Dungeness Watershed, Summer 2019 Drought
Photo Credit: Washington Department of Ecology

Dungeness Water Resources Planning

Recommendations Summary

Prepared for:
Dungeness River Management Team (DRMT)

Prepared by:
Dungeness Water Resources Technical Group
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Approved by DRMT: August 10, 2022

1. Introduction

On January 12, 2022, the Dungeness River Management Team (DRMT) formed the Dungeness Water Resources Technical Group (WRTG), a new Committee of the DRMT. The DRMT Executive Committee (EC) recommended this action[1] based on the need to identify and discuss priority water resource management topics in the context of current and future effects of climate change in the DRMT's Focus Area. The initial timeline suggested for the WRTG's effort was four to six months, in which members would research and propose relevant topics, meet regularly for related discussion and deliberation, seek expert opinion/review when possible, and culminate with a set of agreed-upon[2] recommendations to be provided to the full DRMT for potential further action.

The WRTG is comprised of the following membership and representations as nominated or volunteered during the DRMT's January 12, 2022, monthly meeting:

Member	Affiliation	Member Status
Chitwood, Scott	Former Jamestown S'Klallam Tribe NR Director Former DRMT Chair	Active
Corrado, Tony	Protect the Peninsula's Future Chair, Dungeness Water Resources Technical Group	Active
Creasey, Carol	Clallam County Water Resources Program Manager/Hydrogeologist	Active
Hals, Hansi	Jamestown S'Klallam Tribe Natural Resources Director, DRMT Chair	Active
Hines, Shawn	Jamestown S'Klallam Tribe Watershed Planner	Active
Holtrop, Joe	Clallam Conservation District Former Executive Director	Active
Knapp, Robert	Jamestown S'Klallam Tribe Environmental Planning Manager	Active
Martin, Tom	Clallam PUD #1 Water and Wastewater Systems Manager	Active
Scagliotti, Alex	Graysmarsh Wildlife and Natural Resource Manager	Active
Soule, Ann	City of Sequim Hydrogeologist, Resource Manager	Active
Vail, Lance	Olympic Peninsula Audubon Society Hydrologist	Active

[1] Per the DRMT's Operating Procedures (2018).

[2] Ground Rules, established at WRTG's first meeting, January 28, 2022, state that voting requires a quorum (defined as 50% + 1), and that in the absence of a consensus, a majority vote prevails.

These eleven members, many of whom have extensive planning and/or technical experience working in the Dungeness or other watersheds, were designated as **Active**, voting members[3]. The WRTG appointed Tony Corrado, of Protect the Peninsula's Future, to be the group's Chair.

An additional six members were designated as **Technical/Advisory** members, from whom the WRTG sought review and commentary on specific topics relevant to their areas of expertise:

Member	Affiliation	Member Status
Gallagher, Mike, LHG	Washington Department of Ecology Water Resources Program Section Manager	Technical/Advisory
Lea, Jolyne	Natural Resource Conservation Service Hydrologist	Technical/Advisory
Miller, Ian, PhD	Washington Sea Grant/University of Washington Coastal Hazards Specialist	Technical/Advisory
Murphy, Ryan	Point No Point Treaty Council Climate Change Action Analyst	Technical/Advisory
Schwartzman, Peter	Mott Macdonald Principal Hydrogeologist	Technical/Advisory
Smith, Ben	Sequim-Dungeness Water Users Association President	Technical/Advisory

Comments provided by Technical/Advisory members were either incorporated into the Recommendations in this summary report (and in the Topic pages in the Appendix) or added to the WRTG Comments sections in the Topic pages of the Appendix.

Following a collaborative process, including nine Zoom meetings attended by the Active members approximately every other week between January 28 and June 3, 2022, the Dungeness Water Resources Technical Group now presents this record of their methodology and culminating recommendations to the DRMT for follow-up actions.

2. Context

Most comprehensive water resources studies within the Dungeness Watershed area were conducted at least 10 years ago. The Dungeness Water Management and Instream Flow Rule (Chapter 173-518 WAC) was adopted in late 2012 and went into effect shortly thereafter, in January of 2013 (Washington State Legislature, 2012). The Rule was informed by the Elwha-Dungeness Watershed Management Plan (2005), which was prepared over a period of several years prior to Rule adoption with data preceding that. Population growth, development, metering of new wells, piping of leaky irrigation ditches, implementation of shallow aquifer recharge projects, changes in the amount of impervious surface, and other landscape or land-use changes have the potential to significantly affect watershed hydrology and water supplies.

[3] Note that the Jamestown S'Klallam Tribe (JST) affiliations were limited to a single, collective vote representing JST.

Water demand due to population growth is expected to increase, and water shortages are possible, especially coupled with current and future climate change impacts. Recent modeling suggests that Olympic Peninsula glaciers will be completely melted by 2070 (Fountain, 2022). The accuracy of water supply and consumption predictions based on previous studies has not been validated; however, assumptions about parameters used in future predictions may need updating.

While the effects of climate change on the area's water supply are impossible to precisely predict, some are already evident. For example, 35 glaciers and 16 perennial snowfields in the Olympic mountains have disappeared since 1980 due to warming air temperatures (Fountain, 2022). Other effects manifest as changes in storm severity and timing; total precipitation and annual temperature extremes; lower and earlier peak summertime stream flows; and shifting growing conditions for farming. It is vital that these parameters and changing trends be better understood, that previous assumptions be checked and updated, and that monitoring be augmented so that we may better plan for watershed resiliency to both short- and long-term climate-related extremes.

The DRMT tasked the WRTG with identifying what is most needed to update our knowledge of the current and future state of water resources within the Dungeness Basin. Following a collaborative process, the WRTG presents this document summarizing the group's methodology and culminating recommendations to the DRMT for follow-up actions.

3. Objectives

The WRTG's Mission Statement, as refined at their second meeting (February 11, 2022), is as follows:

> *To offer recommendations to the DRMT regarding specific studies of water supply and water demand/streamflow needs for the purpose of updating water resource management tools in the Dungeness watershed.*

The initial concept from the EC specified that the WRTG would identify the most relevant water management questions for our area that could be answered (with further research and/or study) within one to three years. The EC provided the WRTG an initial list of concerns (EC 2022) for consideration in bolstering future water resources planning. The initial list included the following main categories:

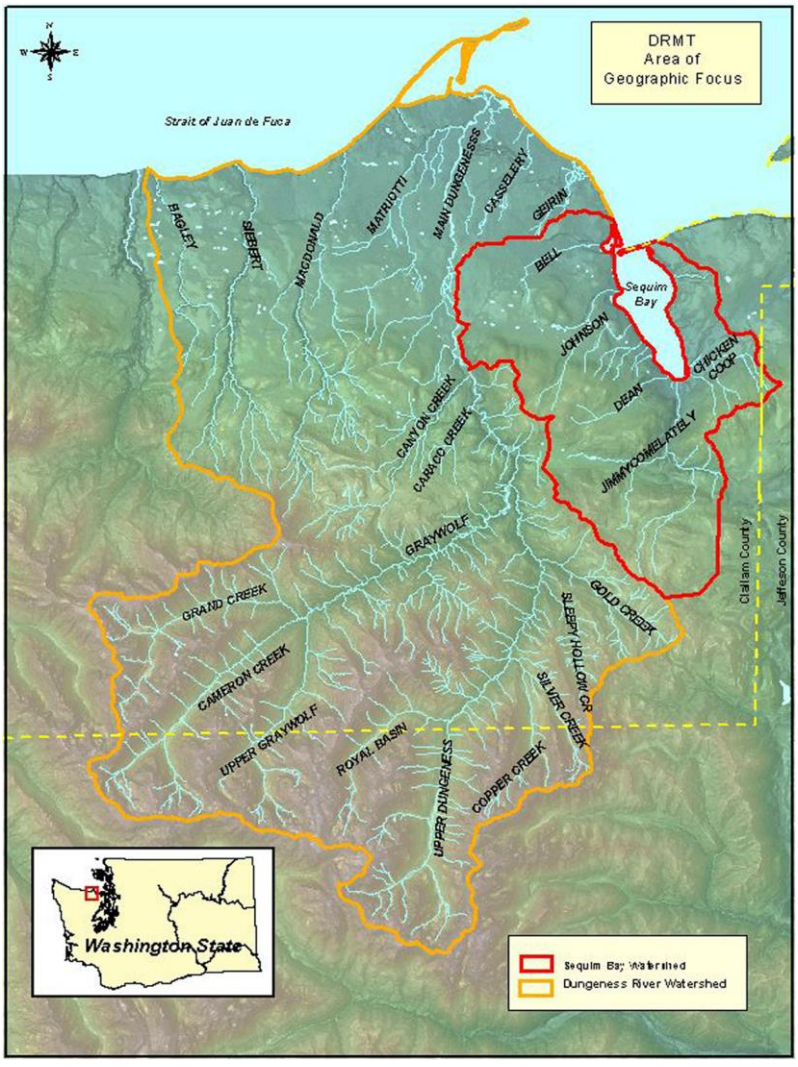
3.1 What is the most essential data/information to obtain?
3.2 What are the most essential technical studies?
3.3 What are the most essential management tools (new or updated)?

The WRTG used the list as a starting point and guide for discussing local water resources information, resources, and data gaps; and then formulated its own list of topics and recommendations for further action (see Section 6).

4. Spatial Domain

The spatial domain for the recommendations is the DRMT Focus Area (see Figure 1), which includes East Water Resources Inventory Area (WRIA) 18 and the Sequim Bay drainage in West WRIA 17, as defined in the Elwha-Dungeness Watershed Plan (2005). This area includes the Dungeness River Watershed (or, the Sequim-Dungeness Watershed) and those waters influenced by it through the irrigation system, streams draining into Sequim Bay, and the groundwater and aquifers beneath these surficial areas. The impact on fish and wildlife dependent upon or affected by estuaries and marine areas receiving drainage from these watersheds or sub-watersheds is also an essential concern for this group.

Figure 1: DRMT Focus Area



5. Topics

The WRTG identified 13 water resources topics of focus, listed at right in the order they were discussed and as they were labeled by the group.

WRTG topics of focus listed in the order they were discussed.

6.1 Updated Ground Water Characterization
6.2 Expanded Monitoring Programs
6.3 Characterization of 4th Aquifer
6.4 Updated Water Demand Projections
6.5 Climate Research on Impacts to Fish
6.6 Community Support through Public Outreach
6.7 Interactive Hydrologic Map
6.8 Comprehensive, Integrated Forecasting Model
6.9 Saltwater Intrusion Studies
6.10 Expanded Snowpack Study
6.11 Mitigating Potential Use of 4th Aquifer
6.12 Shallow Aquifer Recharge Effectiveness
6.13 Future Water Sourcing Studies

Categorization

Among the 13 topics, themes emerged around the availability and use of relevant hydrologic data; the status of or need for climate-related predictive tools and models; as well as some general interest concerns related to climate change impacts. These themes are represented as Categories alongside their associated list of topics in the following table.

Category A Information and Data Enhancement	6.1 Updated Groundwater Characterization 6.2 Expanded Monitoring Programs 6.3 Characterization of 4th Aquifer 6.4 Updated Water Demand Projections 6.10 Expanded Snowpack Study 6.11 Mitigating Potential Use of 4th Aquifer 6.12 Shallow Aquifer Recharge Effectiveness
Category B Enhanced Models/Tools	6.3 Characterization of 4th Aquifer 6.7 Interactive Hydrologic Map 6.8 Comprehensive, Integrated Forecasting Model
Category C General Interest	6.5 Climate Research on Impacts to Fish 6.6 Community Support through Public Outreach 6.9 Saltwater Intrusion Studies 6.13 Future Water Sourcing Studies

While all the topics/recommendations are considered crucial to both near- and long-term resource planning, some, such as those in Category A, may be near-term attainable and perhaps addressed by existing, local responsible agencies in conjunction with state and/or federal entities. These include increased monitoring, surveillance, and compilation of planning data. Category B topics include longer term tasks, such as improved and enhanced modeling, due to their required planning, funding, and determination of leadership and responsible agencies. It is considered essential that the recommended modeling tools be initiated as soon as possible, as

they may require years of effort and validation. The remaining recommendations fall into Category C, and as do all the recommendations, support the WRTG's objective to improve understanding about our water resources.

Urgency

Crews installing rock dams in the Dungeness River to help fish move upstream during the 2015 Drought.

Photo Credit: Chris Burns, JST

The topics and associated recommendations are considered urgent due to the following factors:

1. Climate change induced events are already occurring. For example, watersheds in the Pacific Northwest have experienced peak streamflow (i.e., snowmelt runoff events) shifts to earlier in the spring (Snover et. al., 2013). WRTG considers the near-term period of 0-5 years to be critical.

2. These impacts could manifest as shortages in the availability of water for human consumption and other uses, for irrigation in farming and ranching; and as critical low stream flows affecting aquatic life, particularly spawning salmon.

The recommendations were developed in recognition of the fact that the DRMT Focus Area is dependent on local, annualized precipitation (occurring as rain and snow) for sustaining surface-water (streamflows) and recharging groundwater aquifers. Precipitation amounts are highly seasonal. Winter snowpack accumulation has historically provided the substantial portion of the annual sustaining water resource as it melts in the spring, and flows and percolates into summer. Figure 2 below, although representing 42-year-old (and earlier) data, illustrates the consistent and necessary summer "bump" in the hydrograph of Dungeness River flow, which coincides with months having little rain. However, already declining annual snowpack accumulations continue to diminish and melt earlier due to global warming. Annual rainfall, affected by the area's microclimates and the rainshadow from the Olympic Mountains, has supplemented this snow-melt resource, but annual patterns for rain are also changing. Studies anticipate rainfall to become more variable, and possibly decline, during the critical summer/dry season. As summarized in the local *Climate Preparedness Plan for the North Olympic Peninsula* (Peterson, S. et. al., 2015): "Changing snowpack, frequent drought periods, and lower summer precipitation may decrease water supply and increase competition for water resources between in-stream flows and ecosystem needs, water access for vulnerable populations, industrial access, and agricultural use".

Figure 2: Long-Term* Dungeness River Hydrograph and Average Monthly Precipitation

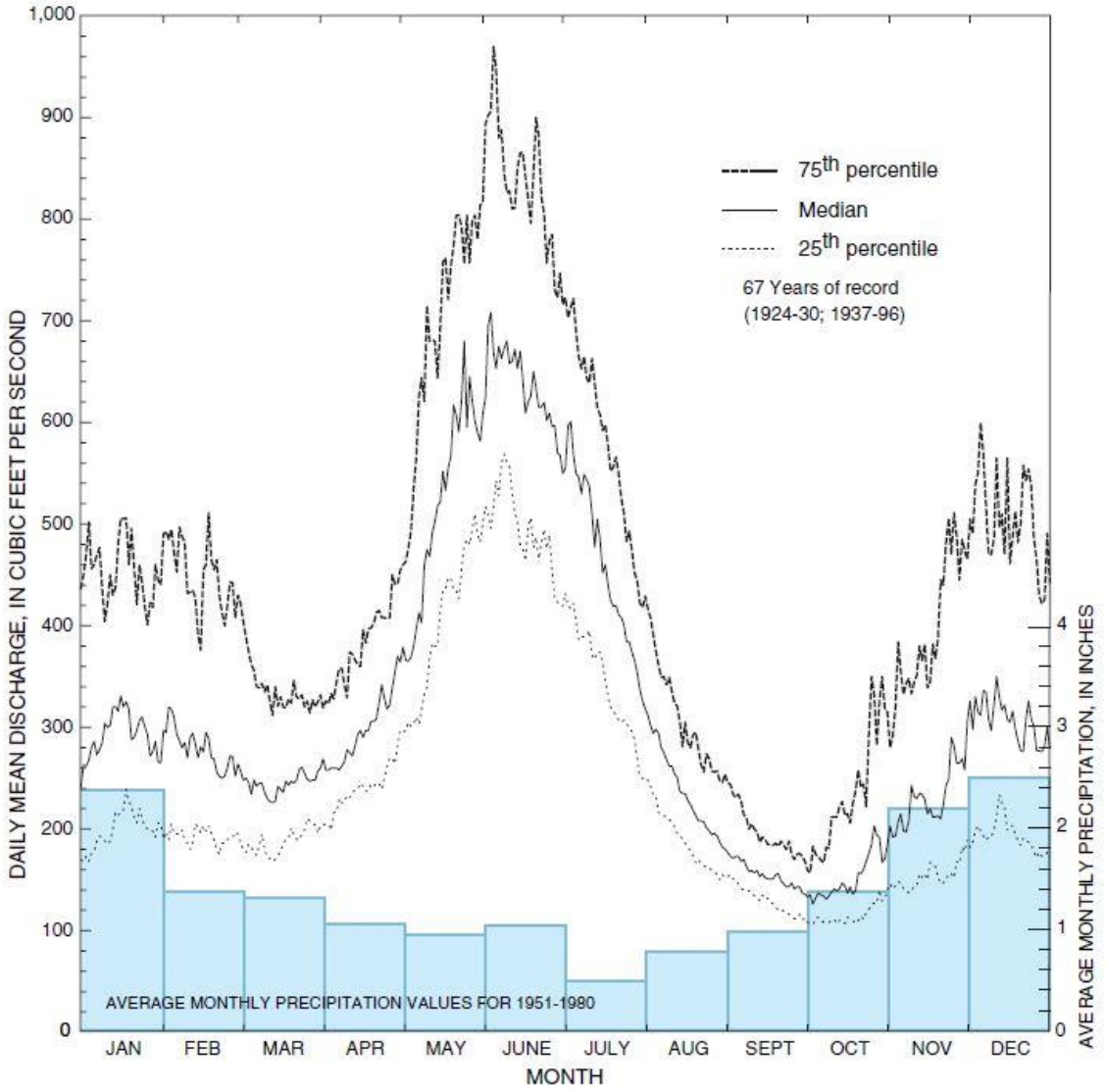


Figure Credit: Figure 5 in Simonds and Sinclair, 2002. Discharge data from U.S. Geological Survey stream-gaging station 12048000 and precipitation data from National Oceanic and Atmospheric Administration (1982).

**Note, while Figure 2 is the most current such illustration, both the hydrograph and the average monthly precipitation graph should be updated with the most current available data. See related recommendations in Section 6 (Topics 6.1 and 6.2).*

The importance of updating our understanding and characterization of the area's water resources at this time derives from the need to: include new information about what we currently know about and anticipate for climate change in this area; incorporate population land use changes in recent decades; and update assumptions used in water management tools to plan for the near- and long-term future.

6. Recommendations

The topics and associated recommendations are summarized in the table below in the order they were discussed by the WRTG. The Appendix to this Recommendations Summary provides further detail on each topic, including the basis for each recommendation, individual WRTG comments, as well as topic references and additional resources.

A "***Volunteer Resource Team***" subject line is included underneath each topic header, the intent being to solicit volunteer expertise and interested parties to collaborate on advancing or implementing the recommended actions associated with each topic. Some WRTG members have already added their names to these lists, but additional volunteers are needed.

6.1 Updated Groundwater Characterization ***Volunteer Resource Team:*** *Ann Soule (additional volunteers needed)*
1. An effort should be undertaken to assess the current status of groundwater aquifer levels within the Dungeness watershed area. This effort should include identifying optimal well measurement locations and frequencies, and implementing continuous, automated water level monitoring and reporting. 2. Data analyses, similar to those performed by the USGS (Thomas, 1999) and by Pacific Groundwater Group (2009), including a revised (current) water budget, should include the relationship between aquifer levels, precipitation, recharge from the upland watershed region across the southern boundary of the existing numerical model, other forms of recharge, ground-surface water interactions, imported/exported water, discharge to salt water, and withdrawals. 3. An analysis of available groundwater chemistry information should be compiled in a database to provide a snapshot of water chemistry and then evaluated over time to determine parameters and regions of concern.
6.2 Expanded Monitoring Programs ***Volunteer Resource Team:*** *Streamkeepers (suggested); (additional volunteers needed)*
1. A listing of historic data sources and current monitoring programs related to water resources should be created and be available online for reference and easy access. Key gaps should be highlighted and addressed. 2. An effort should be undertaken to create an historical graphical profile based on detailed measurements that show the trend lines for all forms of precipitation, including snowpack, rainfall along with streamflow. This information should be updated continuously as data becomes available and be provided to decision makers and include potential, near-term, weather impacts based on the historical profiles.

3. A standard format, collection time period and graphical interface should be established so this complete data set can be displayed as overlays of the selected display parameters.

4. Initiate an expanded groundwater monitoring program, according to results of groundwater status assessment and analyses (Recommendations in Section 6.1).

6.3 Characterization of Fourth Aquifer

Volunteer Resource Team: (volunteers needed)

1. Compile any existing and new data from the Weyerhaeuser, Dungeness Spit, "Carlsborg Very Deep Well" (on Van Lan parcel), Graysmarsh, and any other deep wells drilled into or almost into Aquifer 4.

2. Define the geographical locations, geological character, predictive water quantity, recharge capabilities and expected demand requirements for the deep aquifer and incorporate data from Recommendation 1, above.

3. Guided by existing and new Aquifer 4 data and monitoring experience, design a combined study to monitor detectable impacts on all levels of the aquifer system to determine the interactions which may result when the 4th Aquifer is utilized as added supply.

4. An analysis should be undertaken to determine the permeability of multiple confining layers among all aquifers.

5. A study should be conducted to determine the nature of the water in the 4th Aquifer to determine its source age. The intent of such a study, possibly using carbon dating or nuclear isotope techniques, is to enable more accurate recharge predictions.

6.4 Updated Water Demand Projections

Volunteer Resource Team: Student volunteers (suggested); (additional volunteers needed)

1. An effort should be undertaken to compile available data on current water consumption by all sectors (e.g., residential, agricultural, commercial/industrial) on a monthly basis, and population changes on a quarterly basis (or monthly, if possible).
   A comparison analysis should be conducted of the actual data (from Recommendation #1) to that which was historically projected for water demand and population growth during the same timeframe.

2. Using results from the above analyses, and incorporating additional relevant information (e.g., metering data, climate change projections, land use changes, fish and wildlife water needs, etc.), updated estimates of future water demand (e.g., at 5, 20, 50 years) should be prepared for review.

3. Metering records should be aggregated and analyzed to determine the current volume of water used per dwelling and/or household and applied to any future demand projections.

6.5 Climate Research on Impacts on Fish

Volunteer Resource Team: *(volunteers needed)*

1. The climate change impact research (stream modeling) efforts initiated by PNPTC to predict impacts of warming scenarios on fish habitat should be supported and continued, including proposed next phases incorporating riparian vegetation impacts on stream temperatures, and changes to peak streamflow events.

2. A study task should be added to determine the potential climate change impacts on birds and land-dwelling animals.

3. A study task should be added to include the addition of temperature sensing, ideally in a variety of different stream settings (e.g., riffles, pools, shaded vs. unshaded, etc.) to obtain data on more relevant stream flows.

6.6 Community Support through Public Outreach

Volunteer Resource Team: *Ann Soule (Water Column Blog), Dungeness River Nature Center Staff (suggested), Clallam League of Women Voters (Story of Water Presentations, suggested); (additional volunteers needed)*

1. A coordinated effort, inclusive of the water manager community (CCD, City, County, JST, WUA, etc.) should be undertaken to intentionally improve and build upon community support within the Dungeness basin. Such efforts should include public education opportunities, volunteer outreach, public forums, events (e.g. booth at irrigation fest, short films about the Dungeness), as well as promoting previously successful outreach efforts (such as *The Story of Water* Lecture Series, *The Water Column Blog*, and the Dungeness River Nature Center's classes), etc.

2. Consider updating and redistributing Ecology's 2011/2012 *Dungeness Water Watch* series and Ecology's 2010 *A Guide to Water and How We Use It in the Dungeness Watershed* and establishing a designated program for new and continued public outreach on basic water resources topics relevant to this area.

3. Consider developing, as an outreach demonstration tool, a 3-D digital animation of the watershed that shows (and quantifies) changes to the amount of land surface area available for snow "storage" at different elevations (i.e., as snow elevation increases with global warming, there is less surface area for snowpack storage).

4. As part of an existing or new curriculum on climate change for elementary and middle school, add an element to convey changes in glaciers, rivers and other water resources in the Pacific Northwest due to global warming and relate these changes with the pace of human settlement in this area.

6.7 Interactive Hydrologic Map

Volunteer Resource Team: *Alex Scagliotti; (additional volunteers needed)*

1. A groundwater database should be developed for the DRMT Focus Area. Using this data, an ArcGIS map should be created that displays, through a colorimetric scale, groundwater influent/effluent reaches of Dungeness basin streams and open irrigation canals. The tool should provide the capability of viewing a variety of layers, including at minimum one representative of typical irrigation season conditions, and one representative of off-season conditions. A map of the basin's recharge/discharge zones could then be referenced to support sustainable water management planning (see Data/Reference section for examples of such maps).

2. Well water depths in Aquifers 1, 2, 3 and 4 should be monitored continuously and the data included as a layer option on the ArcGIS map. The wells should be located across the Dungeness watershed, be equipped with pressure transducers and communicate wirelessly with a central data collecting entity. All available historic and current data, from as many wells as possible, should be included.

   Example of one use for this tool:

   - Relative elevations of groundwater could be compared to median background conditions based on current well monitoring plans (hopefully this will be expanded in the future)
     - Interpolations can be made for areas between wells to display a general groundwater elevation map of the basin
     - Baseline conditions are based on historic levels and not "the new normal"
     - If connected to a central database, these maps can be automatically updated with annual inputs of new data

6.8 Comprehensive, Integrated Forecasting Model

Volunteer Resource Team: *Tony Corrado; (additional volunteers needed)*

It is recommended that a feasibility study be initiated to determine if an integrated, data-based, predictive model can be developed to provide a continuous, seasonally based forecast of Dungeness River streamflow correlated to climate effects.

6.9 Saltwater Intrusion Studies

Volunteer Resource Team: *(volunteers needed)*

An effort should be undertaken to obtain additional information on the extent of seawater intrusion along the coastline; identify seawater intrusion susceptible lands; and use the data to plan/develop policies/programs to protect ecosystems and aquifer integrity. Specific tasks would include:

a. Design and implement a coastal well sampling program for chloride (at minimum), salinity, and water levels in wells identified 0.5 miles inland from the coast.

b. Use sampling results and climatic events (such as sea-level rise and/or storm surges) to identify location, extent, and severity of seawater intrusion impacts.
c. Assess vulnerability of wells and septic systems in seawater intrusion susceptible areas and develop regulations and policies for new and old development that protect public health/drinking water and conserve/restore ecosystems.

6.10 Expanded Snowpack Study

Volunteer Resource Team: *Lance Vail, Ann Soule; (additional volunteers needed)*

1. An effort should be undertaken to quantify the year-round ice and permanent snowfields in the upper Dungeness watershed.

2. Produce a report on estimated water supply derived from ice and snow melt over time, as it relates to summertime streamflow in the Dungeness River. The expected pace of permanent ice/snowfield decline should be included as a basis of this effort.

3. Relate estimated future streamflow in the Dungeness River to volume of aquifer recharge - annually, seasonally, or monthly.

4. Establish an online, real-time reporting tool for snow/ice parameters useful to Dungeness water managers in the future.

6.11 Mitigating Potential Use of the 4th Aquifer

Volunteer Resource Team: *(volunteers needed)*

1. A new analysis, or adjustments to Ecology's current Mitigation Calculator ("Lookup Table"), should be considered to improve predictability of mitigation requirements[4] for potential developers of water supplies from "Unit 6" (the undifferentiated unconsolidated deposits, which includes the 4th Aquifer).

2. The County and PUD proposed a new method to estimate the impacts of pumping from Aquifer 4. The method uses new data collected from the drilling and testing of the Carlsborg Very Deep Well (the "Van-Lan Well") and data from the existing Mitigation Calculator. This method should be considered in evaluating the Draft Mitigation Plan for the PUD's specific (2006) water right application for expansion of the retail service area of their Carlsborg Water System.

3. An analysis should be undertaken to represent the 4th Aquifer in the Dungeness Model (to the extent that its occurrence is understood to be an "uncertainty analysis" based on various possible configurations) and then the model should be used to estimate mitigation requirement(s)[5] for pumping from the 4th Aquifer.

[4] Any update to the current mitigation analysis should be considered along with the original guiding principles for managing water in the WRIA 18 East – Dungeness Watershed set for in the February 15, 2011, Cooperators' Agreement (Clallam County, WUA, Ecology, 2011) and supported by the Jamestown-S'Klallam Tribe (JST, 2011).

[5] Ecology requires mitigation to be in compliance with WAC 173-518-070(3)(a)(i) and -518-070(3)(c).

6.12 Shallow Aquifer Recharge Effectiveness *Volunteer Resource Team: Joe Holtrop, Alex Scagliotti, Lance Vail (adaptive management perspective), Ecology EAP Program Staff (suggested); (additional volunteers needed)*
The shallow aquifer recharge (SAR) facilities installed over the past few years should be analyzed to determine how effectively they are achieving the intended objectives of mitigating the impacts of new well use and benefiting streamflows.
6.13 Future Water Sourcing Studies *Volunteer Resource Team: (volunteers needed)*
A study should be undertaken to consider future sources of water that can supplement existing sources. This study should include desalination, additional use of processed sewage effluent, and additional storage (above ground or underground) facilities.

Please see the Appendix to this Recommendations Summary for further detail on the Background, WRTG Comments (by individual members), and References related to each of the 13 topics.

7. References[6]

Allen, Ron. April 23, 2022. Speaking at Port Angeles City Pier Earth Day Celebration. Port Angeles, WA.

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[6] Please see the **Appendix** for references cited in specific Recommendations, as well as for additional References/Resources relevant to the 13 topics.