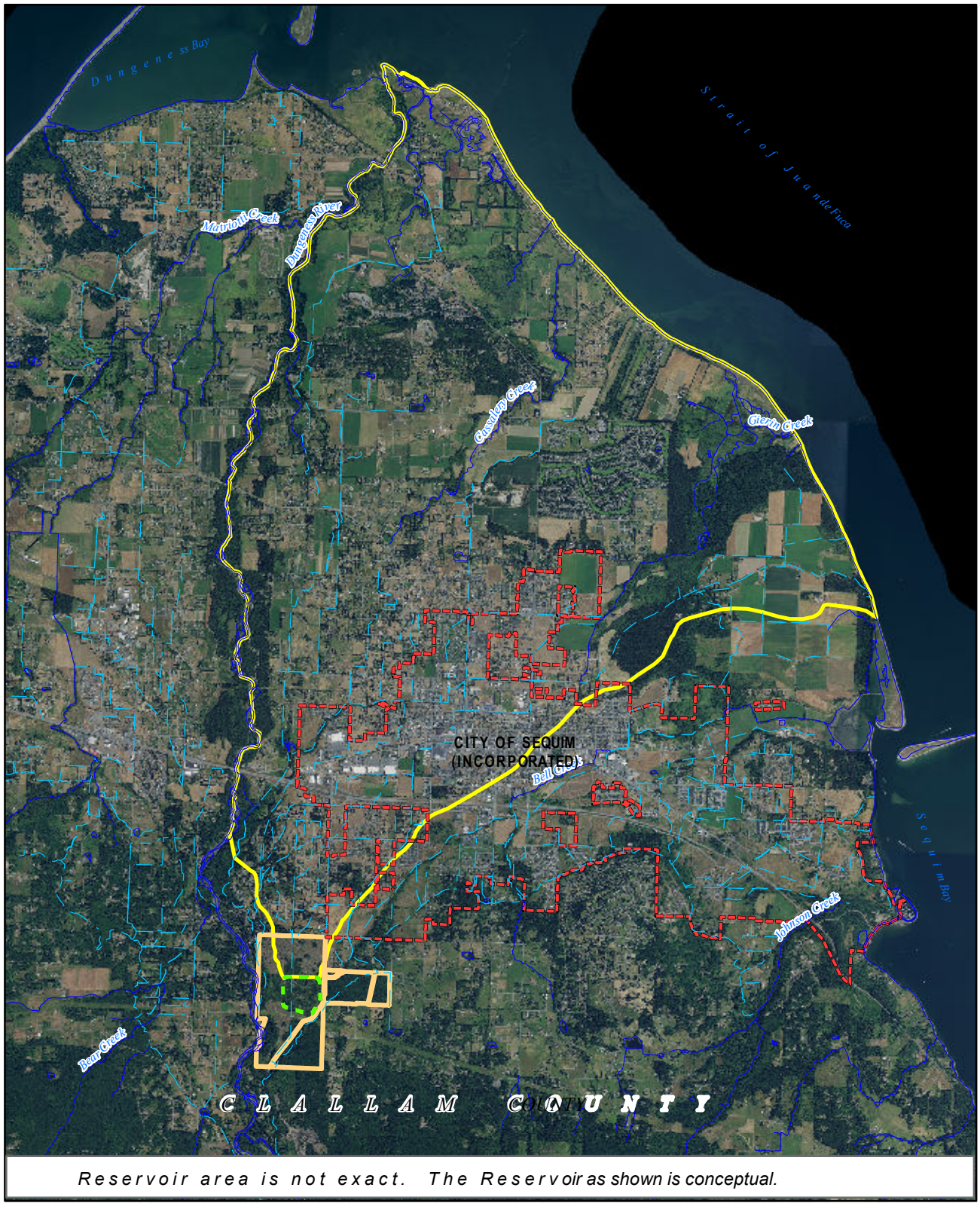
Proposed Dungeness Reservoir - Downgradient Area



Legend

- Stream
- Irrigation conveyance ditches (includes piped and non-piped)
- City of Sequim
- Subject Parcels
- Downgradient Area Impacted By Project
- Conceptual Reservoir

Air Photo source- Clallam County, 2019

Date: 11/2/2021 CT

N
W E
S

0 3,250 6,500 13,000 Feet

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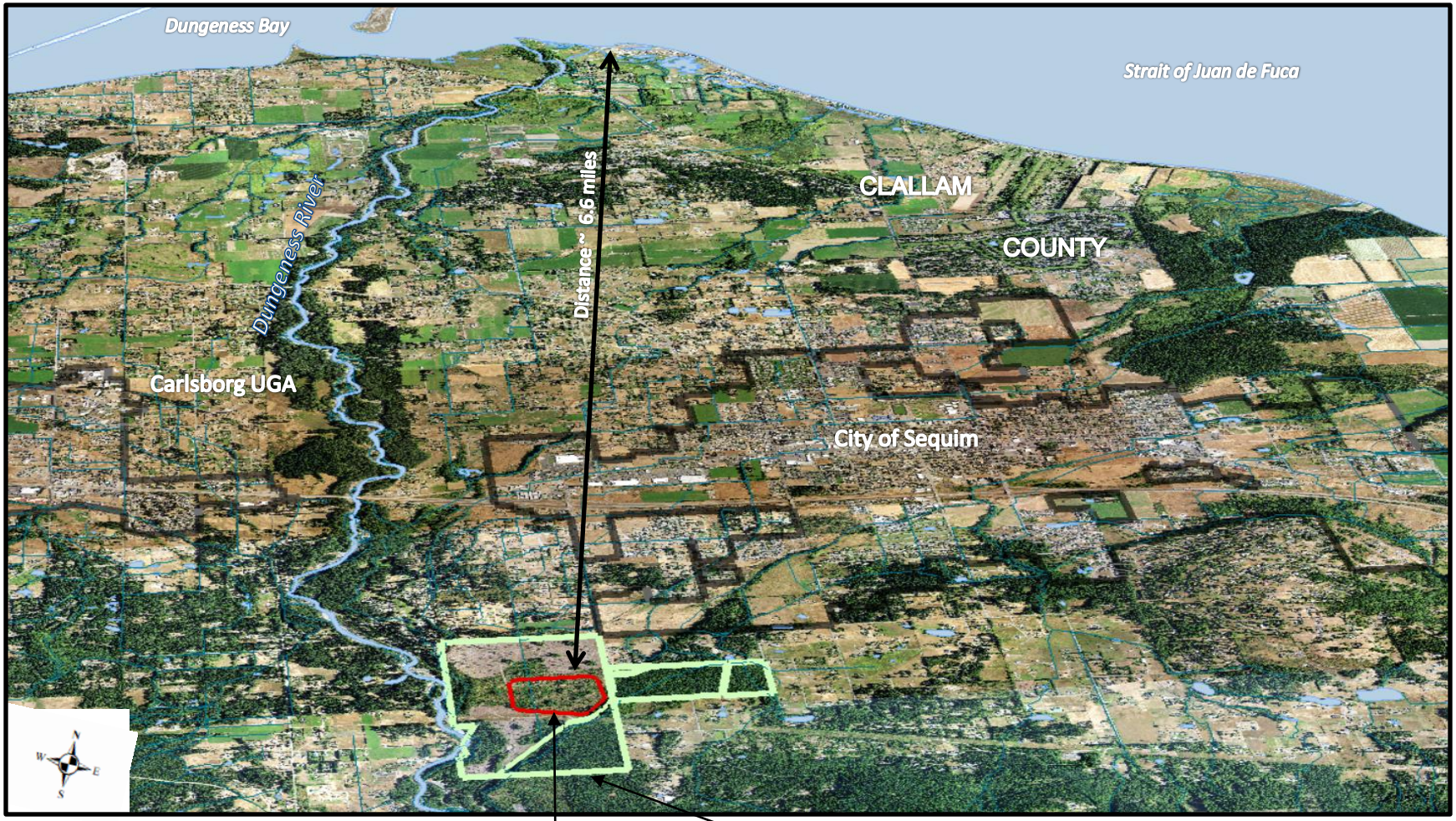
Dungeness Reservoir- Regional Aerial Photo



J:\GRANTS\RESERVOIR\FEMA BRIC\Oblique Aerial4.pdf
J:\GRANTS\RESERVOIR\FEMA BRIC\Oblique.sxd

Note- Sizes are distorted due to perspective.

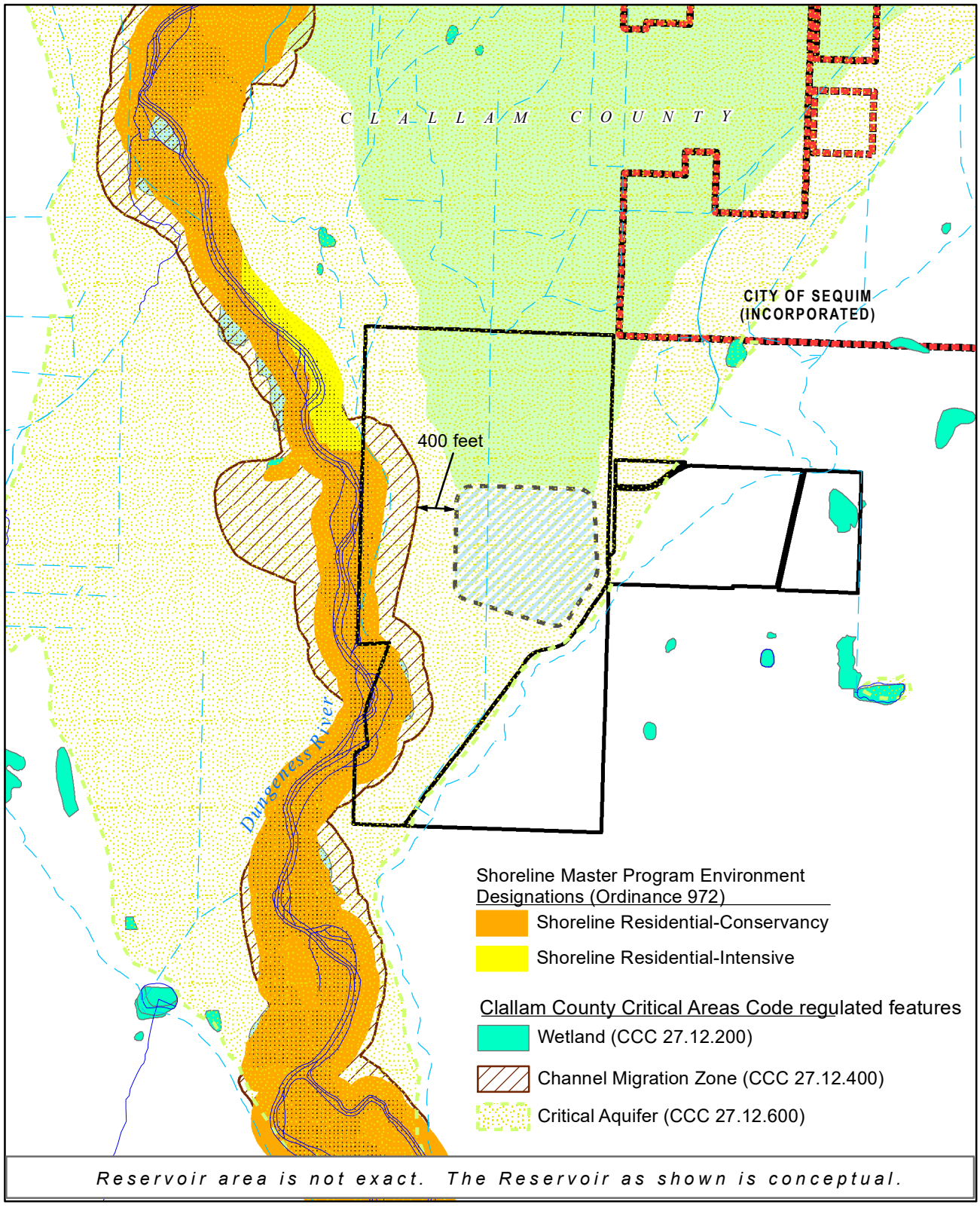
Air Photo Date- 2017, Source: Clallam County.

Date: 11-03-21 CT

Park Boundary

Proposed Reservoir

Proposed Dungeness Reservoir - Natural Feature Regulation



Legend

- Stream
- Water conveyance canals
- City of Sequim
- Downgradient Area Impacted By Project
- Subject Parcels
- Conceptual Reservoir
- FEMA 100 year floodplain[1]

1- The FEMA Flood Hazard Area is a preliminary data release and is still out for comment. It has not adopted by Clallam County as of the date of this map. The adopted FIRM maps digital product did not register or line up with other Clallam County spatial data. For this reason, the prelinary data is shown on this map.

N W E S

0 900 1,800 3,600 Feet

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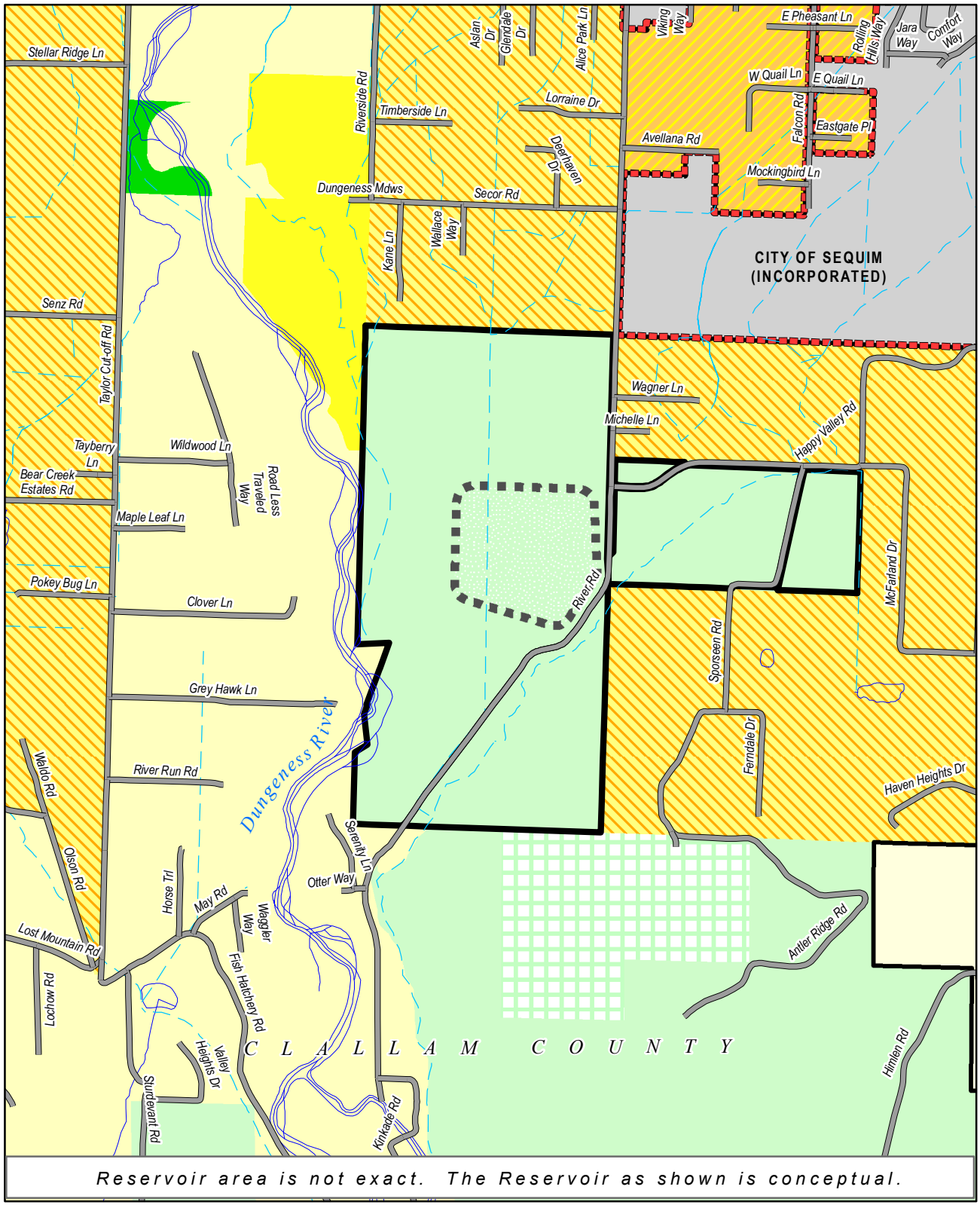
Date: 11/13/2022 CT

Proposed Dungeness Reservoir - Zoning



Legend

- Stream
- Water conveyance canals
- City of Sequim
- Subject Parcels
- Conceptual Reservoir

Zoning (CCC Title 33)

- Comercial Forest
- Commercial Forest/ Mixed Use 20
- Parks and Recreation
- Rural Moderate
- Neighborhood Commercial
- Rural Low

0 900 1,800 3,600 Feet

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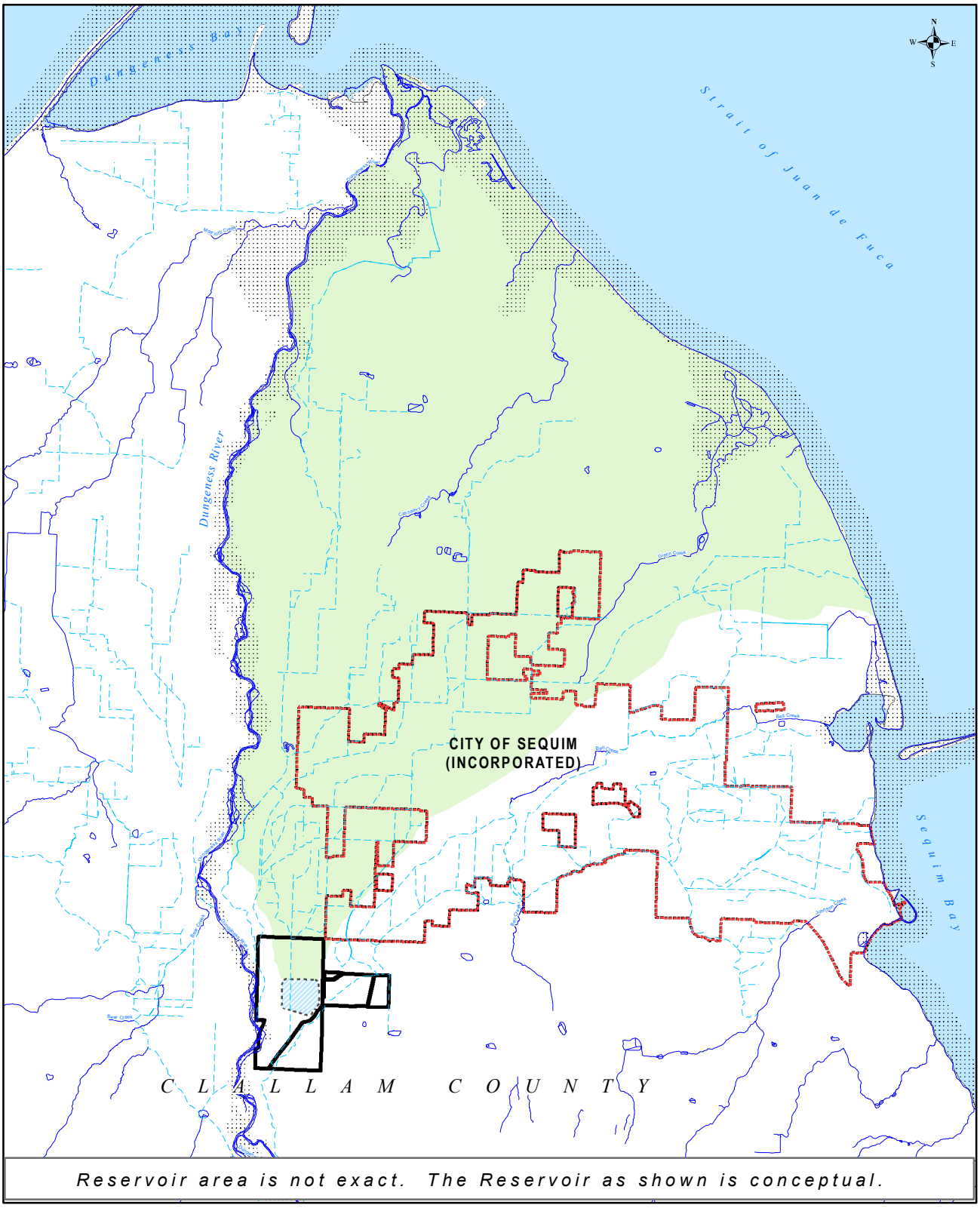
Date: 11/13/2022 CT

Proposed Dungeness Reservoir - Downgradient Area



Legend

- Stream
- Water conveyance canals
- City of Sequim
- Downgradient Area Impacted By Project
- Subject Parcels
- Conceptual Reservoir
- FEMA 100 year floodplain[1]

1- The source of the 100-year floodplain as shown is from the adopted FEMA FIRM maps. The digital product does not always register or line up with other layers shown on this map.

Document Path: J:\GRANTS\RESERVOIR\FEMA BRIC\ResShed_FEMA.mxd

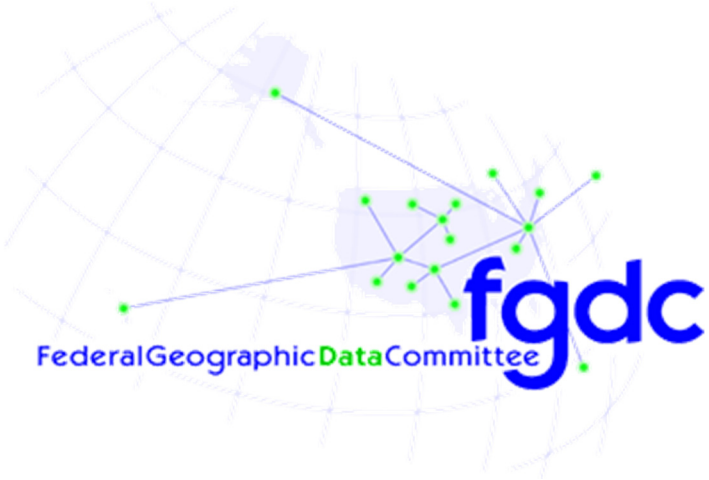
Date: 11/13/2022 CT

0 3,500 7,000 14,000 Feet

ATTACHMENT G

US EPA Wetland Classifications

FGDC–STD-004-2013
Second Edition



Classification of Wetlands and Deepwater Habitats of the United States

Adapted from Cowardin, Carter, Golet and LaRoe (1979)

Wetlands Subcommittee
Federal Geographic Data Committee

August 2013

limit of wetland emergents, shrubs, or trees where they are not included in (2). The Estuarine System also includes offshore areas of continuously diluted sea water.

Description. The Estuarine System includes both estuaries and lagoons. It is more strongly influenced by its association with land than is the Marine System. In terms of wave action, estuaries are generally considered to be low-energy systems (Chapman 1977).

Estuarine water regimes and water chemistry are affected by one or more of the following forces: oceanic tides, precipitation, freshwater runoff from land areas, evaporation, and wind. Estuarine salinities range from hyperhaline to oligohaline (see Section 3.3.2.1 for Salinity Modifiers). The salinity may be variable, as in hyperhaline lagoons (e.g., Laguna Madre, Texas) and most estuaries (e.g., Chesapeake Bay, Virginia-Maryland); or it may be relatively stable, as in sheltered euhaline embayments (e.g., Chincoteague Bay, Maryland) or embayments with partly obstructed access or small tidal range (e.g., Pamlico Sound, North Carolina). (For an extended discussion of estuaries and lagoons, see Lauff 1967.)

Subsystems.

Subtidal. The substrate in these habitats is continuously covered with tidal water (i.e., located below extreme low water).

Intertidal. The substrate in these habitats is flooded and exposed by tides; includes the associated splash zone.

Classes. Rock Bottom, Unconsolidated Bottom, Aquatic Bed, Reef, Streambed, Rocky Shore, Unconsolidated Shore, Emergent Wetland, Scrub-Shrub Wetland, and Forested Wetland.

3.1.3 Riverine System

Definition. The Riverine System (Figure 4) includes all wetlands and deepwater habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with water containing ocean-derived salts of 0.5 ppt or greater. A channel is “an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water” (Langbein and Iseri 1960:5).

Limits. The Riverine System is bounded on the landward side by upland, by the channel bank (including natural and man-made levees), or by wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. In braided streams, the System is bounded by the banks forming the outer limits of the depression within which the braiding occurs.

The Riverine System terminates at the downstream end where the concentration of ocean-derived salts in the water equals or exceeds 0.5 ppt during the period of annual average

low flow, or where the channel enters a lake. It terminates at the upstream end where tributary streams originate, or where the channel leaves a lake. Springs discharging into a channel are considered part of the Riverine System.

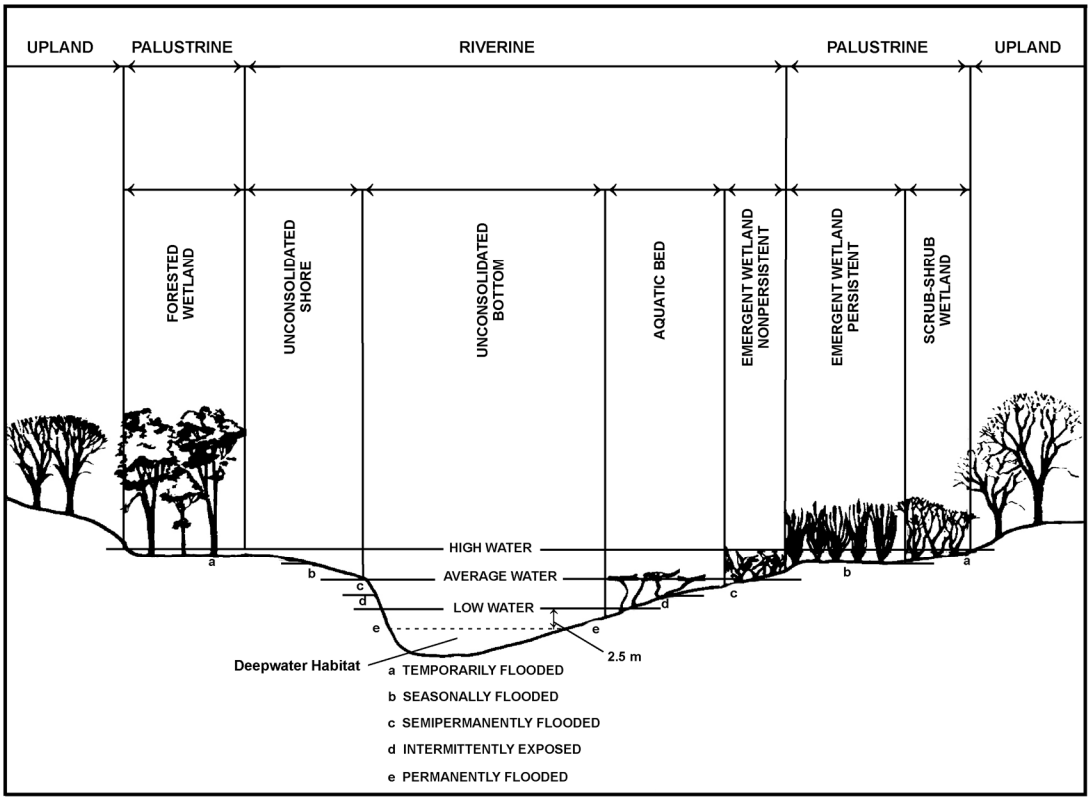


Figure 4. Distinguishing features and examples of habitats in the Riverine System.

Description. Water is usually, but not always, flowing in the Riverine System. Upland islands or Palustrine wetlands may occur in the channel, but they are not included in the Riverine System. Palustrine Moss-Lichen Wetlands, Emergent Wetlands, Scrub-Shrub Wetlands, and Forested Wetlands may occur adjacent to the Riverine System, often on a floodplain. Many biologists have suggested that all the wetlands occurring on the river floodplain should be a part of the Riverine System because they consider their presence to be the result of river flooding. However, this classification follows Reid and Wood (1976:72,84) who stated, "The floodplain is a flat expanse of land bordering an old river…. Often the floodplain may take the form of a very level plain occupied by the present stream channel, and it may never, or only occasionally, be flooded…. It is this subsurface water (the groundwater) that controls to a great extent the level of lake surfaces, the flow of streams, and the extent of swamps and marshes."

ATTACHEMENT H

“Riparian Buffer Zone” Definition

FEMA Region X Biological Opinion

U.S. Department of Homeland Security
Region X
130 228th Street SW
Bothell, WA 98021-9796

FEMA

January 11, 2012

FAQ: Does a jurisdiction have to adopt the Riparian Buffers required by the Biological Opinion?

Under the 2009 errata to the Biological Opinion, communities that choose to use the BO checklist (Option#2) are under the obligation to explain how their existing regulations, and any proposed changes to those regulations, will adequately protect the greater of (see Appendix 4 of the BO):

1) "250 feet measured perpendicularly from the ordinary high water for Type S (Shorelines of the State) streams, 200 feet for Type F streams (fish bearing greater than 5 feet wide and marine shorelines), and 150 feet for Type F stream less than 5 feet wide" (and) "for lakes". "For type N (nonsalmonid-bearing) perennial and seasonal streams a 150 foot to 225 foot buffer applies, depending on slope stability (the 225 foot buffer applies to unstable slopes)."

2) "The Channel Migration Zone plus 50 feet."

3) "The mapped Floodway."

The 2009 errata also states that "The Riparian Buffer Zone is an overlay zone that encompasses lands as defined above on either side of all streams, and for all other watercourses including all off-channel areas. The RBZ is a non-disturbance zone, **other than for activities that will not adversely affect habitat function.** Any property or portion thereof that lies within the RBZ is subject to the restrictions of the RBZ, as well as any zoning restrictions that apply to the parcel in the underlying zone." Note that some actions are allowable within the RBZ. Only those actions that would Adversely Affect habitat functions for threatened and endangered species are not allowed.

Jurisdictions currently meet several regulatory standards that overlap in some of the provisions required in the NFIP BO, such as those within the State of Washington's Growth Management Act (critical areas regulations) and Shoreline Master Program, as well as local additional regulations. Each of these programs require communities to use Best Available Science (BAS) and Best Management Practices (BMPs) in managing riparian buffer zones. Often times the buffer widths mandated by the jurisdiction's current local standards are narrower than the buffer widths required in the 2009 errata. Most Best Available Science peer-reviewed literature considers impacts at basin scale or larger spatial perspectives, attempting to characterize average conditions, functions, and buffer needs across that landscape. In reality, each often varies greatly by stream reach due to variations in geomorphology, hydrology, and site potential tree heights (vegetative potential). The NFIP Biological Opinion requires that the estimated impacts of proposed projects can not Adversely Affect current existing habitat functions, nor preclude potential future instream or riparian improvements in functions (i.e. via active or passive improvements in riparian vegetation or other actions) within the Riparian Buffer Zone.

U.S. Department of Homeland Security
Region X
130 228th Street SW
Bothell, WA 98021-9796

FEMA

If a community's current jurisdictional buffer is less than the required buffer in the 2009 errata to the Biological Opinion, they must demonstrate that any potential development activities allowed within the area between these two different buffer widths (referred to here as the "***delta area,***" see Diagram 1) will not have an Adverse Effect to habitat functions that support threatened or endangered species. There are several options to accomplish this:

1. Extend the buffers to the required buffers contained in the 2009 errata to the Biological Opinion (see above).

2. Require a habitat assessment for each proposed project in the delta area (the land area between the community's designated buffer and the buffer required by the BO) that demonstrates that the project will not cause an Adverse Effect to any of the remaining habitat functions and processes in the affected stream reaches. There are no simple standards in ESA consultation for what constitutes an Adverse Effect. The habitat assessment needs to analyze what impacts proposed land disturbing actions (i.e. the project proposal) would have to key habitat functions in reaches that potentially support TES (similar to those variables in the Matrix of Pathways and Indicators (NMFS 1998)).

3. Require a separate ESA consultation (Section 7, 10, or 4(d)) for each proposed project in the delta area.

4. Provide a communitywide assessment of the habitat functions and process that remain in the delta area, and that may reasonably exist in the future, and describe any anticipated development for the area. In most cases the community (jurisdiction) will need to describe current and anticipated future conditions and functions across several watersheds or sub-watersheds. Hydrologic, geomorphic, and vegetative potential (e.g. site potential tree heights) can vary greatly among watersheds, and even within reaches of the same watershed, hence the potential to adversely impact functions via land management actions within their respective protected area also varies. Generalizations regarding remaining habitat functions across large geographic areas that include multiple diverse watersheds will not be accurate.

Jurisdictions need to assess the functions that may be affected within areas of similar geomorphic and hydrologic nature (i.e. by reach or subwatersheds), and either avoid those actions completely, or minimize them to the point where potential negative impacts are either "negligible or discountable". Another potential option may be for jurisdictions to propose a restoration package(s) for those watersheds where other proposed actions would result in an incremental loss of some function(s) over the short-term, but the net outcome of all actions would be beneficial (see separate FAQ regarding Habitat Analysis at an Appropriate Scale).

U.S. Department of Homeland Security
Region X
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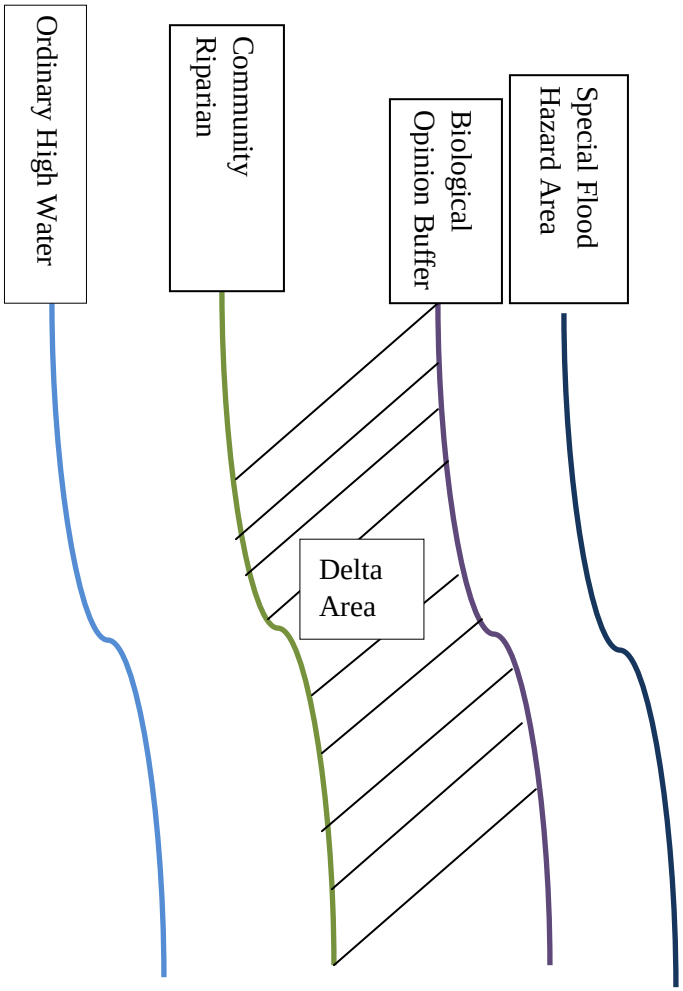
FEMA

Diagram 1



ATTACHEMENT I

BCA Report

FEMA Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: Clallam County, WA-Dungeness Off Channel Reservoir-Drought Mitigation Project

				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)			
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)	
1	Floodwater Diversion and Storage @ 1492 River Rd, Sequim, Washington, 98382	•••	DFA - Riverine Flood	$ 61,926,542	$ 32,473,325	1.91	$ 115,454,286	$ 34,650,371	3.33	
TOTAL (SELECTED)				**$ 61,926,542**	**$ 32,473,325**	**1.91**	**$ 115,454,286**	**$ 34,650,371**	**3.33**	
TOTAL				**$ 61,926,542**	**$ 32,473,325**	**1.91**	**$ 115,454,286**	**$ 34,650,371**	**3.33**	

Property Configuration

Property Title:	Floodwater Diversion and Storage @ 1492 River Rd, Sequim, Washington, 98382
Property Location:	98382, Clallam, Washington
Property Coordinates:	48.05597312421954, -123.13510630736137
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodwater Diversion and Storage
Property Type:	Other
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Floodwater Diversion and Storage @ 1492 River Rd, Sequim, Washington, 98382

Project Useful Life (years):	50
Project Cost:	$29,954,689
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$182,500

Comments

-

Project Useful Life:

See attached BCA Methodology Memorandum

-

Mitigation Project Cost:

See Attached BCA Methodology Memorandum

-

Annual Maintenance Cost:

See Attached BCA methodology Memeorandum

Damage Analysis Parameters - Damage Frequency Assessment

Floodwater Diversion and Storage @ 1492 River Rd, Sequim, Washington, 98382

Year of Analysis was Conducted:	2022
Year Property was Built:	0
Analysis Duration:	10 Use Default:Yes

Professional Expected Damages Before Mitigation

Floodwater Diversion and Storage @ 1492 River Rd, Sequim, Washington, 98382

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
82	2,910,147	0	0	0	0	0	2,910,147

Comments

-

Damages Before Mitigation:

See attached BCA methodology memorandum

Annualized Damages Before Mitigation

Floodwater Diversion and Storage @ 1492 River Rd, Sequim, Washington, 98382

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
82	2,910,147	35,489
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	2,910,147	35,489

Professional Expected Damages After Mitigation

Floodwater Diversion and Storage @ 1492 River Rd, Sequim, Washington, 98382

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
82	1,221,343	0	0	0	0	0	1,221,343

Comments

-

Damages After Mitigation:

See attached BCA methodology memorandum

Annualized Damages After Mitigation

Floodwater Diversion and Storage @ 1492 River Rd, Sequim, Washington, 98382

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
82	1,221,343	14,894
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,221,343	14,894

Standard Benefits - Ecosystem Services
Floodwater Diversion and Storage @ 1492 River Rd, Sequim, Washington, 98382

Total Project Area (acres):	396
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	80.30%
Percentage of Riparian:	3.90%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	15.80%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$4,466,593

Comments

-

Percent Riparian:

See attached BCA methodology memorandum

-

Percent Rural Green Open Space:

See attached BCA methodology memorandum

-

Percent Inland Wetlands:

See attached BCA methodology memeorandum

-

Total Project Area:

See attached BCA methodologu memorandum

Benefits-Costs Summary
Floodwater Diversion and Storage @ 1492 River Rd, Sequim, Washington, 98382

Total Standard Mitigation Benefits:	$61,926,542
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$61,926,542
Total Mitigation Project Cost:	$32,473,325
Benefit Cost Ratio - Standard:	1.91
Benefit Cost Ratio - Standard + Social:	1.91