CITY OF BAINBRIDGE ISLAND

Environmental Technical Advisory Committee Regular Meeting Thursday
March 21, 2024, 3:00 PM
Chamber Conference Room, City Hall
280 Madison Ave N
Bainbridge Island, WA

The Environmental Technical Advisory Committee will hold this meeting in person, in the City Hall Chamber Conference Room, 280 Madison Ave N, Bainbridge Island, WA
It is recommended that attendance be in person, but it is also accessible via the Zoom meeting platform.

https://bainbridgewa.zoom.us/j/82237251377

Webinar ID: 822 3725 1377
Or iPhone one-tap: US: +12532158782Or Telephone: +1 253 215 8782 or +1 669 900 9128 or +1 346 248 7799

Agenda for March 21, 2024, ETAC Meeting

Call to Order / Roll Call / Conflict of Interest Disclosure - 3:00 PM

Members: Melanie Keenan, Malcolm Gander, Dylan Frazer, Ben Harrison, and Brian Harmon

Council Liaison: Clarence Moriwaki

COBI Staff: HB Harper – Planning Manager
Renee Argetsinger - PCD Administrative Specialist

Approval of Agenda – March 21, 2024 - (5 min)

Approval of Minutes – November 16, 2024, January 18, 2024, and February 15, 2024 - (5 min)

Council Liaison Report – Clarence Moriwaki - (5 min)

Chair Report – Melanie Keenan - (5 min)

COBI Staff Comments - (5 min)

1. **Finalize Work Plan - will be submitted to City Council by Melanie** (ETAC Lead) - (5 min)

2. **Groundwater Management Plan (GWMP), Subcommittee Update** - (30+ min)
Update regarding March 4 and March 11 meetings, City Council March 12 meeting, comments concerning GW Model (Appendices A-D):
   - Shortcomings of Water Rights-based model runs v. conventional model approach
   - Model should acknowledge historic population increases require water volume pumping increases greater than volumes modeling exercises are currently addressing, e.g.,

   A ~50% increase in population correlates with greater than 50% increase in pumping

   20,400 people in 2000 used about 300 million gallons of water from KPUD+COBI

   ~ 24,000 people in 2022 used about 570 million gallons from KPUD+COBI

Loss of Recharge, annual rainfall needs to reflect climate impacts, longer drier summer months, less rain events with more intense precipitation and more runoff. Changes due to growth/development increased impervious and disturbed areas for recharge. Model should acknowledge existing significant streamflow decreases in Springbrook, Issei, Shel- Chelb, & Cooper Creeks (among others), and complement Aspect's 2016 & 2023 model updates that predicted 15-58% streamflow reductions in the future.

3. **Importance of complying with requirements for an island-wide & stakeholder-inclusive public process & COBI should videotape upcoming Technical Advisory Committee (TAC) meeting. Last TAC meeting May 2022. -** (5 min)
   How should this be accomplished?

4. **Growth Requirements, new laws, and GMA Preamble (5 min)**
   Patti Charnas has stated Bainbridge Island must comply with growth numbers from Olympia/ Kitsap based on new GMA requirements and laws. What are the citations for the WACs or RCWs or other on which these comments are based on.

5. **Next Meeting Planning -** (5 min)

6. **For the Good of the Order -** (5 min)

7. **Public Comment** - (5 min)

Adjournment: 4:55 PM

Appendices:

Appendix A

(7:20 PM) Update on the Groundwater Management Plan - Public Works, 30 Minutes GWMP City Council Update 031224.pptx

Please include this agenda item from the CC packet

https://d3n9y02raazwpg.cloudfront.net/bainbridgewa/d54c0c44-9df9-11ee-a93d-0050569183fa-1288c45d-5d3e-46ae-af61-2e888e37b46d-1709939487.pdf

Appendix B

GWMP Sub-Committee Agenda Materials copy.pdf

Appendix C

COBI_draft_100year_porduciton-populaiton_estimates_20240308 copy.pdf

Appendix D

Population and Pumping Scenario Rec 021824.pdf

Environmental Technical Advisory Committee Regular Meeting Thursday
March 21, 2024, 3:00 PM
Chamber Conference Room, City Hall
280 Madison Ave N
Bainbridge Island, WA

Meeting February 15, 2024, ETAC Meeting

Call to Order - 3:05 PM

Members Present: Melanie Keenan, Malcolm Gander, and Ben Harrison
Members Absent: Dylan Frazer and Brian Harmon

Council Liaison: Clarence Moriwaki

COBI Staff Present: HB Harper – Planning Manager
Renee Argetsinger - PCD Administrative Specialist

Approval of Agenda – February 15, 2024 - No changes or additions offered.

Approval of Minutes – Minutes from November 16, 2023, and January 18, 2024, - deferred until the March 18, 2024, ETAC meeting.

Council Liaison Report – Clarence Moriwaki – Newly appointed to ETAC, no report yet.

Chair Report – Melanie Keenan – Nothing to report, focus has been on the Work Plan.

COBI Staff Comments – Nothing to report from staff.

GWMP, Subcommittee Update, comments concerning GW Model
Consultant still working on the model. The chair provided update on the GWMP program affecting BI including 5 major concerns. Discussion followed.

Comprehensive Plan Update Discussion - Tabled until Patty can contribute to this topic.

UAC Stormwater Plan Updates, Deadlines -
Discussion regarding new regulations that must be met.

UAC Small Water Systems Memo -
Recap of what UAC talked about, including private wells and water rights. Discussion followed.

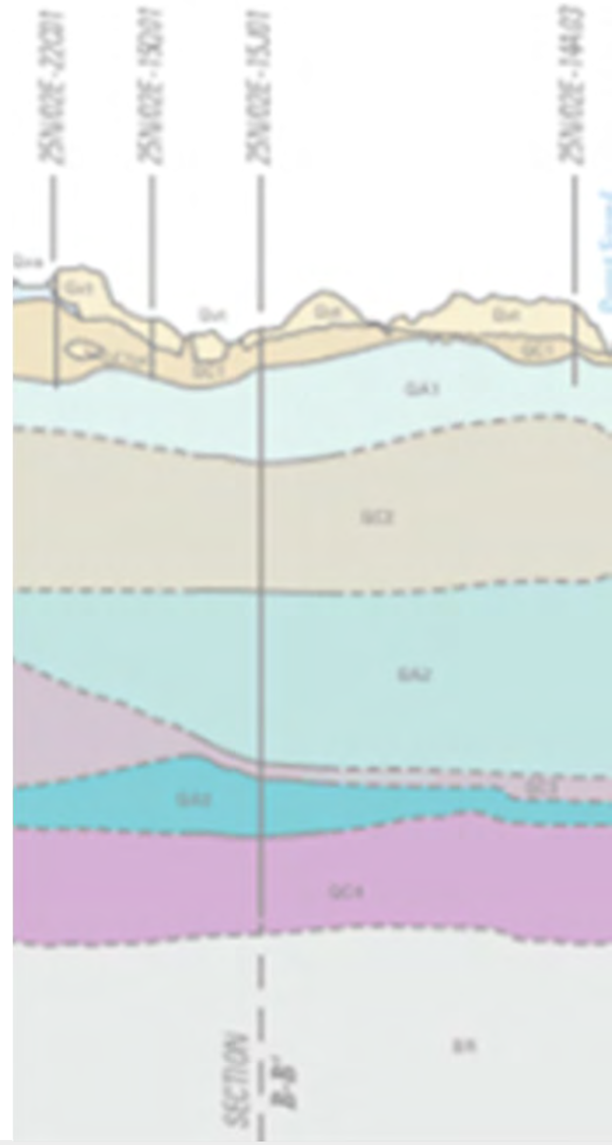
Next Meeting Planning - Topics: Groundwater Management Plan, Stormwater, Comprehensive Plan, the Environmental Impact Statement for Comprehenisve Plan, and updating the ETAC Webpage.

For the Good of the Order – Councilman Moriwaki, as the new Council Liaison, set the expectation of what a Council Liaison does and offered how he will work with the ETAC.

Public Comment - No public comments.

Adjournment: 4:22 PM

Groundwater Management Plan Update



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Groundwater Management Plan - Phasing

In basic terms, the Plan consists of three (3) phases of work:

1. Research - Document existing conditions and data (*complete)*

2. Modeling - Process data and define problems (*in process)*

3. Planning – Document findings, and adopt strategies/ actions to address issues (*started)*

Groundwater Management Plan – February 20, 2024 Recap

1. Groundwater model overview and correction/calibration

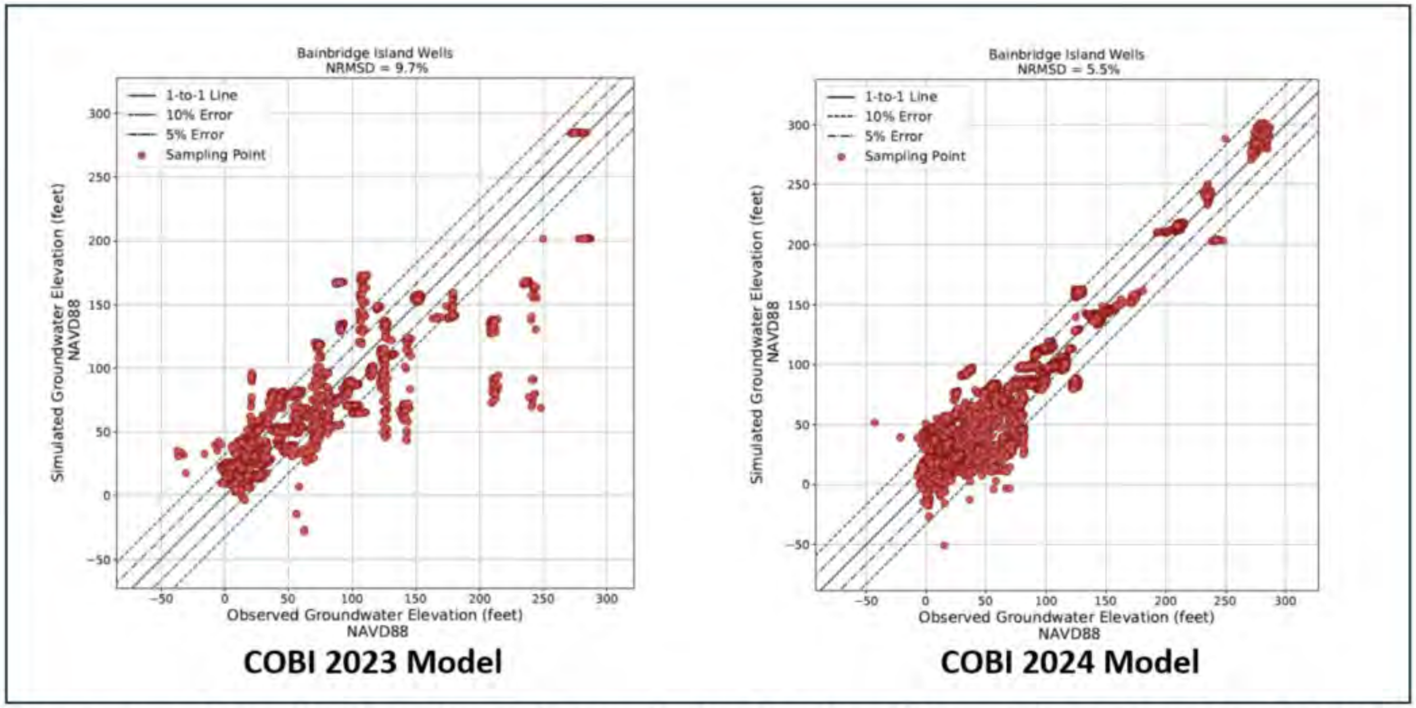
2. Groundwater modeling scenarios

Groundwater Management Plan – March 12, 2024 Update

1. Groundwater model overview and correction/calibration
   - Clarification on results
2. Groundwater modeling scenarios
   - Updates from recent sub-committee meetings
3. Update on schedule, costs and public involvement

Groundwater Model Overview and Calibration

- Model reliability improved by 4.2%
- Sub-committee agreed that further calibration did not have a cost/benefit



Comparison of Simulated vs. Observed Groundwater Elevations between the 2023 and 2024 Models

100-year Groundwater Modeling Scenario Planning

Comparison scenario – Compare 2024 calibrated model with 2022 model

Baseline scenario – Current conditions projected into the future

Sea-Level Rise Stress Sensitivity Scenarios – Baseline + mod./max. sea-level rise

Recharge Stress Sensitivity Scenarios – Baseline + mod./max. recharge

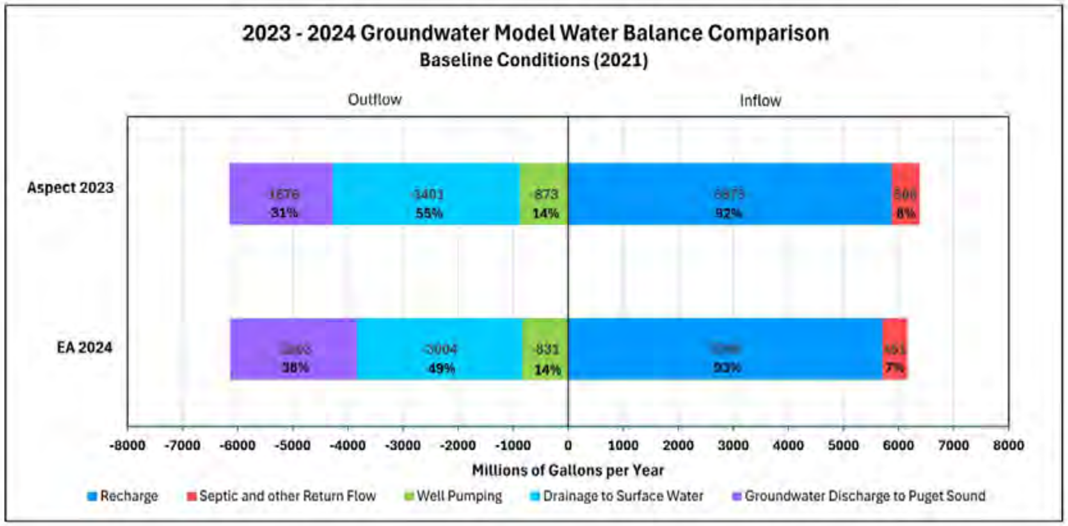
Pumping Stress Sensitivity Scenarios – Baseline + increases in pumping

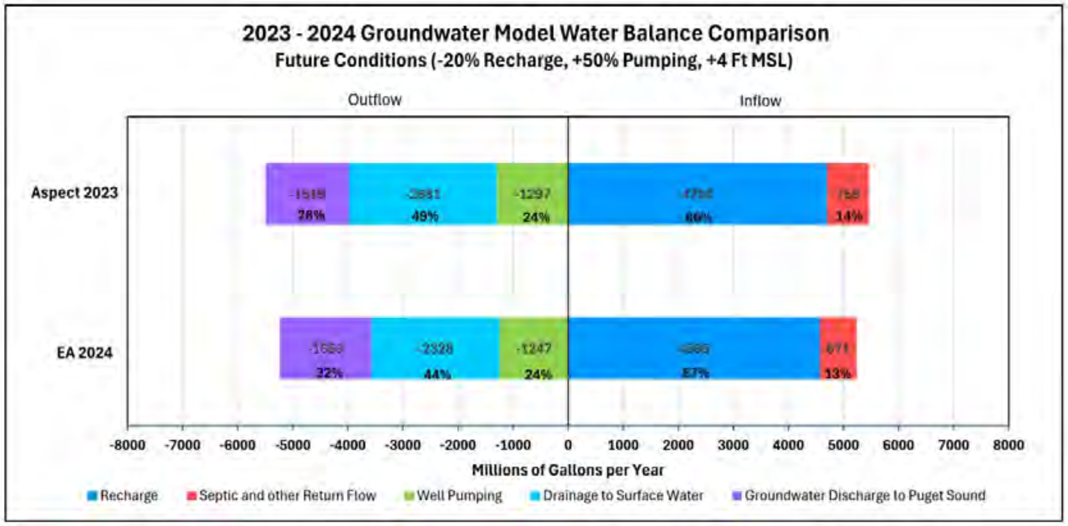
Prediction Scenarios – Combination of Baseline + stresses (basis for planning)

100-year Groundwater Modeling Scenario Planning

Comparison scenario – Compare 2024 calibrated model with 2022 model

Baseline scenario – current conditions projected into the future



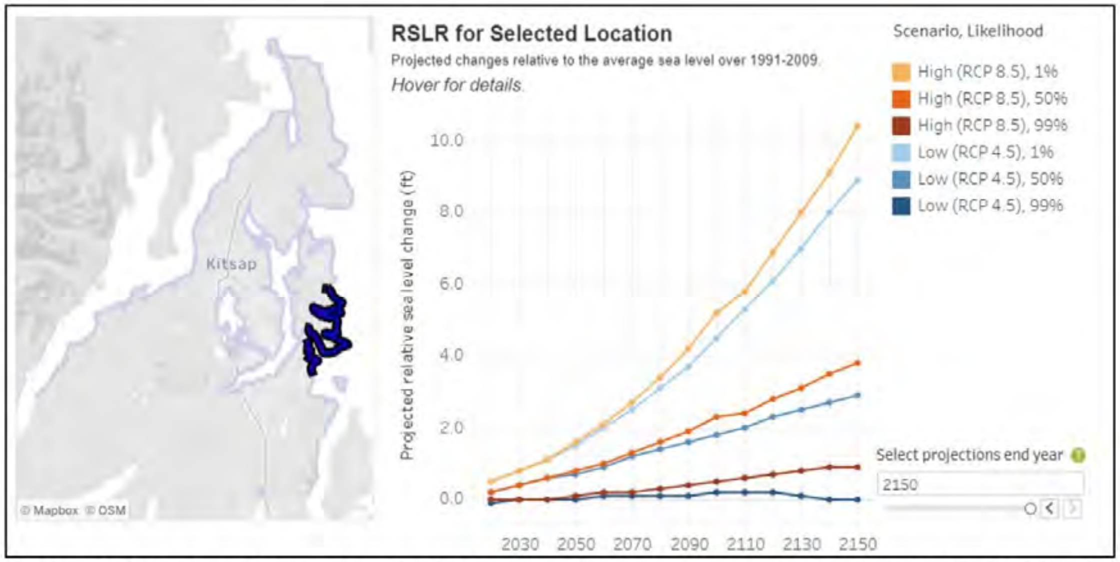


100-year Groundwater Modeling Scenario Planning

Sea-Level Rise Stress Sensitivity Scenarios – Baseline + mod./max. sea-level rise

(sub-committee agreement)

- Baseline + Median sea level rise (2.8 ft in 100 yrs)
- Baseline + Max. sea level rise (6.9 ft in 100 yrs)



Projected Sea Level Rise near Bainbridge Island associated with various Emission Scenarios

100-year Groundwater Modeling Scenario Planning

Recharge Stress Sensitivity Scenarios – Baseline + mod./max. recharge

(sub-committee agreement with further data research)

- Baseline + Median change in precipitation (groundwater recharge): +2.4 inches (wet); -0.3 inches (dry)
- Baseline + Maximum change in precipitation (groundwater recharge): +4.6 inches (wet); -0.60 inches (dry)

Oct.-Mar. Precipitation

Total precipitation from October to March.

Emissions	Time	Value	Change
Historical	1990	34.3 in	
Low	2010-2039	35.5+/-1.2 in	+1.1 in
Low	2040-2069	36.8+/-1.5 in	+2.5 in
Low	2070-2099	37.4+/-1.5 in	+3.1 in
High	2010-2039	35.4+/-1.4 in	+1.0 in
High	2040-2069	36.8+/-1.7 in	+2.4 in
High	2070-2099	38.9+/-1.8 in	+4.6 in

Data Source: MACAv2-METDATA

Apr.-Sept. Precipitation

Total precipitation from April to September.

Emissions	Time	Value	Change
Historical	1990	10.1 in	
Low	2010-2039	10.0+/-0.8 in	-0.1 in
Low	2040-2069	9.8+/-0.8 in	-0.3 in
Low	2070-2099	9.6+/-0.8 in	-0.5 in
High	2010-2039	9.9+/-0.5 in	-0.2 in
High	2040-2069	9.8+/-0.8 in	-0.3 in
High	2070-2099	9.5+/-0.7 in	-0.6 in

Data Source: MACAv2-METDATA

Predicted Changes in Precipitation associated with the High Emissions Scenario (RCP 8.5)

100-year Groundwater Modeling Scenario Planning
(This slide will be updated for the City Council meeting based on feedback from the sub-committee meeting on 3/11/24)

Pumping Stress Sensitivity Scenarios – Baseline + increases in pumping (subcommittee agreement)

- City Water System - Winslow area population to match sub-area planning
- KPUD Water Systems - North and South Island population increases to match current trajectories
- Residential well increases to match current trajectories
- Model with and without a cap on water rights

100-year Groundwater Modeling Scenario Planning

Prediction Scenarios – Combination of Baseline + stresses (basis for planning)

- Combination of best outcome stress
- Combination of worst outcome stress
- Combination of stresses with highest sensitivity analysis
- Other scenarios

Schedule / Public Involvement

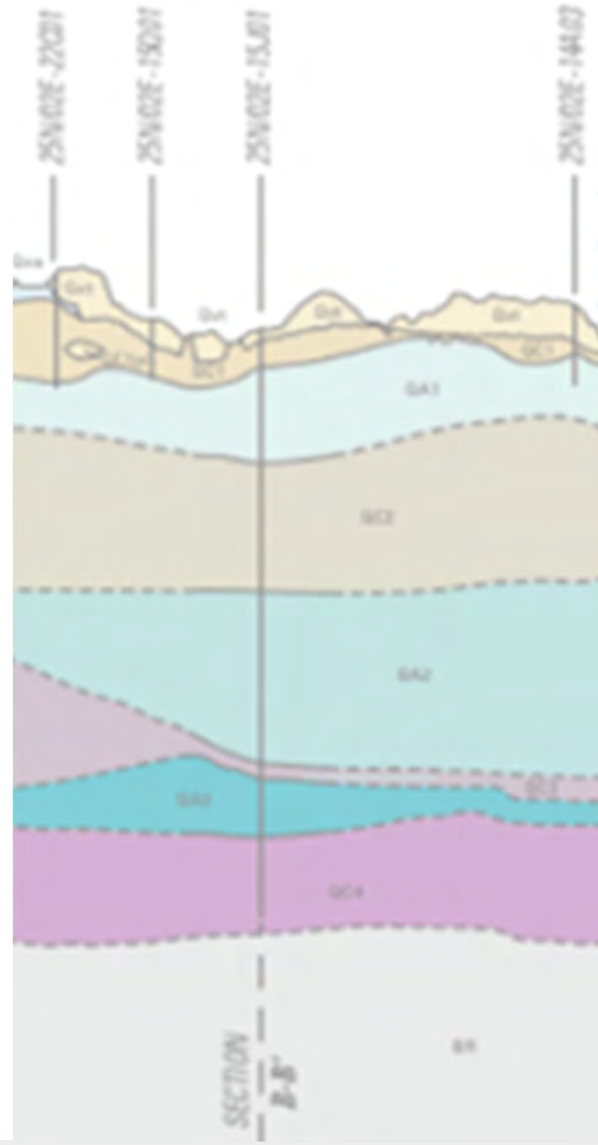
- Mid-March - Review Council feedback with sub-committee
- Late March – Review calibration / modeling scenarios with technical advisory committee (TAC)
- Early April – Review TAC feedback with sub-committee
- Mid-April – City Council check-in
- Late April – begin running scenarios
- May-June – Review scenario findings with sub-committee, TAC and City Council

Project Costs to Date

- Staffing - ~$150K
- Consultant Services - ~$285K (not entirely expended)
- Anticipated additional modeling costs - ~$40K
- Anticipated total = ~$475K

Groundwater Management Plan Update

Q&A



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GROUNDWATER MANAGEMENT PLAN
SUB-COMMITTEE MEETING
MONDAY, MARCH 4, 2024
11:30 AM
VIRTUAL – ZOOM
JOIN ZOOM MEETING
HTTPS://BAINBRIDGEWA.ZOOM.US/J/87102567215

AGENDA

1. CALL TO ORDER / ROLL CALL / ACCEPT OR MODIFY AGENDA / CONFLICT OF INTEREST DISCLOSURE
   2:00 PM

2. OVERVIEW OF PROJECT STATUS, SCHEDULE AND DESIRED MEETING OUTCOMES

   A. PROPOSED SCHEDULE
      I. MARCH 4 - GWMP SUB-COMMITTEE MEETING
      II. MARCH 12 - CITY COUNCIL UPDATE
      III. WEEK OF MARCH 18 TECHNICAL ADVISORY COMMITTEE (TAC) MEETING
      IV. WEEK OF MARCH 25 GWMP SUB-COMMITTEE MEETING – FINALIZE MODELING SCENARIO INPUTS
      V. APRIL 9 - CITY COUNCIL – CONFIRM MODELING SCENARIO INPUTS
      VI. COMPELTE MODELING SCENARIOS BY APRIL 30
      VII. WEEK OF MAY 6 – GWMP SUB-COMMITTEE MEETING AND TAC MEETING TO REVIEW PREILMINARY MODELING SCENARIO RESULTS
      VIII. MAY 14 – CITY COUNCIL – REVIEW PRELIMINARY MODELING RESULTS

3. DISCUSSION OF OUTSTANDING QUESTIONS REGARDING MODELING SCENARIOS

   A. RE-CAP OF PROPOSED SCENARIOS
   B. ADDRESSING WATER RIGHTS IN THE MODELING SCENARIOS
   C. ADDRESSING POPULATION INCREASE ALTERNATIVE
   D. OPTIONS FOR ADDRESSING RECHARGE RELATED TO FUTURE IMPERVIOUS CONDITIONS
   E. QUALIFYING MODEL CAPACITY FOR EVALUATING STREAM/SURFACE WATER IMPACTS
   F. ADDRESSING "CARRYING CAPACITY"

4. GOOD OF THE ORDER QUESTIONS

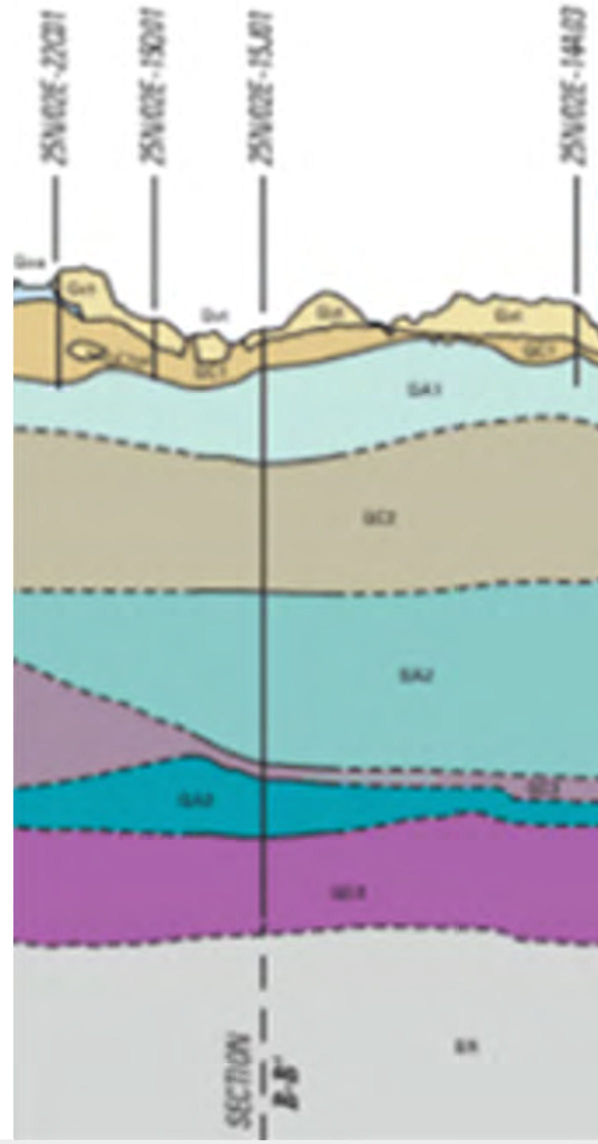
5. NEXT STEPS

6. ADJOURNMENT

MATERIALS ATTACHED:

- 2/20 CITY COUNCIL PRESENTATION
- EA TECHNICAL MEMO – ASPECT MODEL COMPARISON
- EA TECHNICAL MEMO – MODELING EFFORTS

Groundwater Management Plan Update



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Agenda

1. Re-cap last City Council discussion (August 15, 2023)

2. Groundwater model overview and correction/calibration

3. Groundwater modeling scenarios

4. Next Steps / Q&A

Council Actions

- Discussion only
- Acknowledge/discuss forthcoming consultant amendment for additional modeling analysis
    - Note – the work is being guided/reviewed by a sub-committee of members from the Utility Advisory Committee, Environmental Technical Advisory Committee, and Climate Change Action Committee)

August 15, 2023 City Council Re-cap

Ensure clean and sufficient groundwater for our natural environment and ourselves	• Produce groundwater models that inform decisions on land-use and population • Develop and implement water conservation and recharge strategies • Minimize and mitigate threats to water quality
Reduce and adapt to climate change impacts	• Identify climate change impacts to groundwater • Develop and implement strategies to reduce and adapt to climate change impacts • Improve climate change indicator monitoring
Develop community-wide understanding	• Establish advisory subcommittee • Establish islandwide stakeholder engagement • Develop online platform to share information

August 15, 2023 City Council Re-cap

In basic terms, the Plan consists of three (3) phases of work:

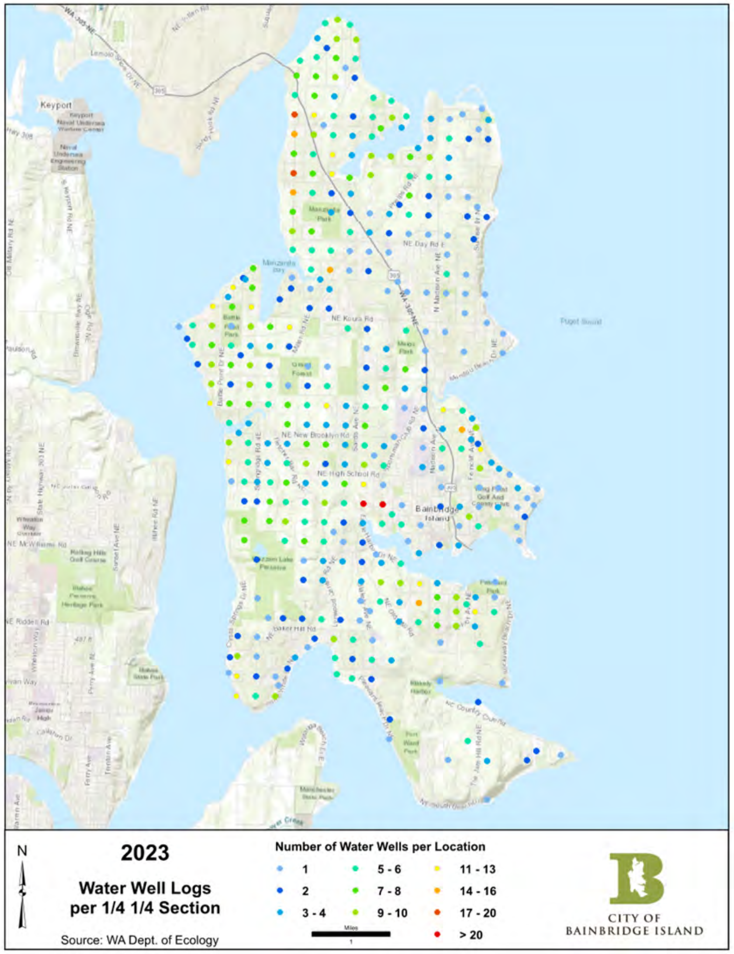
1. Research - Document existing conditions and data (*complete)*
2. Modeling - Process data and define problems (*in process)*
3. Planning – Document findings, and adopt strategies/ actions to address issues (*started)*

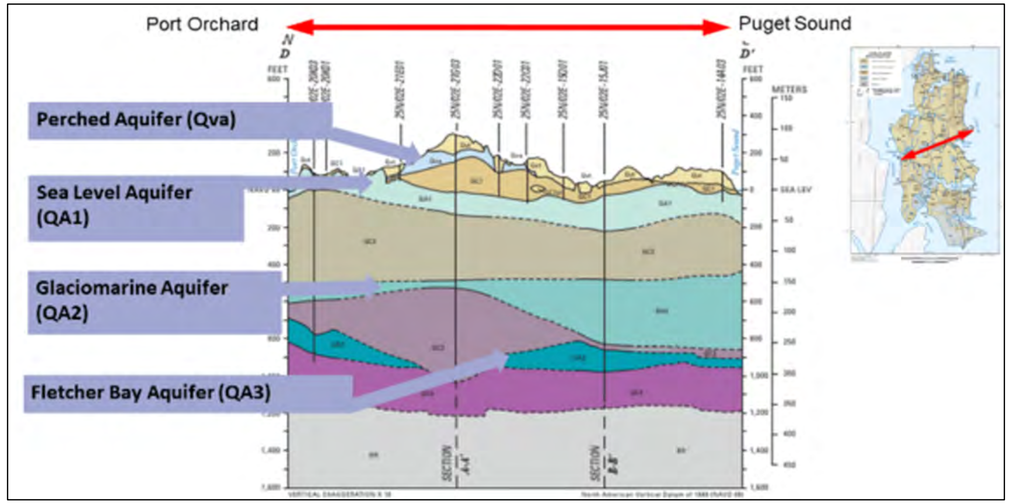
August 15, 2023 City Council Re-cap

From previous discussion, the City Council was interested in:

1. **Modeling growth scenarios across the Island**
2. Understanding "early warning levels" and their use in determining impacts/risk
3. Stream and surface water impacts

Groundwater Model Overview and Correction/Calibration



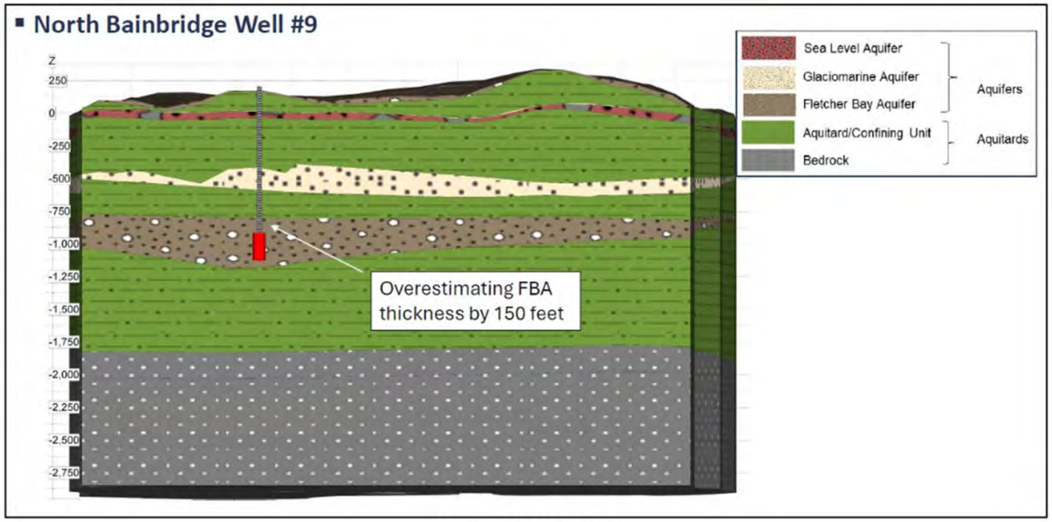


- The model uses information from well logs across the island to build a model of the aquifer and confining layers.
- The model can then simulate current and future scenarios including changes in water usage or environmental conditions.

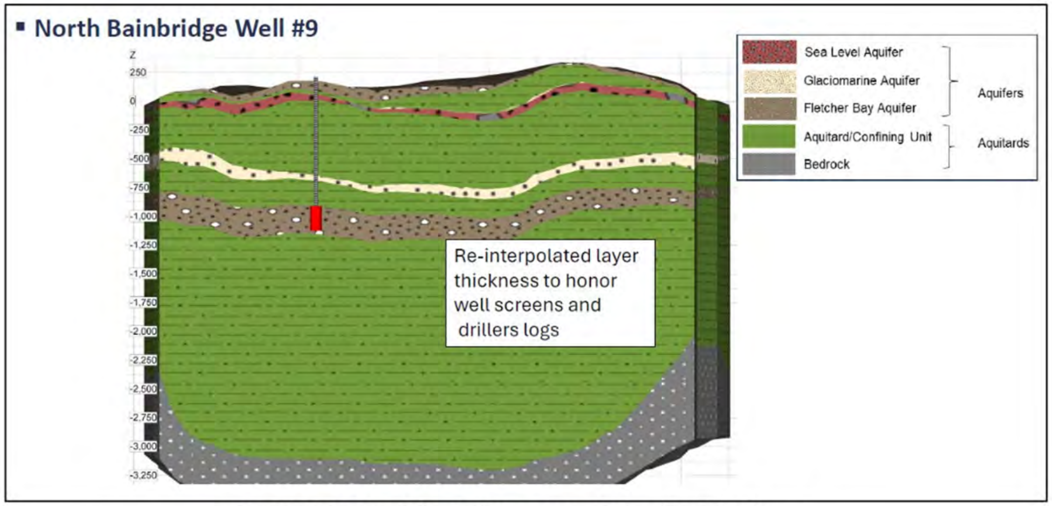
Groundwater Model Overview and Correction/Calibration

- Model correction provides more accurate assessment of aquifer and confining layer thicknesses

- For example, some areas are now more conservative because aquifer thickness is actually narrower



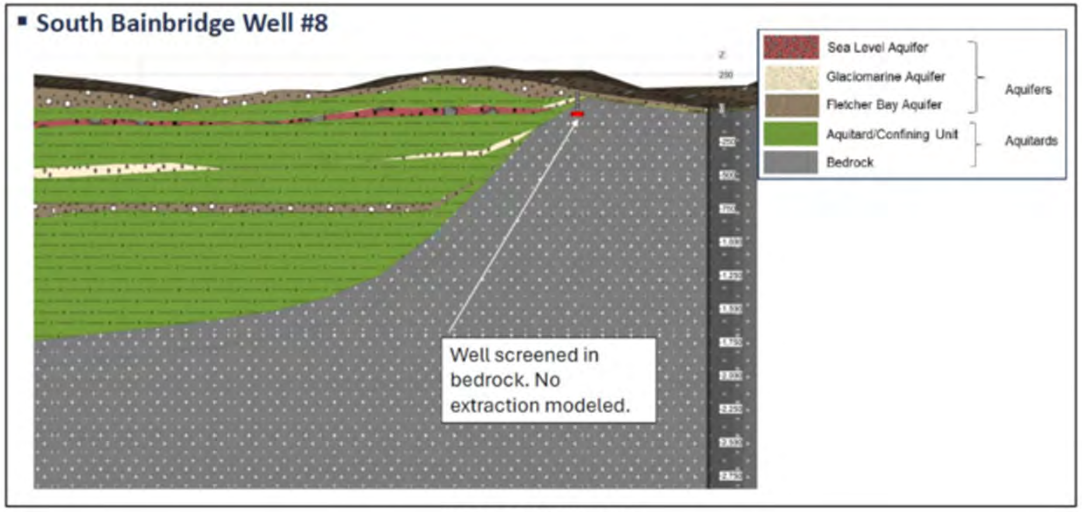
COBI 2023 Model



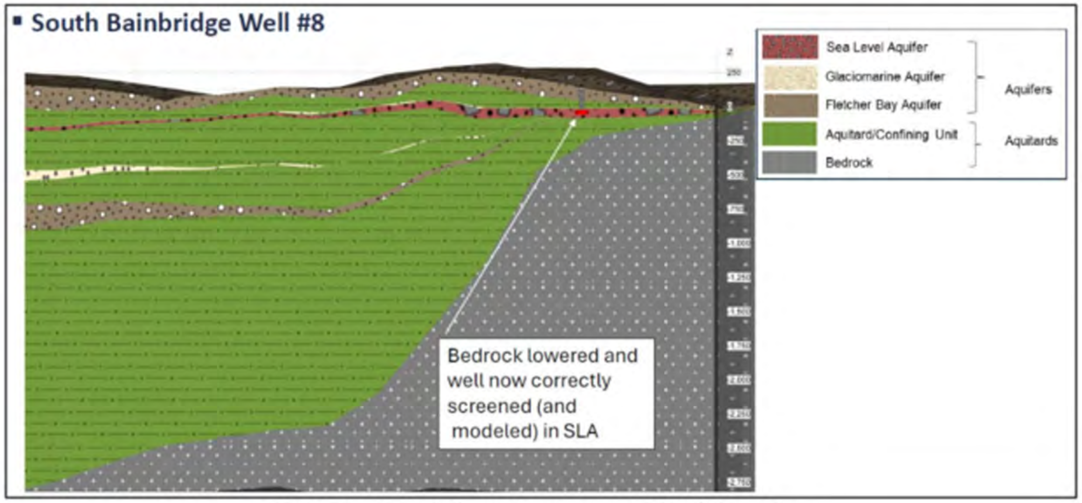
COBI 2024 Model – Adjustment of Aquifer Thickness

Groundwater Model Overview and Correction/Calibration

- Model correction provides more accurate assessment of well locations
- For example, some wells were located in bedrock, but are now shown in the correct aquifer layer



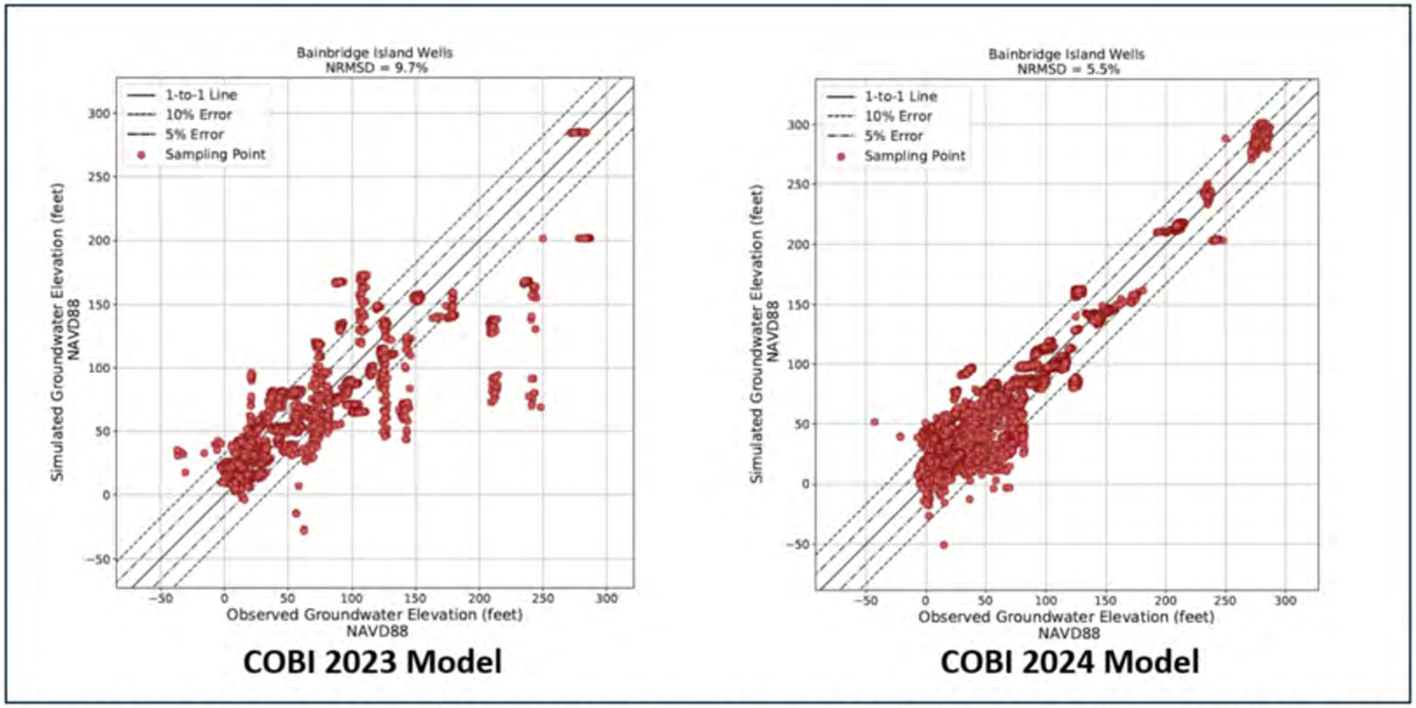
COBI 2023 Model



COBI 2024 Model – Adjustment of Well Location

Groundwater Model Overview and Calibration

- Model calibration resulted in less error between observed and simulated groundwater levels



Comparison of Simulated vs. Observed Groundwater Elevations between the 2023 and 2024 Models

100-year Groundwater Modeling Scenarios (8 Total)

Scenario 0 – A comparison of the newly calibrated model with the original Aspect-run model from 2022

- 4 ft increase in sea level rise
- 20% decrease in groundwater recharge
- 50% increase in groundwater pumping (Islandwide)

100-year Groundwater Modeling Scenarios (8 Total)

Scenario 1 – Baseline conditions; used to compare how various stresses impact the outcomes

- No change in sea level rise
- No change in groundwater recharge
- No change in groundwater pumping (Islandwide)

100-year Groundwater Modeling Scenarios (8 Total)

Scenario 2 – Baseline + Population (pumping) increases up present water rights

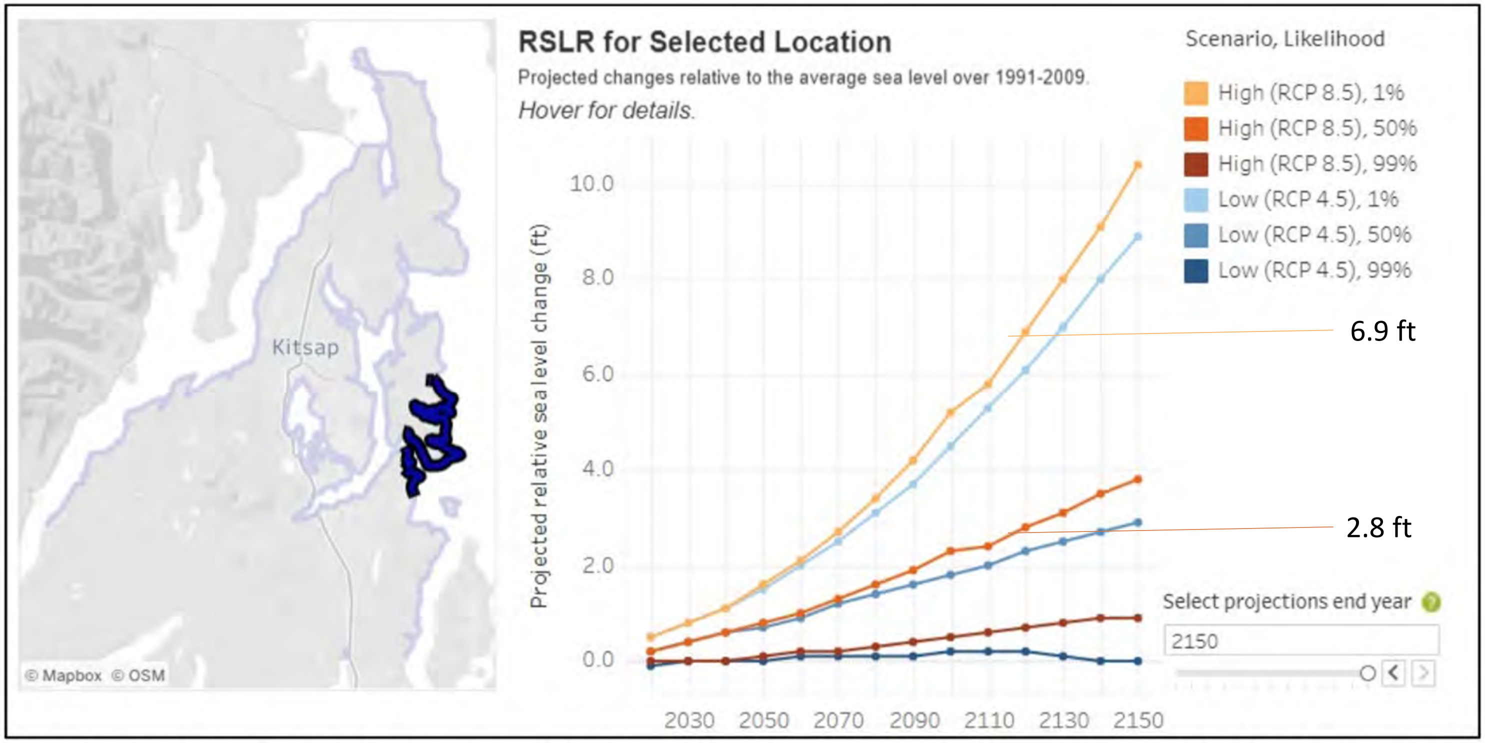
- 4.5% per year in Winslow (City) service area (mimics most conservative growth estimate for Sub-area plan)
- 2.4% per year on north end (current projection)
- 3.7% per year on south end (current projection)
- 0.1% growth rate in new private wells (6 homes per year, current projection)

- No change in sea level rise
- No change in groundwater recharge

100-year Groundwater Modeling Scenarios (8 Total)

Sensitivity Analysis Scenario 3 – Baseline + Median sea level rise (2.8 ft in 100 yrs)

Sensitivity Analysis Scenario 4 – Baseline + Max. sea level rise (6.9 ft in 100 yrs)



Projected Sea Level Rise near Bainbridge Island associated with various Emission Scenarios

100-year Groundwater Modeling Scenarios (8 Total)

Sensitivity Analysis Scenario 5 – Baseline + Median change in precipitation (groundwater recharge): +2.4 inches (wet); -0.3 inches (dry)

Sensitivity Analysis Scenario 6 – Baseline + Maximum change in precipitation (groundwater recharge): +4.6 inches (wet); -0.60 inches (dry)

Oct.-Mar. Precipitation

Total precipitation from October to March.

Emissions	Time	Value	Change
Historical	1990	34.3 in	
Low	2010-2039	35.5+/-1.2 in	+1.1 in
Low	2040-2069	36.8+/-1.5 in	+2.5 in
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High	2010-2039	35.4+/-1.4 in	+1.0 in
High	2040-2069	36.8+/-1.7 in	+2.4 in
High	2070-2099	38.9+/-1.8 in	+4.6 in

Data Source: MACAv2-METDATA

Apr.-Sept. Precipitation

Total precipitation from April to September.

Emissions	Time	Value	Change
Historical	1990	10.1 in	
Low	2010-2039	10.0+/-0.8 in	-0.1 in
Low	2040-2069	9.8+/-0.8 in	-0.3 in
Low	2070-2099	9.6+/-0.8 in	-0.5 in
High	2010-2039	9.9+/-0.5 in	-0.2 in
High	2040-2069	9.8+/-0.8 in	-0.3 in
High	2070-2099	9.5+/-0.7 in	-0.6 in

Data Source: MACAv2-METDATA

Predicted Changes in Precipitation associated with the High Emissions Scenario (RCP 8.5)

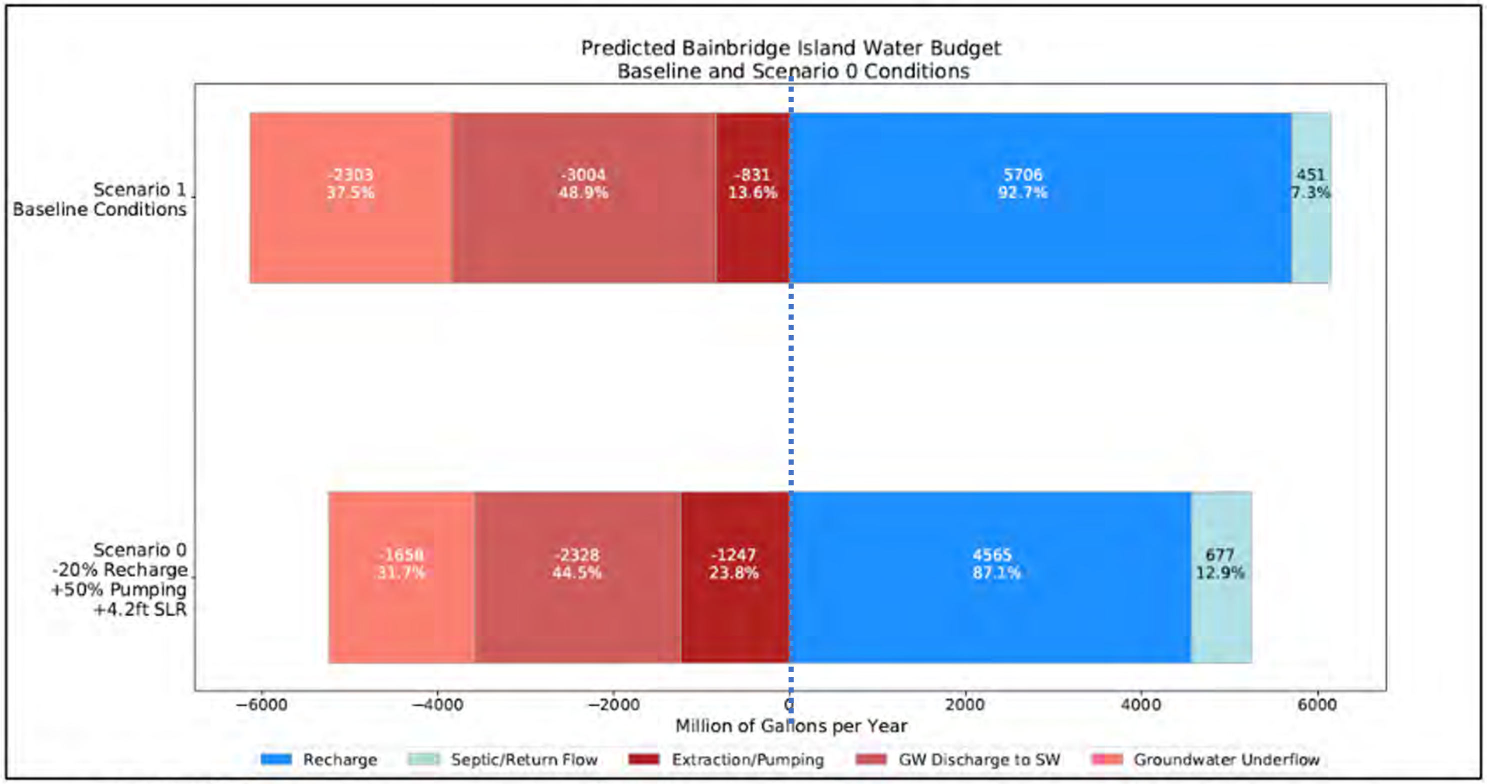
100-year Groundwater Modeling Scenarios (8 Total)

Scenario 7 – Baseline + three median stresses combined

- Scenario 2 population (groundwater pumping) increase
  +
- Scenario 3 median sea level rise
  +
- Scenario 5 median precipitation (groundwater recharge)

Early Modeling Results

- After calibration, the model is producing more reliable results for both Scenario 0 and 1



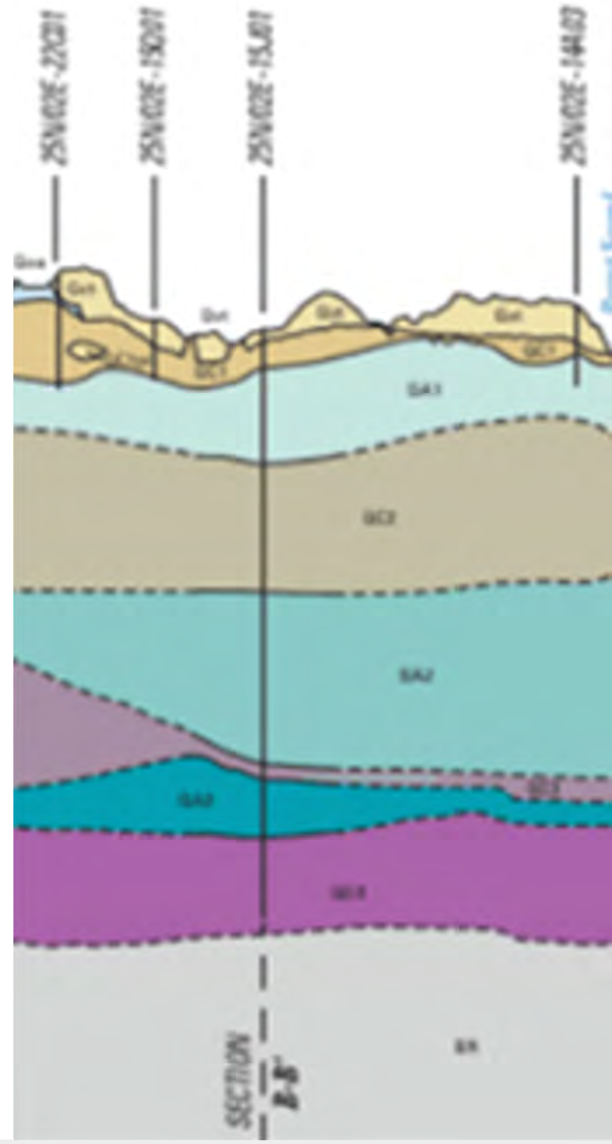
COBI 2024 Model **Comparison of Water Budget between Scenario 0 and Scenario 1**

Next Steps

- Input from City Council on scenarios (today)
- Contract amendment for additional modeling services (March)
- Complete scenario modeling, review results and impacts (including early warning levels and surface water impacts) with Sub-Committee and City Council (March/April)
- Process any revisions to scenario modeling (May)
- Present draft Groundwater Management Plan recommendations (July)

Groundwater Management Plan Update

Q&A



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EA Engineering, Science, and Technology, Inc., PBC

TO: Christopher Wierzbicki, P.E., Director of Public Works, City of Bainbridge Island

FROM: Dave Nazy, LHG, CWRE, EA Engineering, Science and Technology, Inc., PBC

SUBJECT: Groundwater Modeling Update

DATE: February 12, 2024

This memo provides the information you requested regarding EA's current groundwater modeling efforts to support development of the Groundwater Management Plan. The *COBI 2023 Model* provided to EA by Aspect was revised and recalibrated (*COBI 2024 Model*). All modeling scenarios described below will use the *COBI 2024 Model*. The historical groundwater conditions previously calculated by Aspect for the end of 2021 are used as initial conditions for all scenarios.

Final Confirmation of the Scenario Descriptions

0. Comparison to Previous Modeling by Aspect

   This scenario was performed to compare the results of Aspect's *COBI 2023 Model* with EA's *COBI 2024 Model* using the same stresses and time steps applied to both models. This scenario can also be compared to Scenario 1 to evaluate the simulated change relative to baseline conditions.

   This scenario uses a **4-foot increase in sea level**, a **20% decrease in groundwater recharge** and a **50% increase in pumping** relative to 2021 conditions. All three stresses were applied uniformly in the 2022 time-step and held constant throughout the model run, which extends for 100 years using **annual time steps**. For example, all pumping representing 2021 conditions was increased in the same model cells by 50%. There are 100 time-steps representing annual values.

1. Baseline Conditions

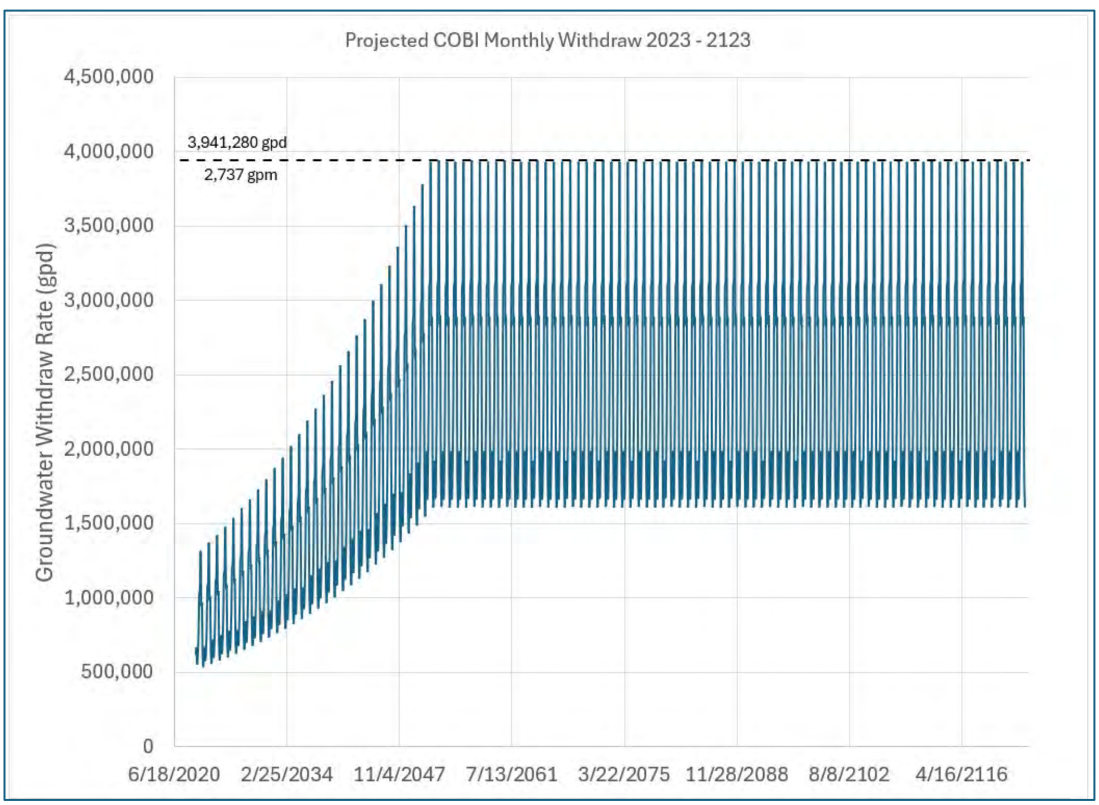
   This scenario will be performed to simulate baseline conditions. The purpose of this scenario is to calculate baseline conditions that can then be used to evaluate how various stresses impact groundwater conditions in the future. Output from the baseline scenario will be compared to output from subsequent scenarios. Thus, the net change to groundwater conditions resulting from specific stresses used in subsequent scenarios can be determined.

   The baseline scenario assumes **no change** in sea level, groundwater recharge, or pumping for the next 100 years. **Monthly time-steps** will be used, rather than annual values. Thus, there are 1,200 time-steps representing monthly values. This is useful for illustrating seasonal changes, as there are significant seasonal variations in recharge and groundwater withdrawals.

2. Planning Level Population Growth with Increased Withdrawals

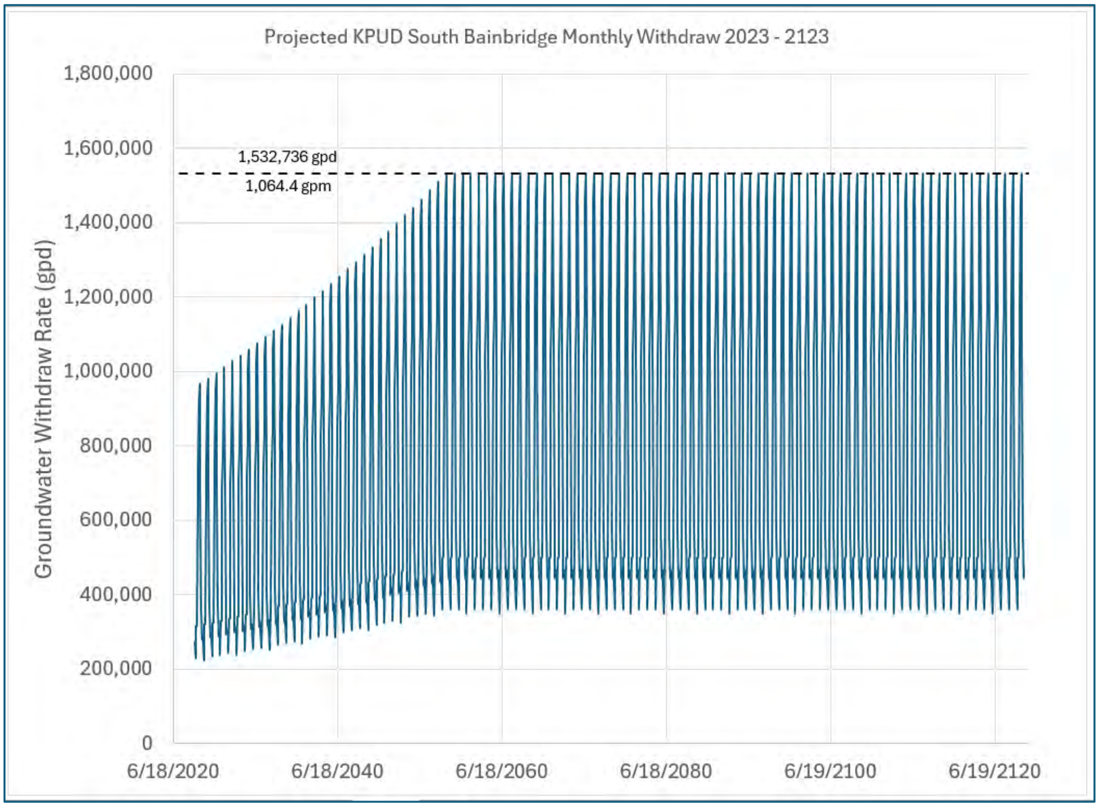
This scenario will be performed to simulate how baseline conditions are impacted from increased groundwater withdrawals over time. Population growth is represented in the model by increases in pumping over time. For this scenario, growth is assumed to occur in the three large Group A water systems until existing water rights are fully utilized. Water rights have both instantaneous and annual withdrawal limits. Because pumping is greater in the irrigation season (peaking in July), the limiting factor is when the pumping rate in July reaches the instantaneous withdrawal limit authorized by current water rights.

Growth within the City of Bainbridge Island's water service area is based on an assumed growth rate of 4.5% per year. When using this rate (assumed to be conservative), the City will fully utilize existing water rights in 2054. Increased withdrawals will be assigned to existing City wells that have additional pumping capacity (Sand Ave. and Fletcher Bay wells). This assumption does not factor in increased conservation measures, additional water rights, or other mitigation efforts such as reuse or managed aquifer recharge which could be used to expand growth beyond 2054. These issues could be incorporated into additional scenarios but will also be discussed and addressed in the Groundwater Management Plan.



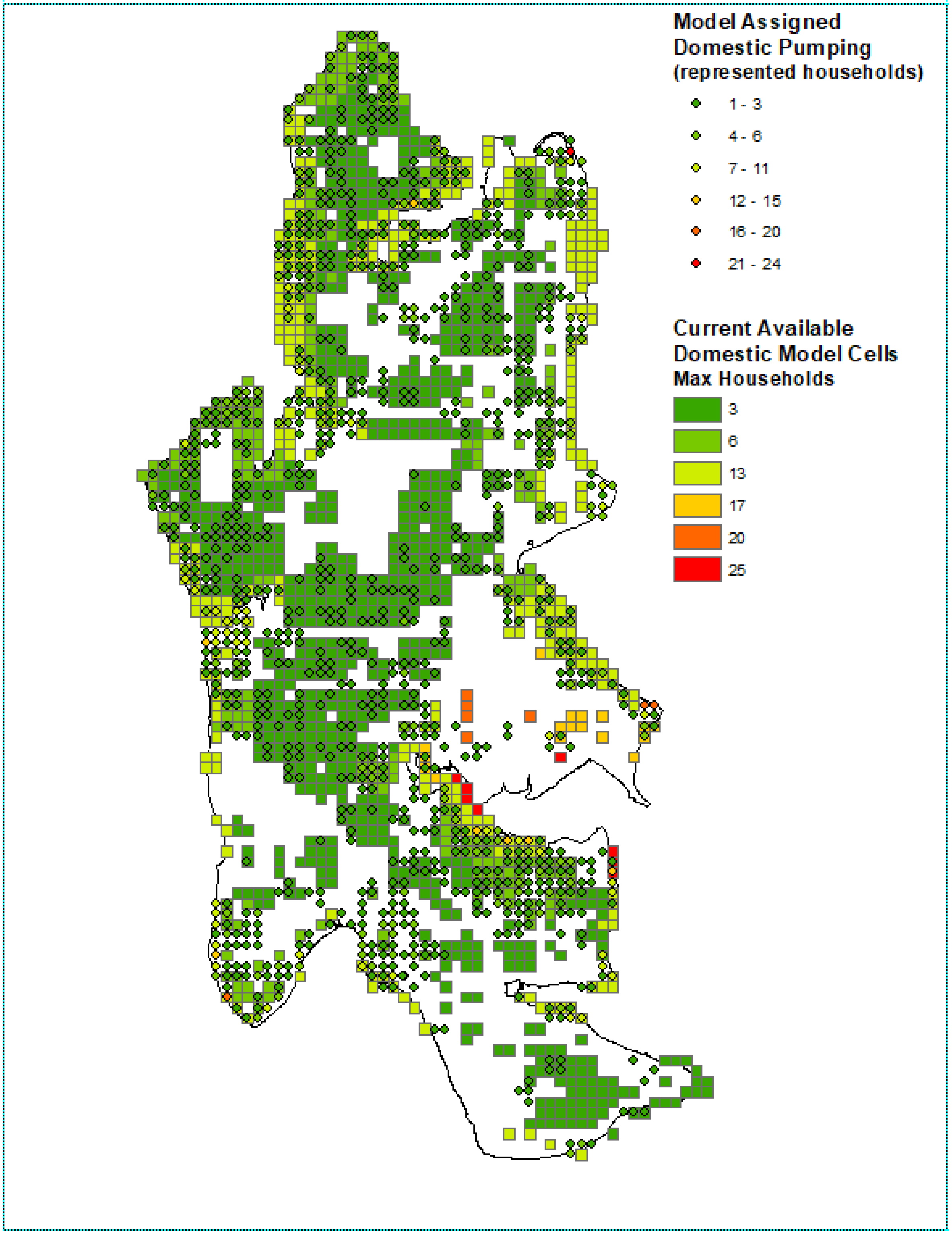
Projected increases in Pumping for the City of Bainbridge Island Water System

Future growth in the North and South Bainbridge water systems is based on historic pumping records over the past 6-10 years, indicating annual growth rates of 2.4% and 3.7%, respectively. Under these assumptions, the North Bainbridge Water System will reach its water rights capacity in 2065 and the South Bainbridge Water System will reach its water rights capacity in 2040. Increases in pumping will be distributed among existing wells.



Projected increases in Pumping for the South Bainbridge Island Water System

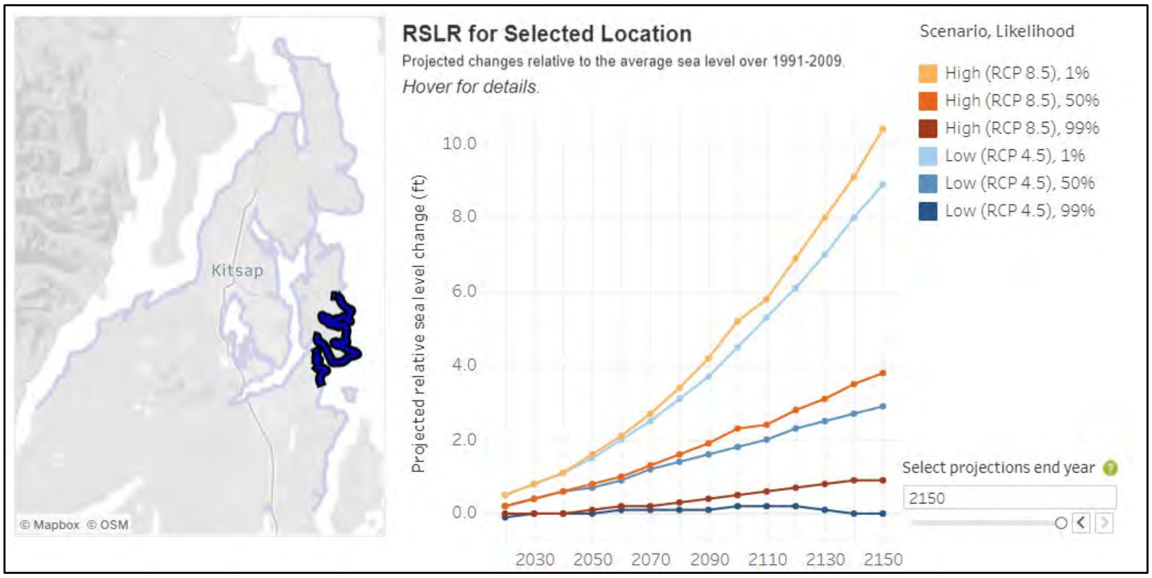
Withdrawal rates for **other small water systems on the island are assumed to remain constant**. Growth in **domestic supply served by permit-exempt wells** outside of water service areas is assumed to occur at a rate of 6 new homes per year (a 0.1% growth rate). Existing domestic wells are represented in the model and will remain going forward. Parcel and zoning data will be used to place new groundwater withdrawals, at a rate of 6 per year, across the island. Zoning, limiting the number of homes per acre, is assumed to remain constant. New withdrawals will be distributed across the island and assigned to model cells that overlap zoning capacity, up to the maximum density allowed by zoning.



Current Domestic Wells and Model Cells that have capacity for New Wells (based on zoning)

3. Median Sea Level Rise

This scenario will be performed to simulate how baseline conditions are impacted from the anticipated median sea level rise over time. The rise of sea level will be the only new stress applied to the baseline model. The rise in sea level will be based on the median value associated with the High Emissions Scenario (RCP 8.5) produced by the Climate Impacts Group at the University of Washington. Under this scenario sea level is predicted to rise 2.8 feet by the year 2021 (medium orange line in graph below).



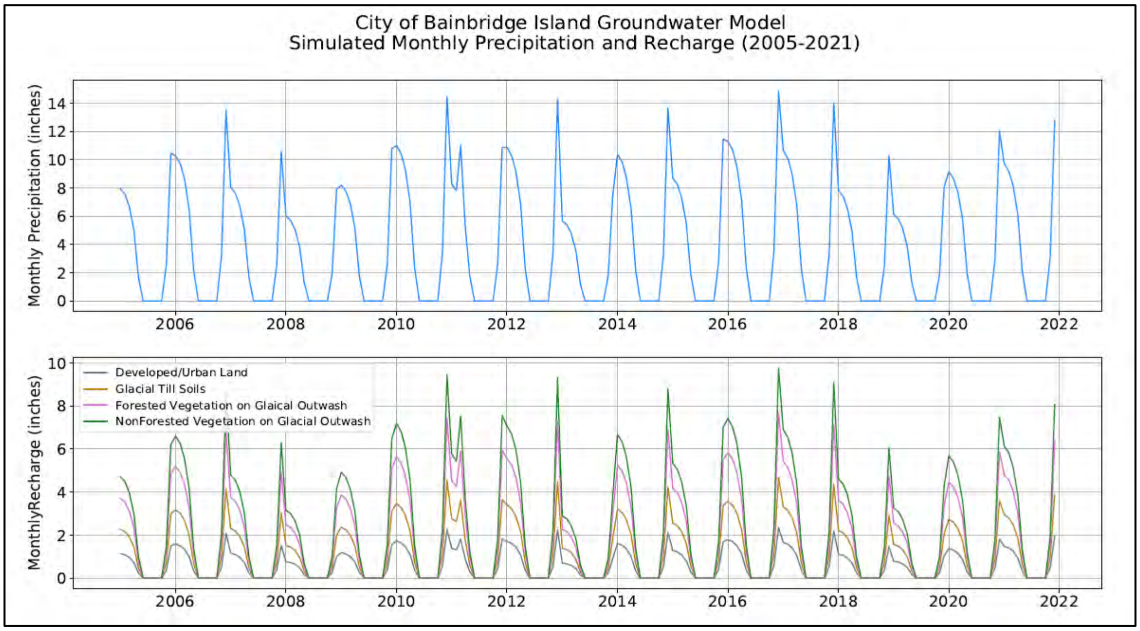
Projected Sea Level Rise near Bainbridge Island associated with various Emission Scenarios

4. Maximum Sea Level Rise

This scenario will be performed to simulate how baseline conditions are impacted from the anticipated maximum sea level rise over time. The rise of sea level will be the only new stress applied to the baseline model. The rise in sea level will be based on the maximum value associated with the High Emissions Scenario (RCP 8.5) produced by the Climate Impacts Group at the University of Washington. Under this scenario sea level is predicted to rise 6.9 feet by the year 2021 (light orange line in graph above).

5. Median Precipitation Change Resulting in Changes to Groundwater Recharge

Groundwater recharge has been estimated by the USGS for various surface geologic units for areas in Kitsap County (Bidlake and Payne, 2001). The study was used to develop predictive equations for annual groundwater recharge based on annual precipitation. This work has been used to estimate groundwater recharge for previous modeling efforts in Kitsap County by the USGS and Aspect. This relationship is shown in the graph below.



Relationship between Precipitation and Recharge to Various Surface Geologic Units

The Climate Impacts group has modeled precipitation changes in Western Washington associated with various emissions scenarios. Using the High Emissions Scenario (RCP 8.5) in 100 years, the median predicted change in precipitation is an increase of 2.4 inches between October and May and a decrease of 0.3 inches between April and September.

This scenario will use the average of the previous 10 years of model applied recharge before applying changes to groundwater recharge based on these predicted changes in precipitation. No changes to the spatial distribution of recharge will occur (same recharge to precipitation factor used in current model). Changes will be gradually applied to the model based on the table below. This scenario will be performed to simulate how baseline conditions are impacted from the anticipated median changes to precipitation over time (the blue arrow in the table below).

Oct.-Mar. Precipitation

Total precipitation from October to March.

Emissions	Time	Value	Change
Historical	1990	34.3 in	
Low	2010-2039	35.5+/-1.2 in	+1.1 in
Low	2040-2069	36.8+/-1.5 in	+2.5 in
Low	2070-2099	37.4+/-1.5 in	+3.1 in
High	2010-2039	35.4+/-1.4 in	+1.0 in
High	2040-2069	36.8+/-1.7 in	+2.4 in
High	2070-2099	38.9+/-1.8 in	+4.6 in

Data Source: MACAv2-METDATA

Apr.-Sept. Precipitation

Total precipitation from April to September.

Emissions	Time	Value	Change
Historical	1990	10.1 in	
Low	2010-2039	10.0+/-0.8 in	-0.1 in
Low	2040-2069	9.8+/-0.8 in	-0.3 in
Low	2070-2099	9.6+/-0.8 in	-0.5 in
High	2010-2039	9.9+/-0.5 in	-0.2 in
High	2040-2069	9.8+/-0.8 in	-0.3 in
High	2070-2099	9.5+/-0.7 in	-0.6 in

Data Source: MACAv2-METDATA

Predicted Changes in Precipitation associated with the High Emissions Scenario (RCP 8.5)

It is recognized that the relationship between monthly precipitation and recharge presented in the graph above may not represent conditions during short, high-intensity precipitation events. These short-duration events cannot be simulated by monthly time-steps used by the groundwater model. Likewise, it is recognized that changes in land cover associated with land use changes and development impact groundwater recharge by increasing runoff and changing evapotranspiration. These factors are also not factored into this simulation. In general, most changes affecting recharge are smaller than the 500' x 500' size of the model cells. In addition, increased runoff may be captured by stormwater facilities and recharged in other areas following development. Although land-use changes that impact recharge may be incorporated into future modeling scenarios, this issue will be addressed in the Groundwater Management Plan.

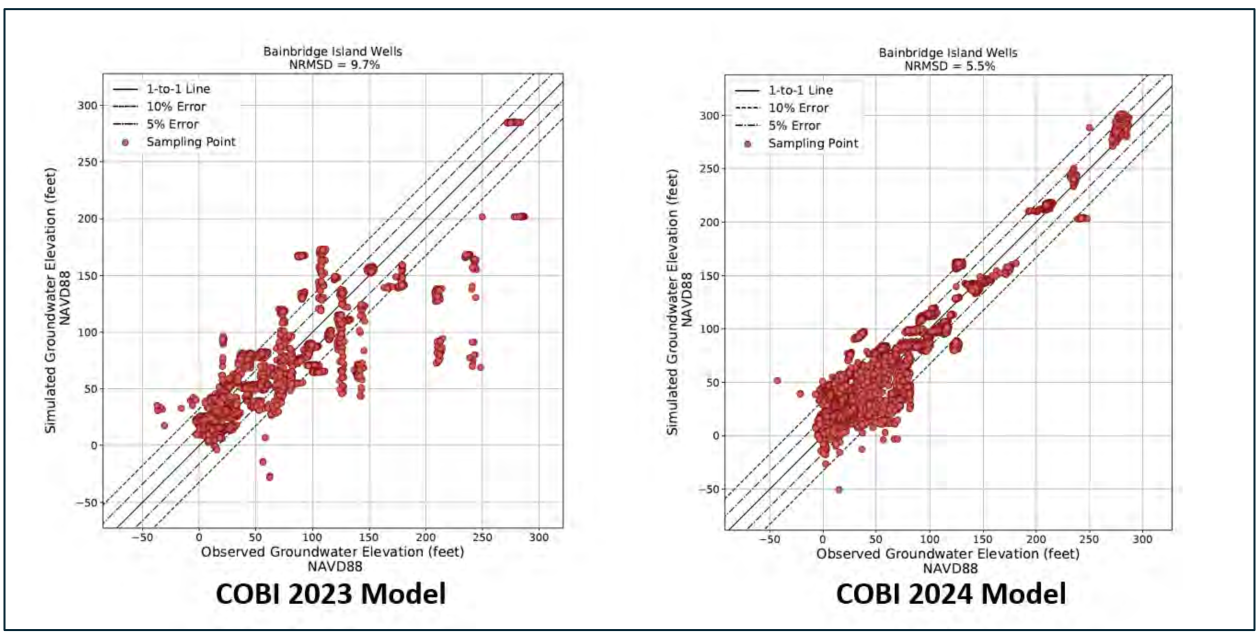
6. <u>Maximum Precipitation Change Resulting in Changes to Groundwater Recharge</u>

   This scenario will be performed to simulate how baseline conditions are impacted from the anticipated maximum changes to precipitation over time. It is essentially the same as Scenario 5 but will apply the larger predicted change in precipitation associated with the High Emissions Scenario RCP 8.5 (the red arrow in the table above).

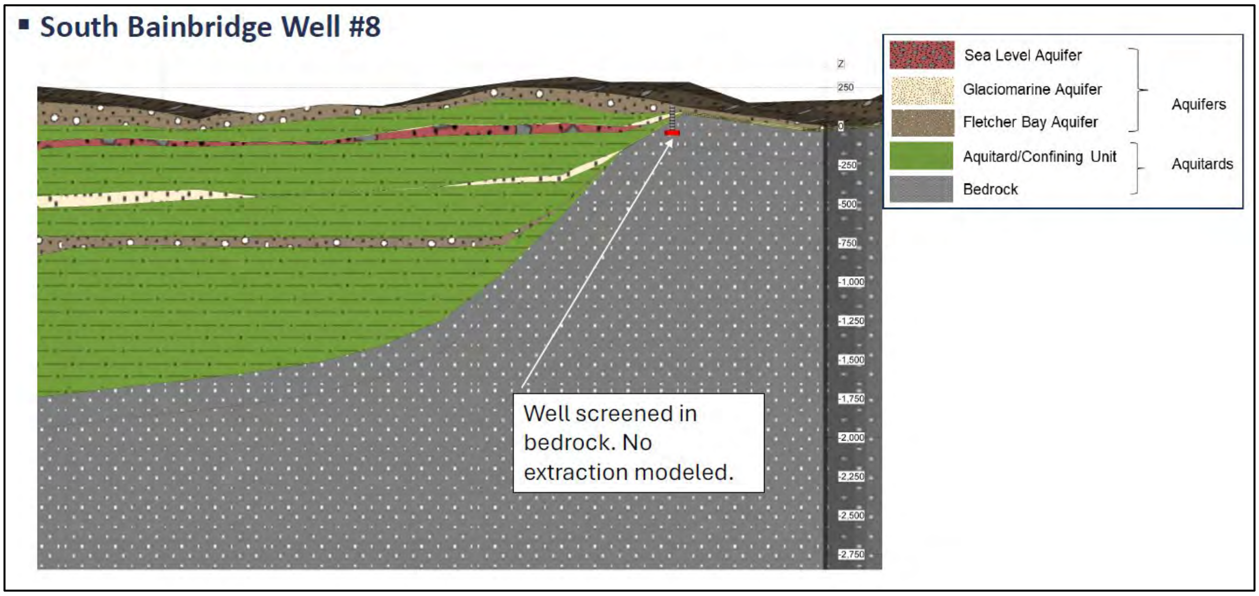
7. <u>Median Projections with all Three Stresses</u>

   This scenario uses the baseline conditions scenario with increases in groundwater pumping (Scenario 2), median sea level rise (Scenario 3) and median precipitation changes (Scenario 5). The purpose of this scenario is to calculate how all the stress changes ramping up over time impact baseline conditions.

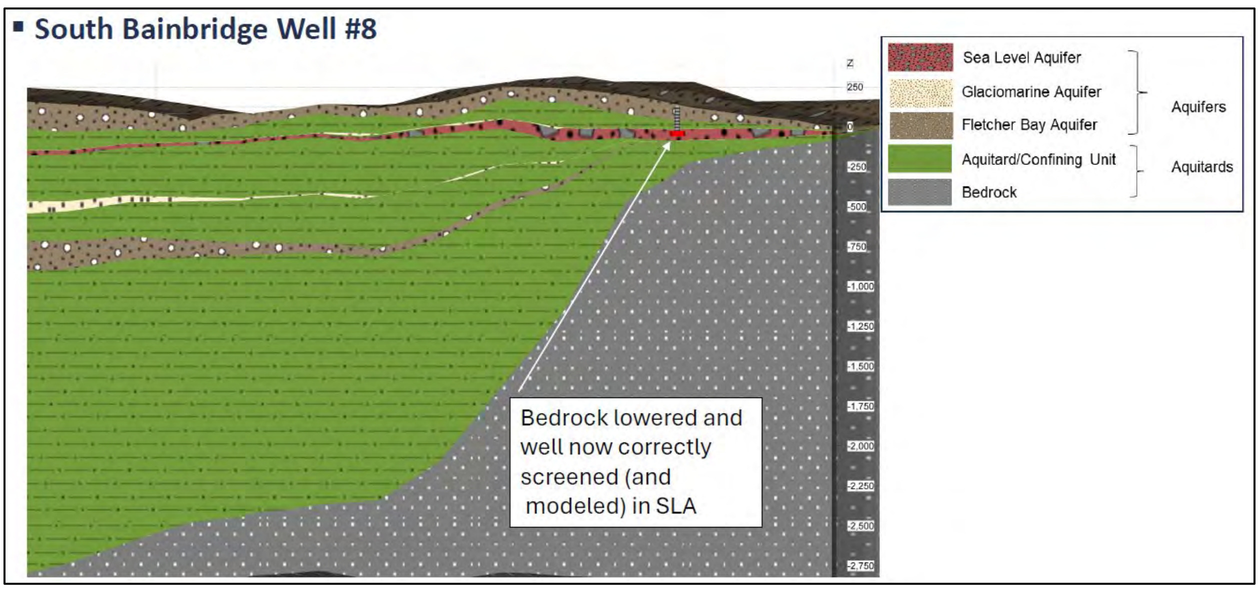
Figures that Show how the Calibration has Increased Reliability/Accuracy



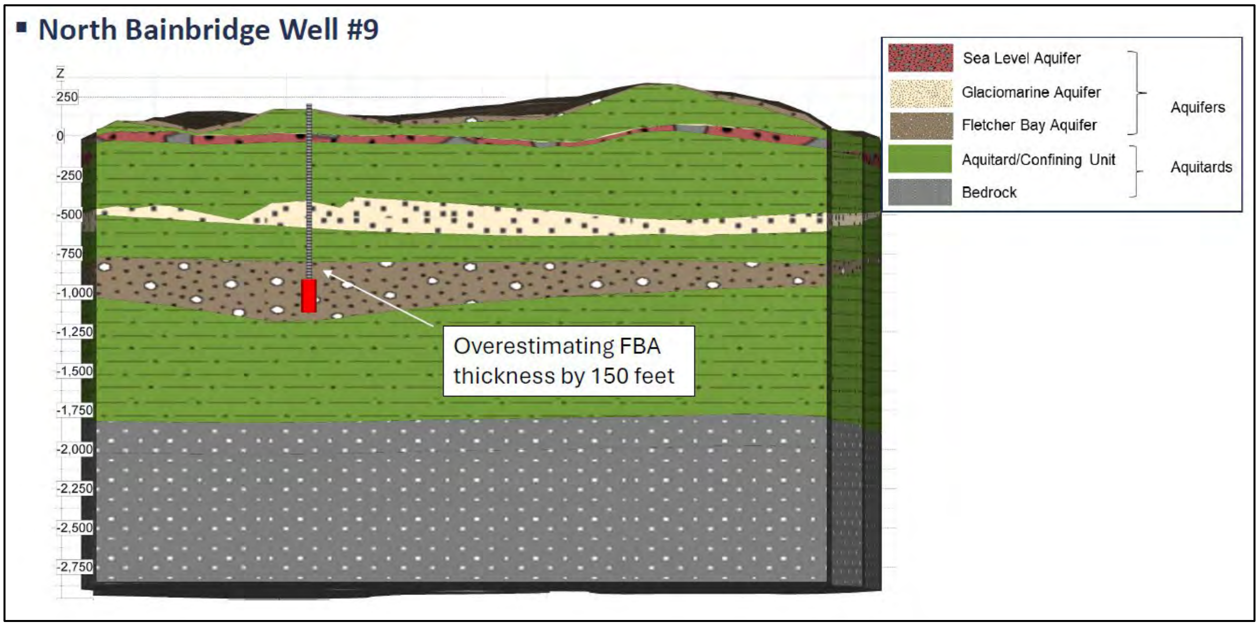
Comparison of Simulated vs. Observed Groundwater Elevations between the 2023 and 2024 Models



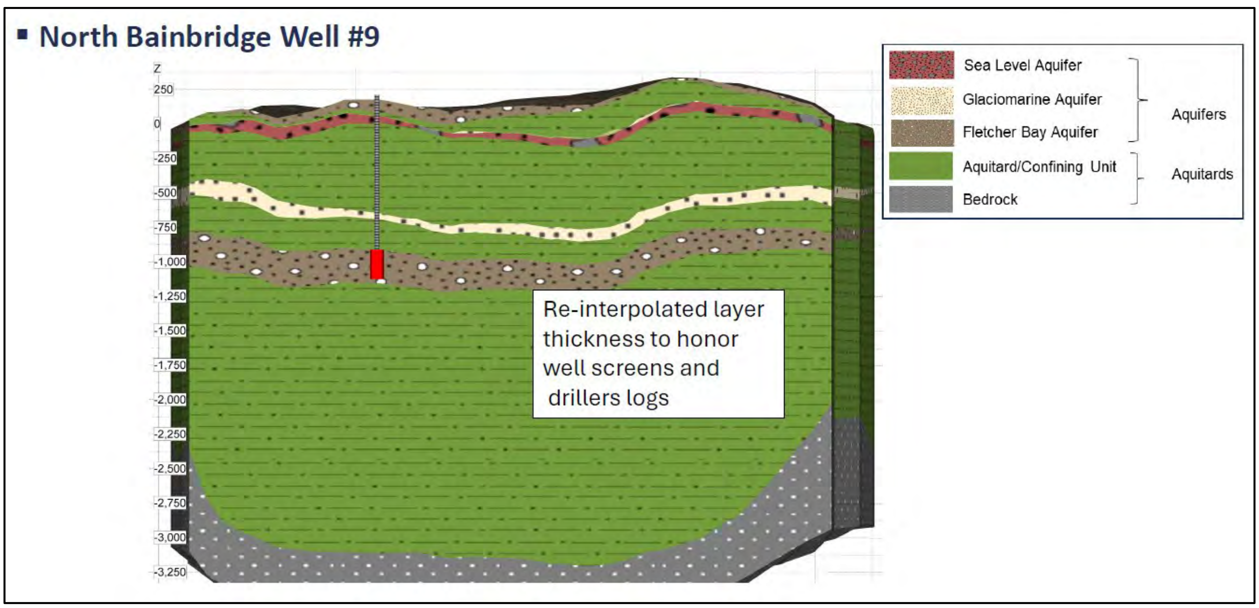
COBI 2023 Model



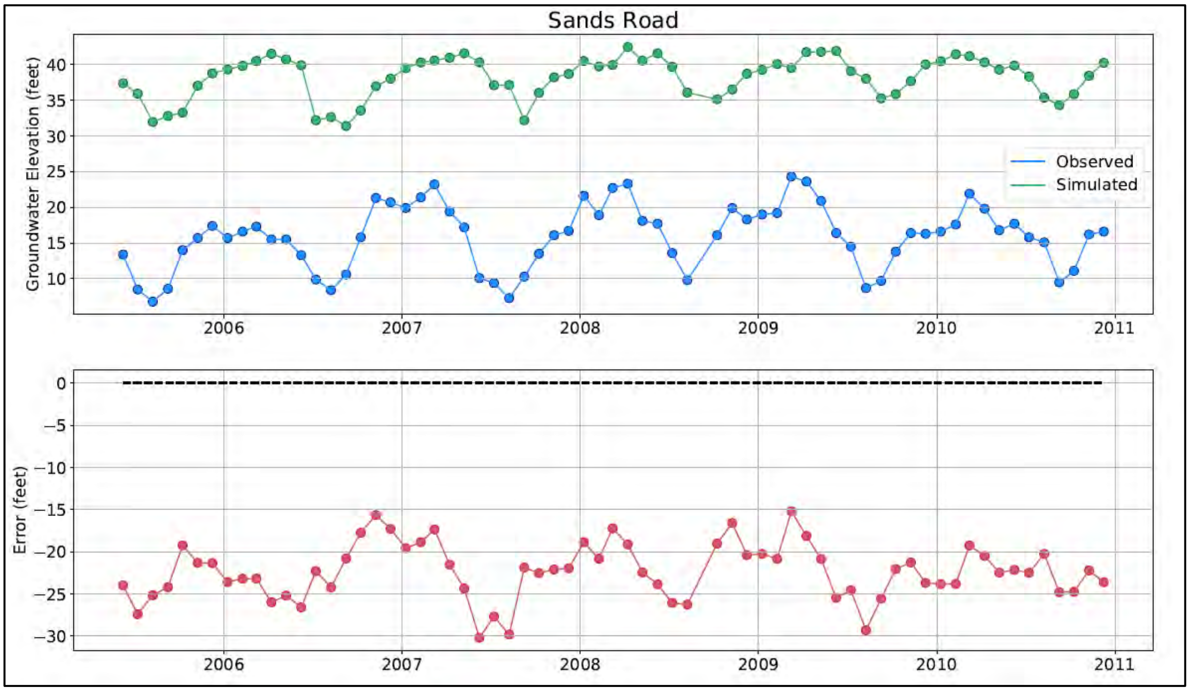
COBI 2024 Model – Adjustment of Well Location



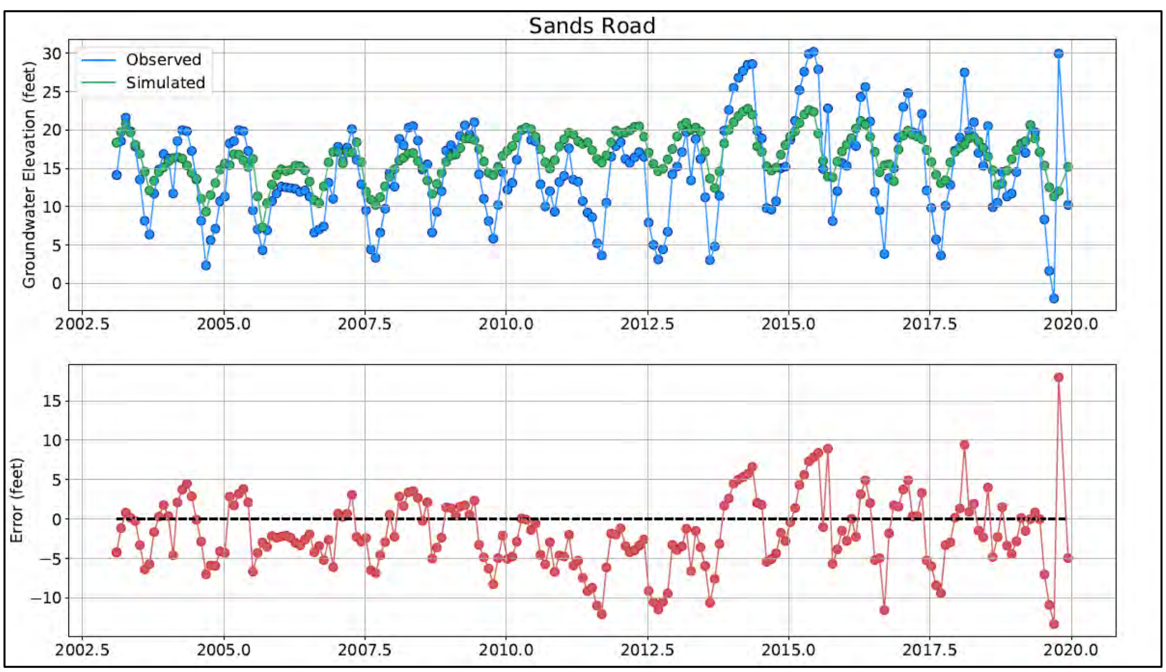
COBI 2023 Model



COBI 2024 Model – Adjustment of Aquifer Thickness

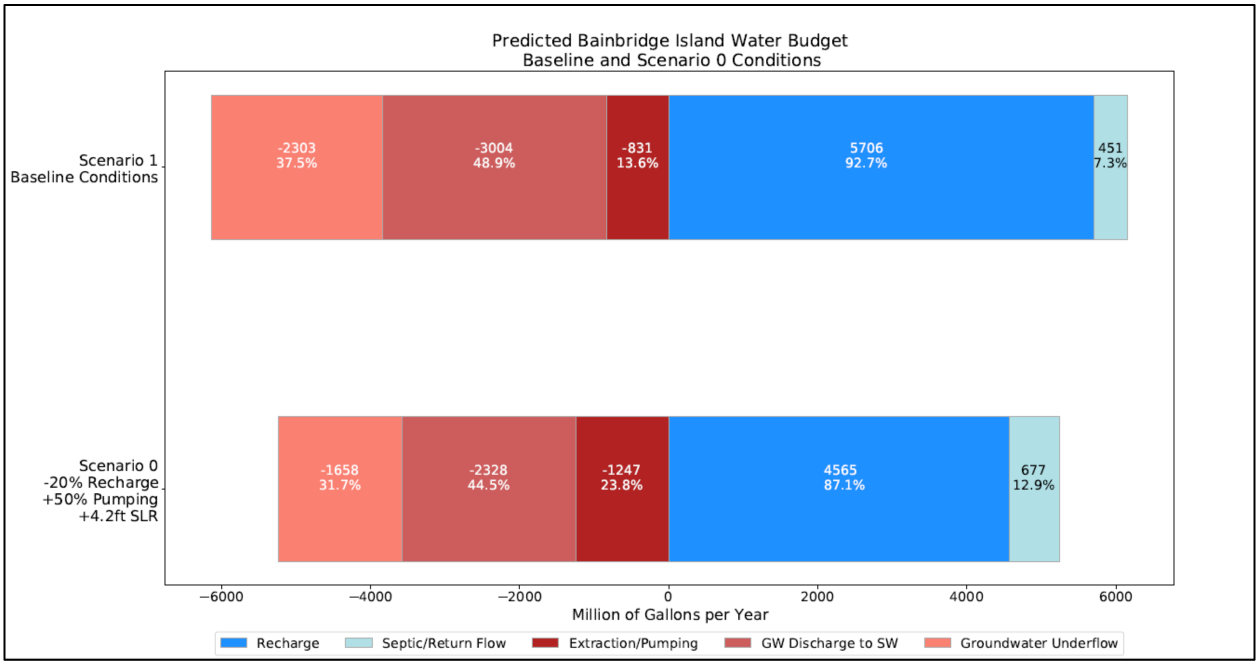


COBI 2023 Model - Sands Road Well Simulation vs. Observed Water Elevations in 2023 Model

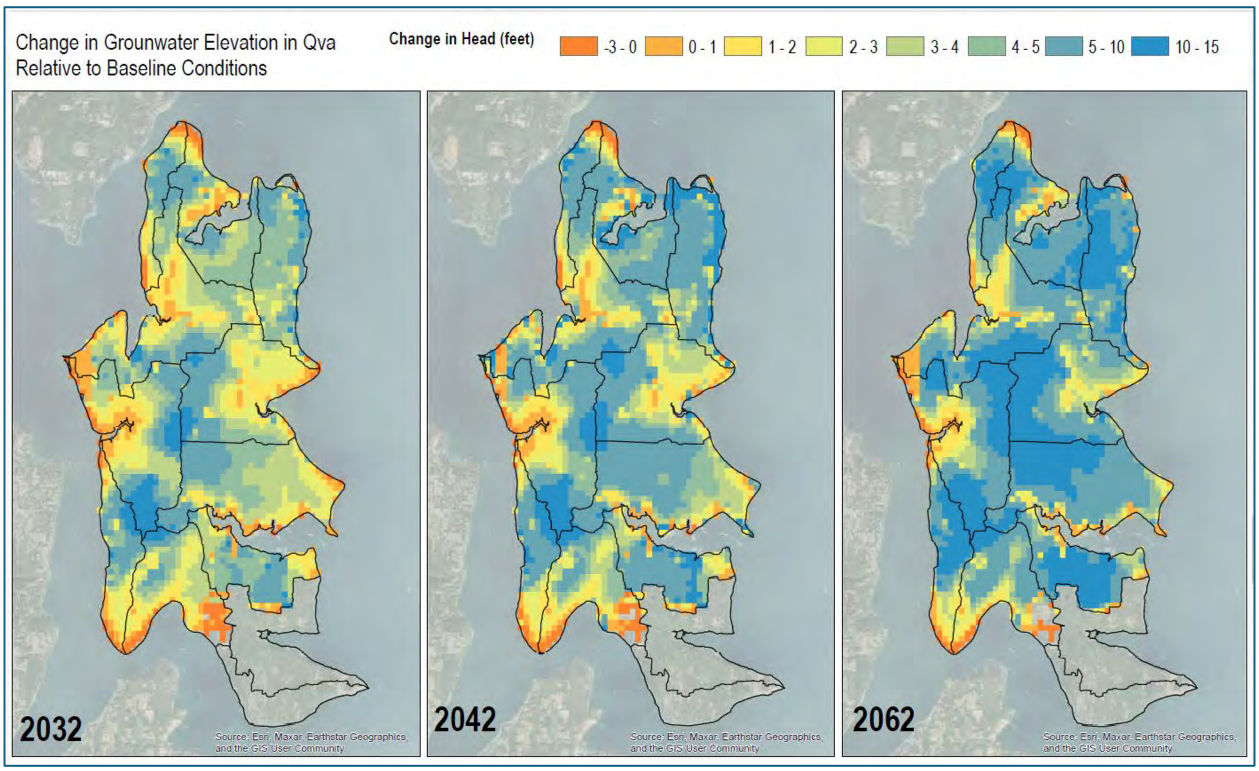


COBI 2024 Model - Sands Road Well Simulation vs. Observed Water Elevations in Recalibrated Model

Results from Model Run Scenario 0, Along with a Simple Storyline that Explains the Results



Comparison of Water Budget between Scenario 0 and Scenario 1



Change in Groundwater Elevation in the Vashon Advance Aquifer between Scenario 0 and Scenario 1

Discussion

EA is using two metrics to evaluate the model runs: **groundwater levels** and **water budgets and fluxes**. Groundwater levels are assessed using the following:

- Changes in groundwater levels for the aquifer units under the island over time, evaluated in both space and time, relative to Early Warning Levels (EWLs).

Water budgets are assessed by:

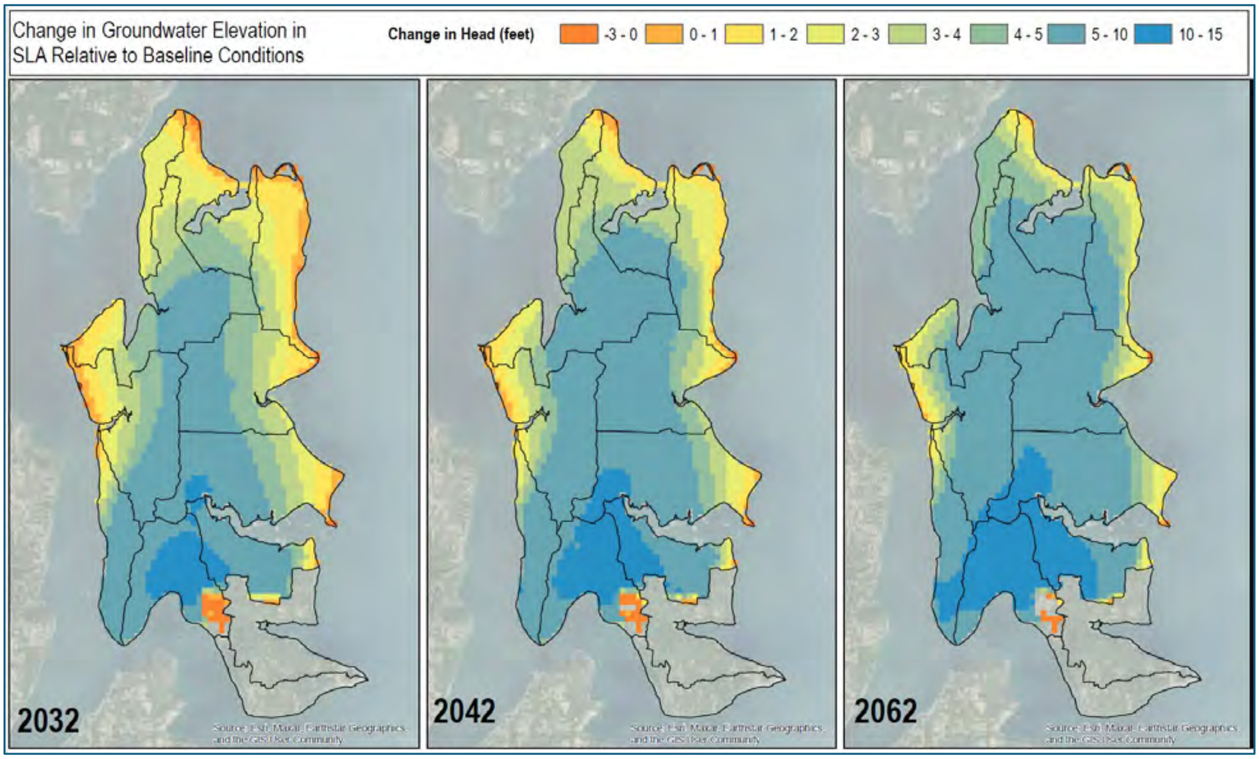
- Quantifying changes to fresh groundwater flux to saltwater Puget Sound.
- Quantifying changes to groundwater discharge to surface water on the Island.
- Reviewing overall water budget moving through the Island.

The second figure on Page 11 shows changes in simulation years 2032, 2042, and 2062 in the Qva (Vashon Advance Aquifer). After 2062, groundwater levels stabilize, reach a new steady state, and so groundwater elevation changes in 2062 are the same as the groundwater elevation changes in 2121 (the final simulation year).

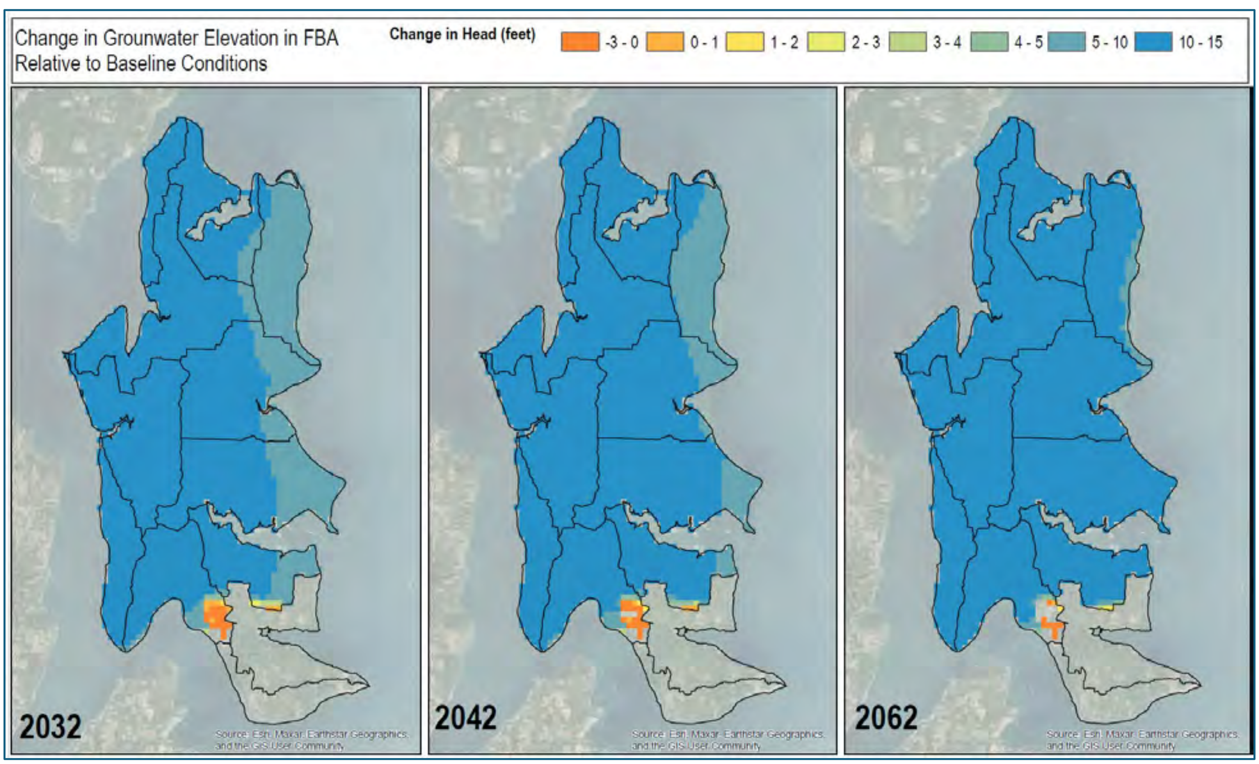
One takeaway is that in the Qva, the greatest groundwater declines are in the center of the island. This is because near the shoreline, groundwater levels are maintained at current levels (or even rise) due to the 4.2 increase in sea level rise. Groundwater levels decline inland due to increases in pumping.

A second takeaway relates to the Early Warning Levels (EWLs) defined by Aspect which state that a 0.5 decrease in groundwater levels per year for 10 years violates the EWLs. In the context of the second figure on Page 11, this means that in 2032, any groundwater level decline greater than 5 feet violates the EWL. In 2043, any groundwater level decline greater than 10 feet violates the EWL. In 2062, any groundwater level decline greater than 20 feet violates the EWL (this does not occur). All of this is to say, in 2032 and within the Qva, nearly half of the island is in violation of the EWL under Scenario 0 conditions (the two darkest blue regions on the map). By 2042 a smaller area of the island is exceeding the EWLs (the darkest blue regions). The same interpretations can be made for the SLA (Sea Level Aquifer) and FBA Fletcher Bay Aquifer maps on Page 13.

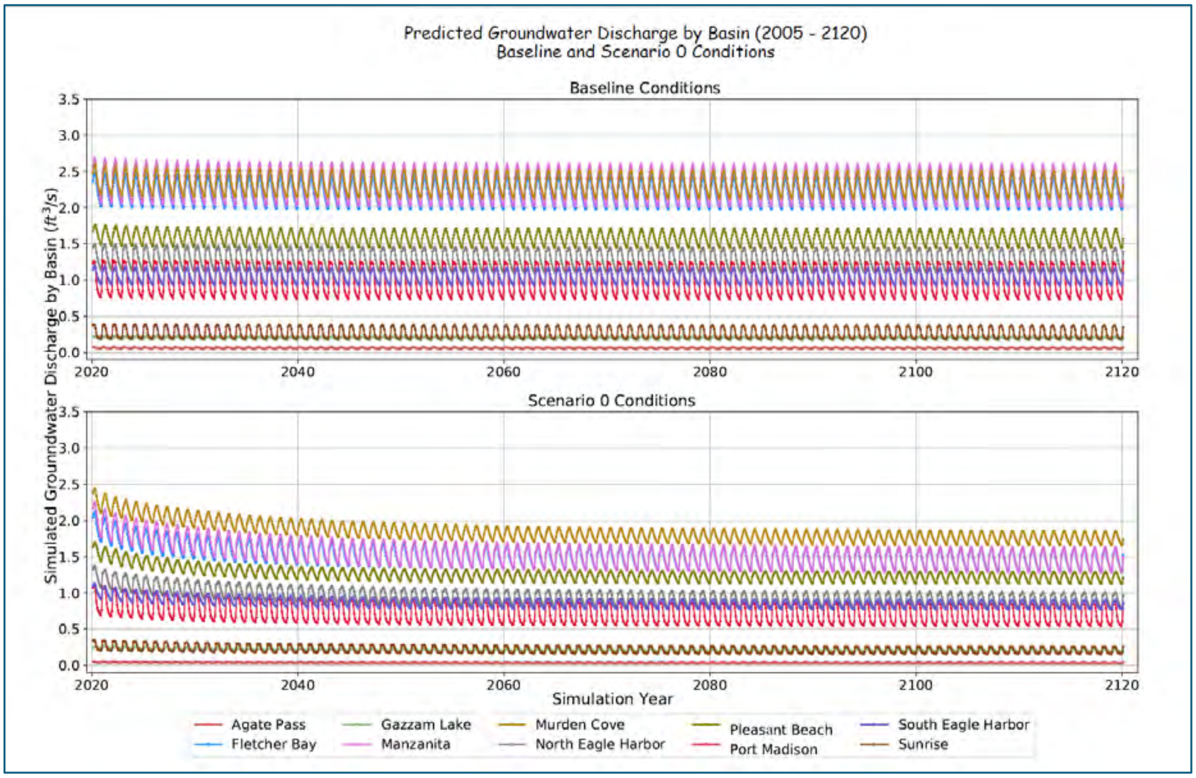
As seen in the top figure on Page 11 and the two figures on Page 14, simulated groundwater discharge to surface water (a proxy for streamflow) decreases from approximately 3,000 million gallons of water per year to 2,300 million gallons of water per year under Scenario 0 conditions (a 23% decrease). The figure on Page 15 shows spatial changes to water discharge to both surface water and water to Puget Sound. Net groundwater discharge (*within the model domain*) to Puget Sound from 11,000 million gallons of water per year to 9,000 million gallons of water per year, representing a 22% decrease. This is suggestive of a freshwater-seawater interface moving closer inland.



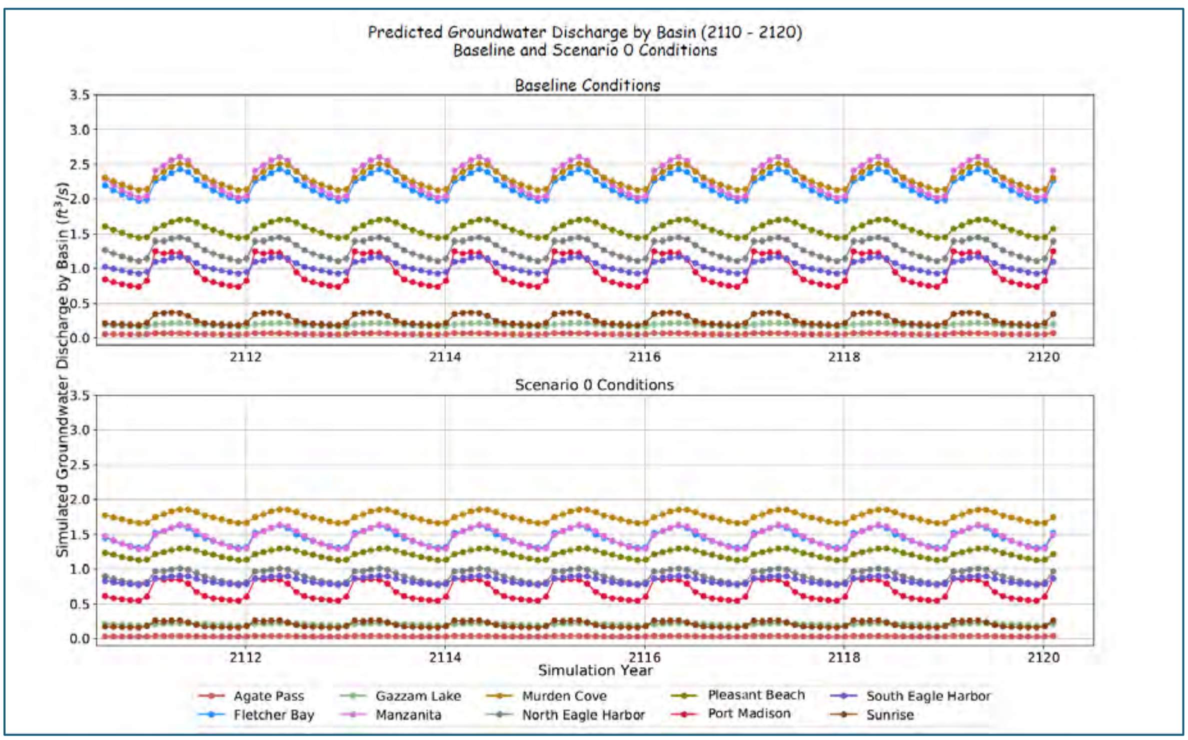
Change in Groundwater Elevation in Sea Level Aquifer between Scenario 0 and Scenario 1



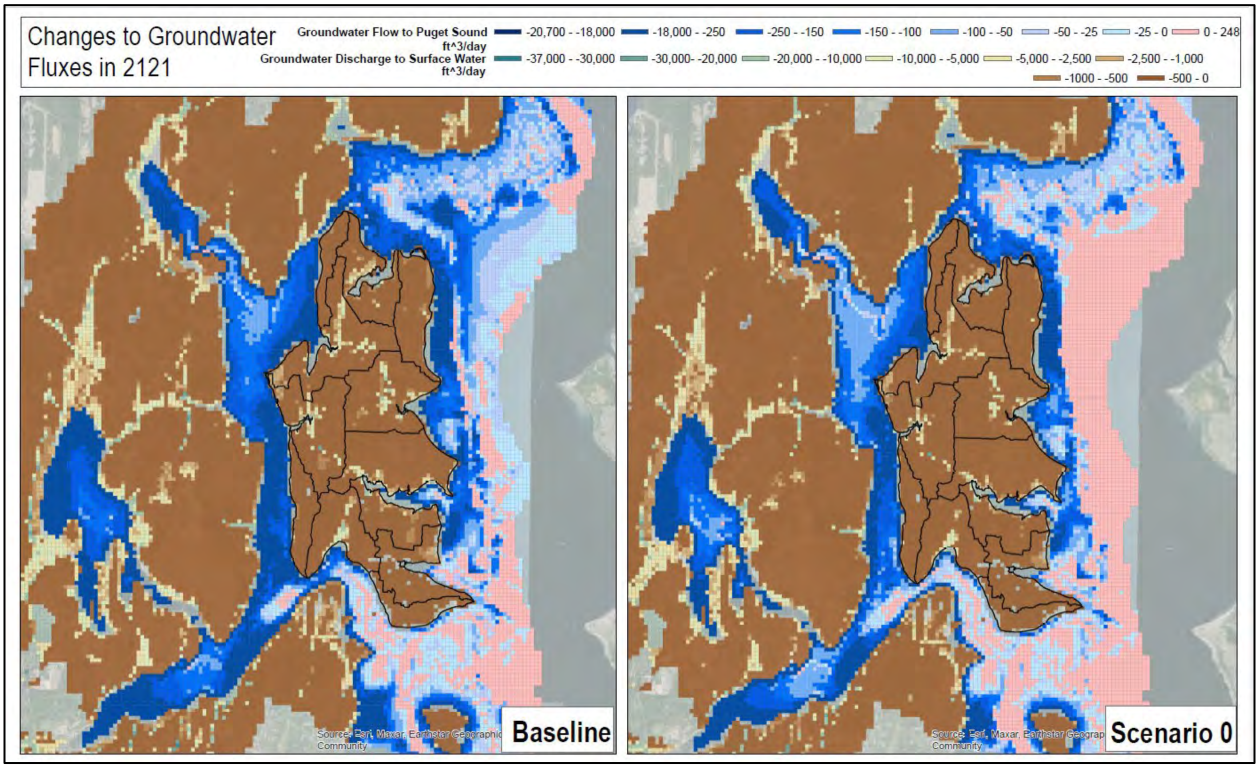
Change in Groundwater Elevation in Fletcher Bay Aquifer between Scenario 0 and Scenario 1



Comparison of Baseflow Discharge between Scenario 0 and Scenario 1 2005-2120



Comparison of Baseflow Discharge between Scenario 0 and Scenario 1 2110-2120



Comparison of Groundwater Discharge to Marine Waters between Scenario 0 and Scenario 1 in 2121

Conclusions

The conclusions of this section are:

1. Early Warning Levels (as define by Aspect) are violated in large areas of the island in the first 20 years of the conditions simulated in Scenario 0 but cease to remain a problem after this time as the groundwater system in the island begins to reach a new steady state.
2. Groundwater discharge to surface water on the island decreases by roughly 23% due to Scenario 0 conditions.
3. Groundwater discharge to the Sound decreases by approximately 22%.
4. The physical conditions of Scenario 0 are not necessarily representative of expected actual physical conditions going forward. For example, most climate models predict rainfall (and recharge) will increase over the next 100 years (this simulation assumed a 20% decrease).

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TO: Christopher Wierzbicki, P.E., Director of Public Works, City of Bainbridge Island

FROM: Dave Nazy, LHG, CWRE, EA Engineering, Science and Technology, Inc., PBC

SUBJECT: Comparing Aspect's 2023 Model Run with EA's Scenario 0 Model Run

DATE: February 13, 2024

This memo provides information regarding EA's modeling efforts compared to Aspect's *COBI 2023 Model* results. Specifically, this memo discusses the results of EA's revised and recalibrated model (*COBI 2024 Model*) run for Scenario 0 with the results provided by Aspect in their Draft Memorandum to you, dated March 17, 2023. Both modeling scenarios used historical groundwater conditions previously calculated by Aspect for the end of 2021 as initial conditions.

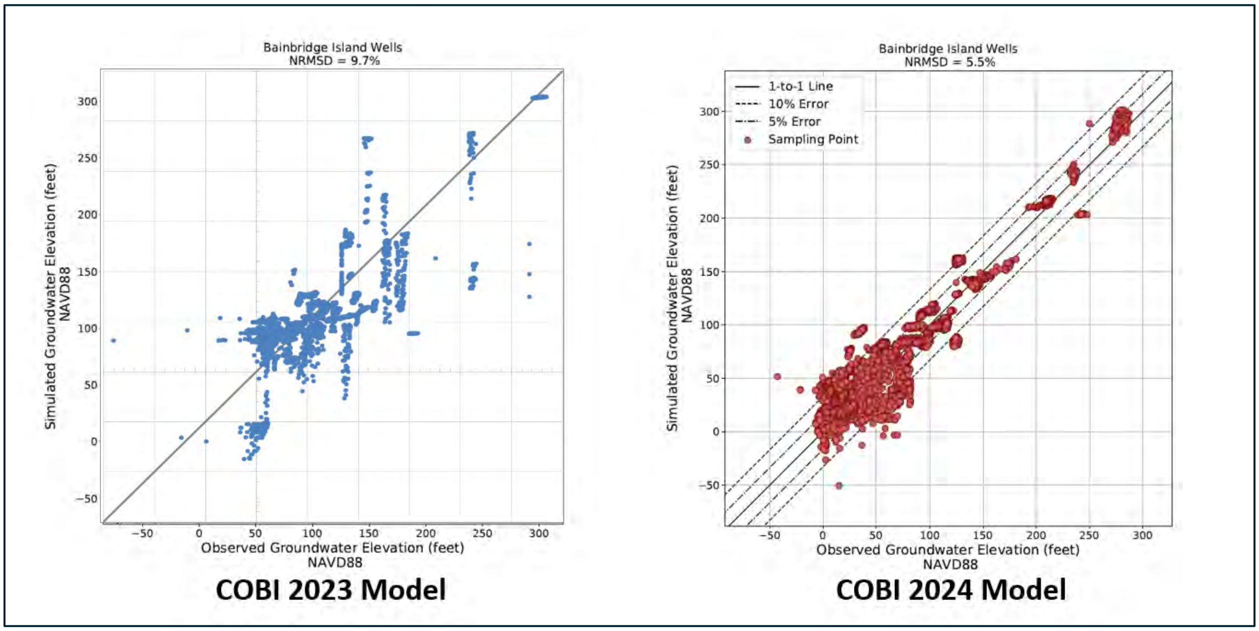
This scenario uses a **4-foot increase in sea level**, a **20% decrease in groundwater recharge** and a **50% increase in pumping** relative to 2021 conditions. All three stresses were applied uniformly in the 2022 time-step and held constant throughout the model run, which extends for 100 years using **annual time steps**. For example, all pumping representing 2021 conditions was increased in the same model cells by 50%. There are 100 time-steps representing annual values.

This comparison is limited by the information presented in Aspect's March 17, 2023. EA has not re-run this scenario using the *COBI 2023 Model* but has generated figures that provide more detail of the results using the *COBI 2024 Model*.

COBI 2023 Model vs. *COBI 2024 Model* Calibration Comparison

As noted in our memo to you dated February 12, 2024, EA made several revisions to the *COBI 2023 Model*. These revisions re-assigned wells to the correct model layer, corrected model layer thicknesses to better represent observed conditions. The revisions were used to recalibrate the model and obtain a better match between simulated and observed groundwater elevations as shown in the figure below.

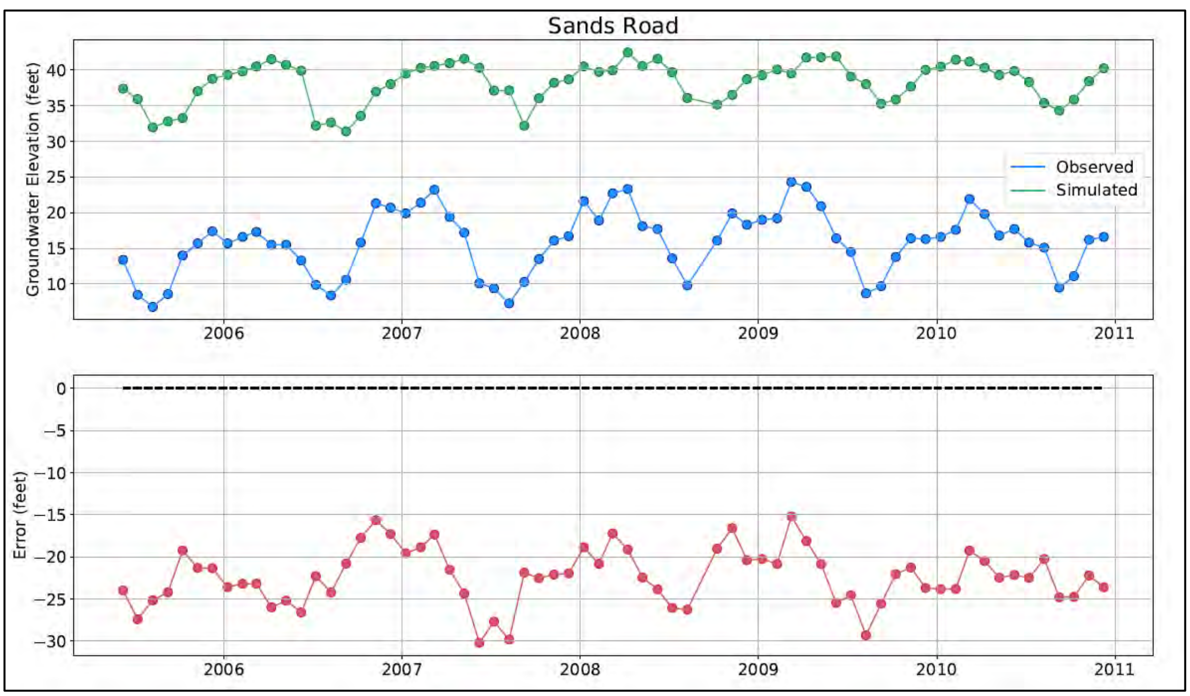
The graph on the left represents the simulated vs. observed water levels as reported by Aspect using the *COBI 2023 Model*. The graph on the right represents output from EA's revised and recalibrated *COBI 2024 Model* comparing simulated vs. observed groundwater elevations. Both calibration graphs represent baseline conditions, prior to applying the stresses used by both Aspect and EA in Scenario 0. Although Aspect's calibration is relatively good (10% error in overall model performance is generally considered good), EA's revisions have improved the model's ability to match observed conditions by 4.2%. Please note, this is overall model performance and does not imply that the model will be within 4.2% of actual conditions at any specific location in the model domain.



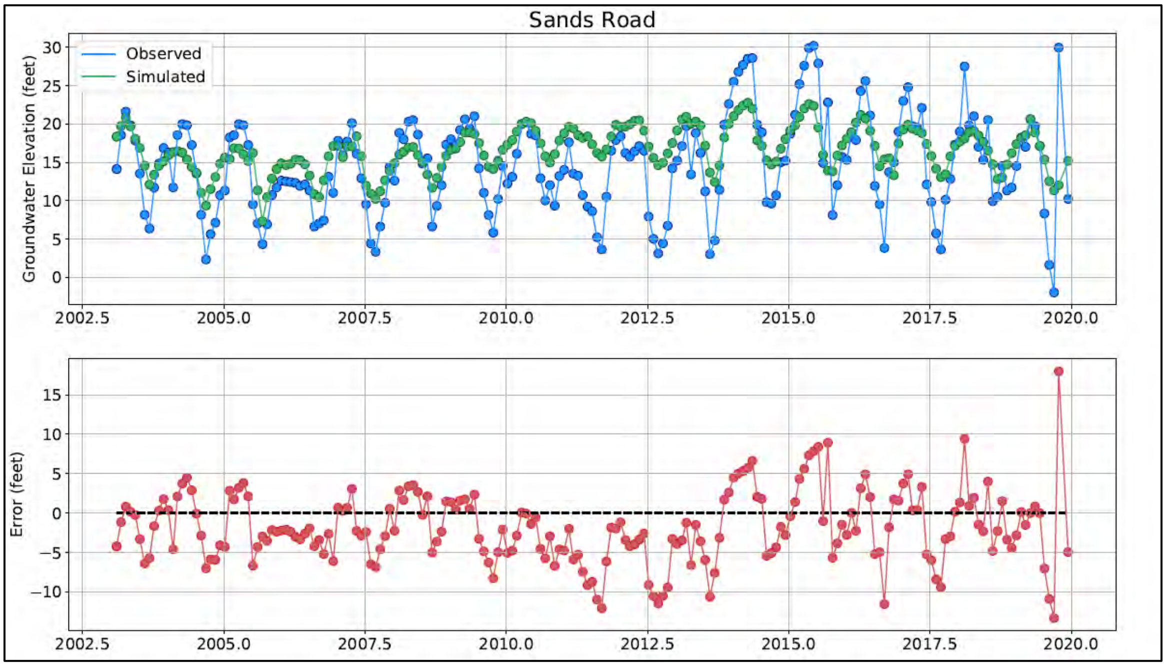
Comparison of Simulated vs. Observed Groundwater Elevations between the 2023 and 2024 Models

COBI 2023 Model vs. *COBI 2024* Groundwater Level Comparison in the Sands Road Well

The figures below illustrate simulated vs. observed groundwater levels in the Sands Road well between 2005 and 2011 for baseline conditions in both the *COBI 2023 Model* and the *COBI 2024 Model*. These figures illustrate how calibration has been improved in the *COBI 2024 Model* for this location in the model. As shown, the COBI 2023 Model consistently predicted lower groundwater levels than have been observed while the COBI 2024 Model more closely simulates observed conditions.



COBI 2023 Model - Sands Road Well Simulation vs. Observed Water Elevations in 2023 Model



COBI 2024 Model - Sands Road Well Simulation vs. Observed Water Elevations in Recalibrated Model

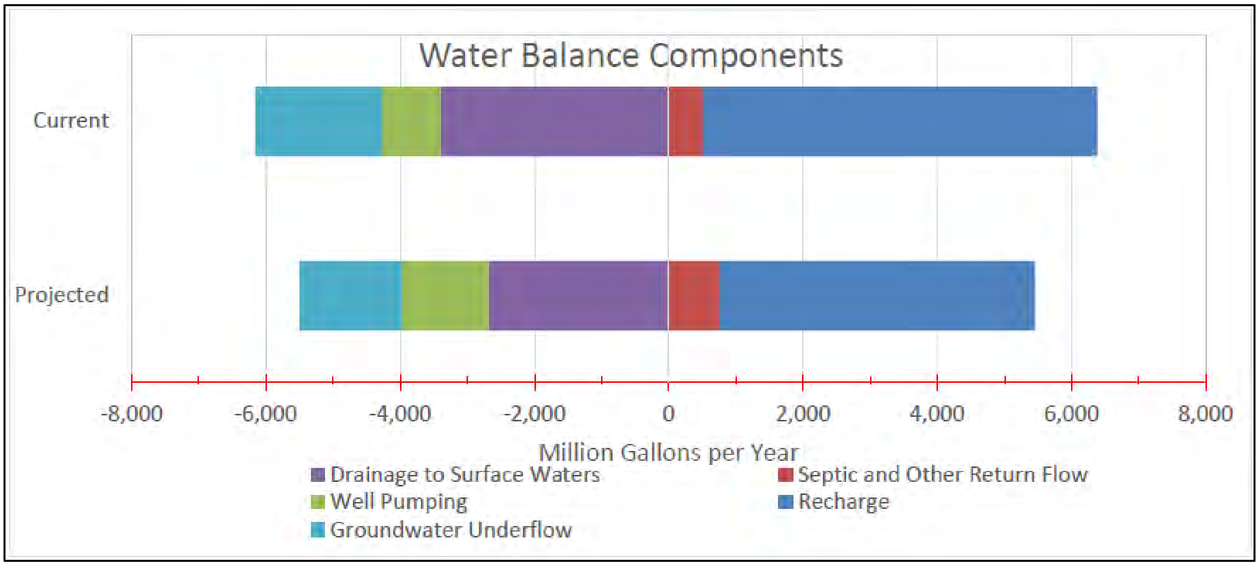
COBI 2023 Model vs. *COBI 2024 Model* Overall Water Balance Comparison

Aspect provided the overall water balance for baseline vs. the future conditions assuming the three model stresses (50% increase in pumping, 20% decrease in recharge, 4 ft rise in sea level) noted above. This comparison mimics the water budget EA prepared comparing Scenario 1 (baseline conditions to Scenario 0 (50% increase in pumping, 20% decrease in recharge, 4 ft rise in sea level). These results are provided in the table below.

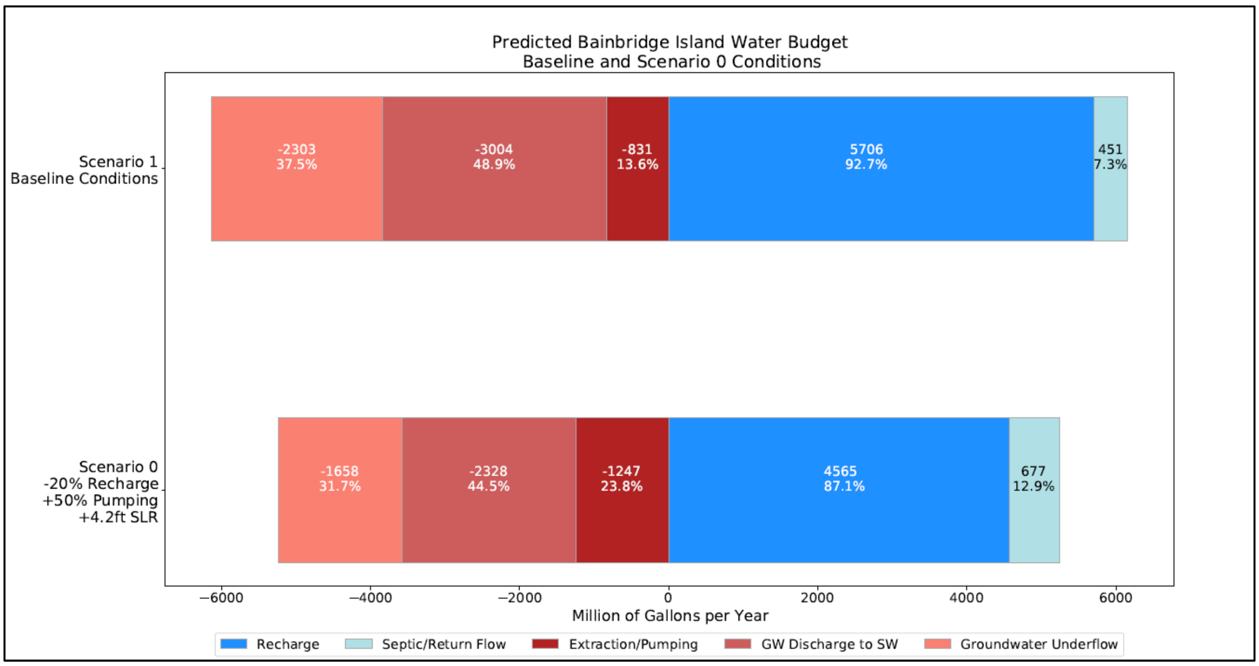
Water Balance Component (Millions of Gallons/Year)	Baseline Conditions			Projected (3 Stresses Applied)		
	2023 Model	2024 Model	Percent Difference	2023 Model	2024 Model	Percent Difference
Recharge	5,875	5,706	-2.88%	4,700	4,565	-2.87%
Septic and other Return Flow	506	451	-10.87%	759	671	-11.59%
Well Pumping	-873	-831	-4.81%	-1,297	-1,247	-3.86%
Drainage to Surface Water	-3,401	-3,004	-11.67%	-2,681	-2,328	-13.17%
Groundwater Underflow	-1,876	-2,303	22.76%	-1,519	-1,658	9.15%

The differences in inputs between Aspect's *COBI 2023 Model* and *EA's COBI 2024 Model* are attributed to revisions to the model that include more representative stratigraphy, more accurate pumping rates and drawdowns at pumping wells, automatic flow reduction turned off, etc.

As shown in the figures below, the overall water budget provided by Aspect for baseline and projected conditions is very similar to the corresponding water budgets calculated by EA. This illustrates that the inputs (initial conditions and stresses) and outputs of the two versions of the model are very similar, although as noted above, the *COBI 2024 Model* significantly improves simulation of observed conditions.



***COBI 2023 Model* Comparison of Water Budget between Baseline and Projected Conditions (Millions of Gallons)**



***COBI 2024 Model* Comparison of Water Budget between Scenario 0 and Scenario 1**

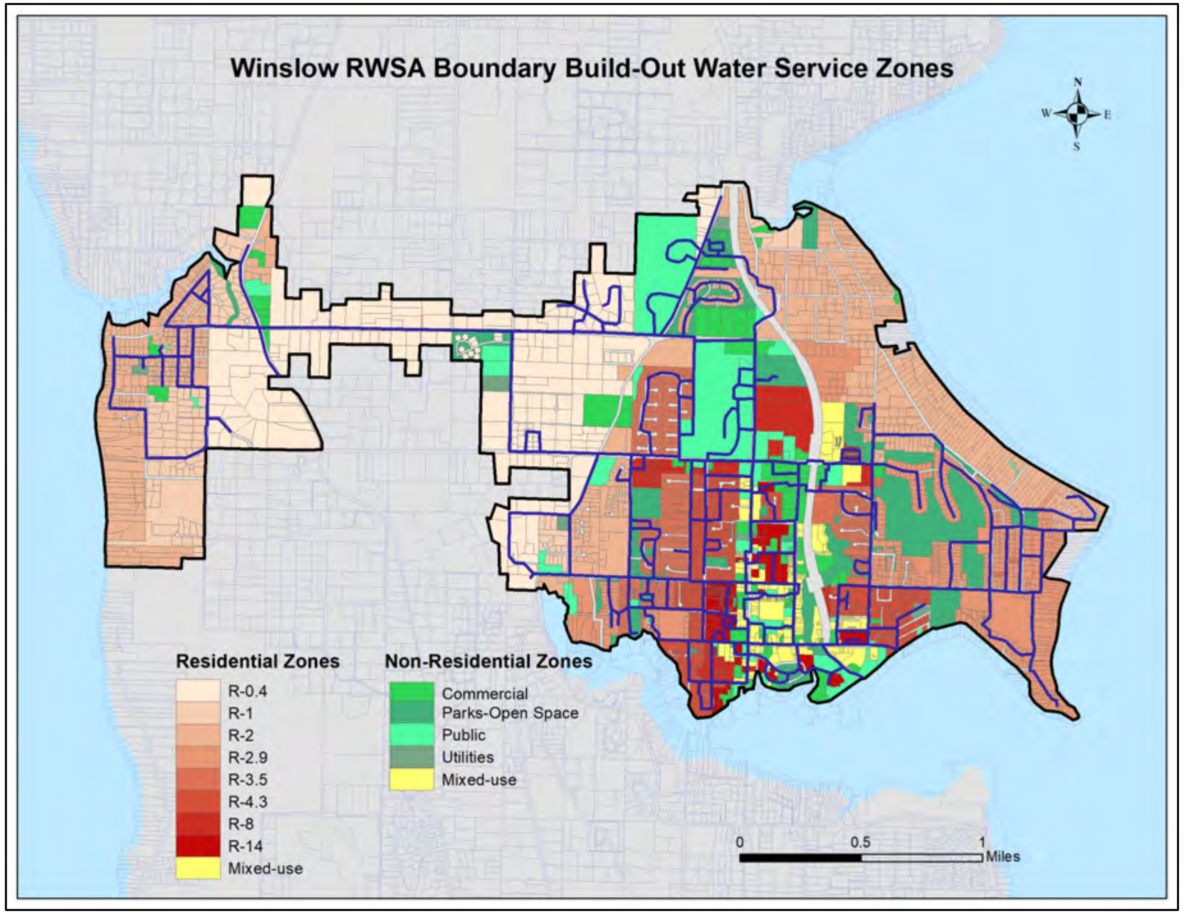
Discussion

Although there are differences between the inputs, outputs and model construction, the overall results between the *COBI 2023 Model* and *COBI 2024 Model* are not significantly different, in terms of predicting future conditions using the three stresses described above. However, as demonstrated above, the revisions and recalibration has significantly improved the model's ability to simulate observed conditions. As such, the City can have confidence that the COBI 2024 Model is an appropriate tool for evaluating future groundwater conditions under various scenarios.

COBI Winslow RWSA Population

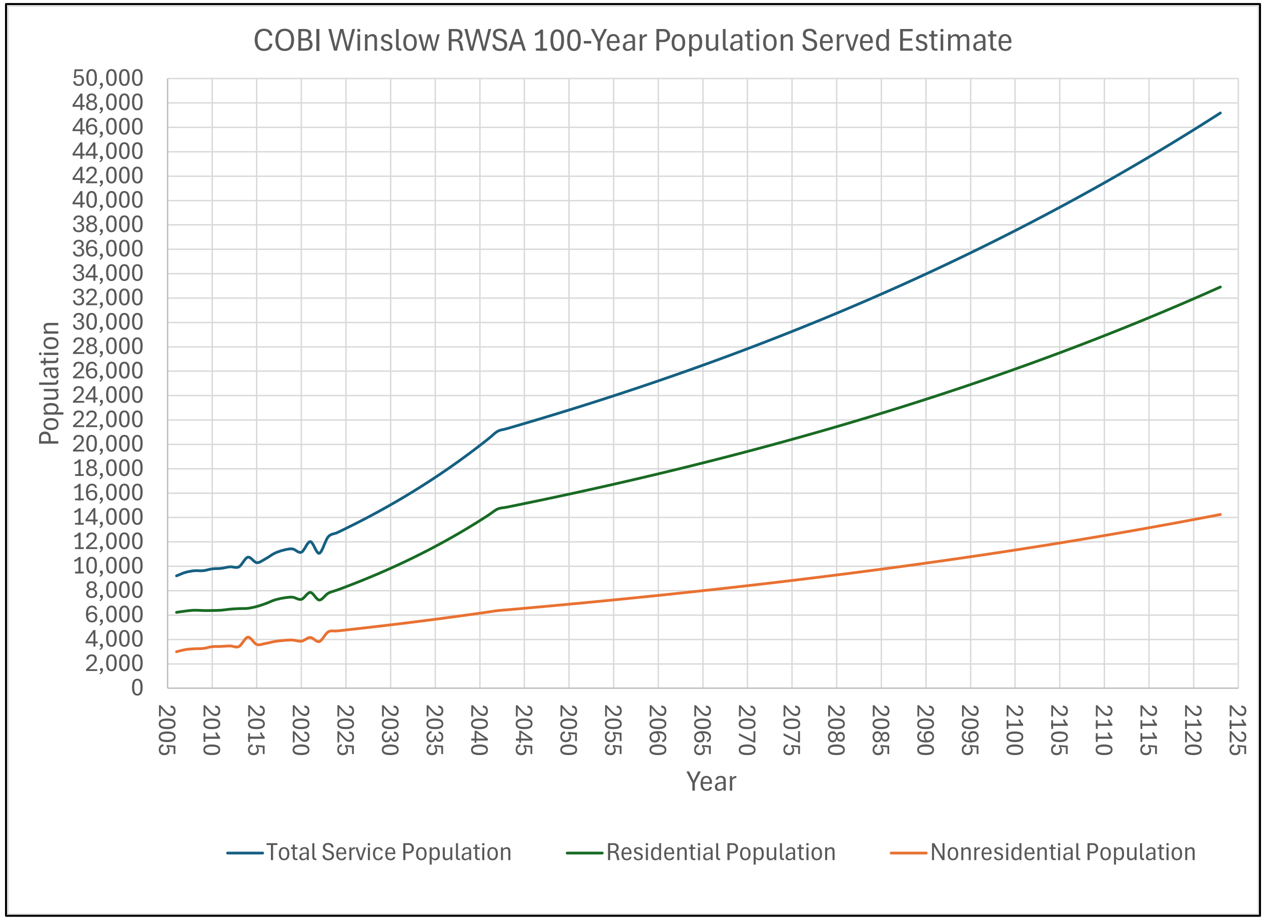
- City of Bainbridge Island Water System (COBI)
  - 2023 Residential service population
    - 7,787
  - 2023 Nonresidential service population
    - 4,642

- COBI Winslow RWSA Zoning
  - Residential – 73%
    - Low Density – 35%
    - Medium Density – 27%
    - High Density – 39%
  - Mixed Use – 3%
  - Nonresidential – 23%



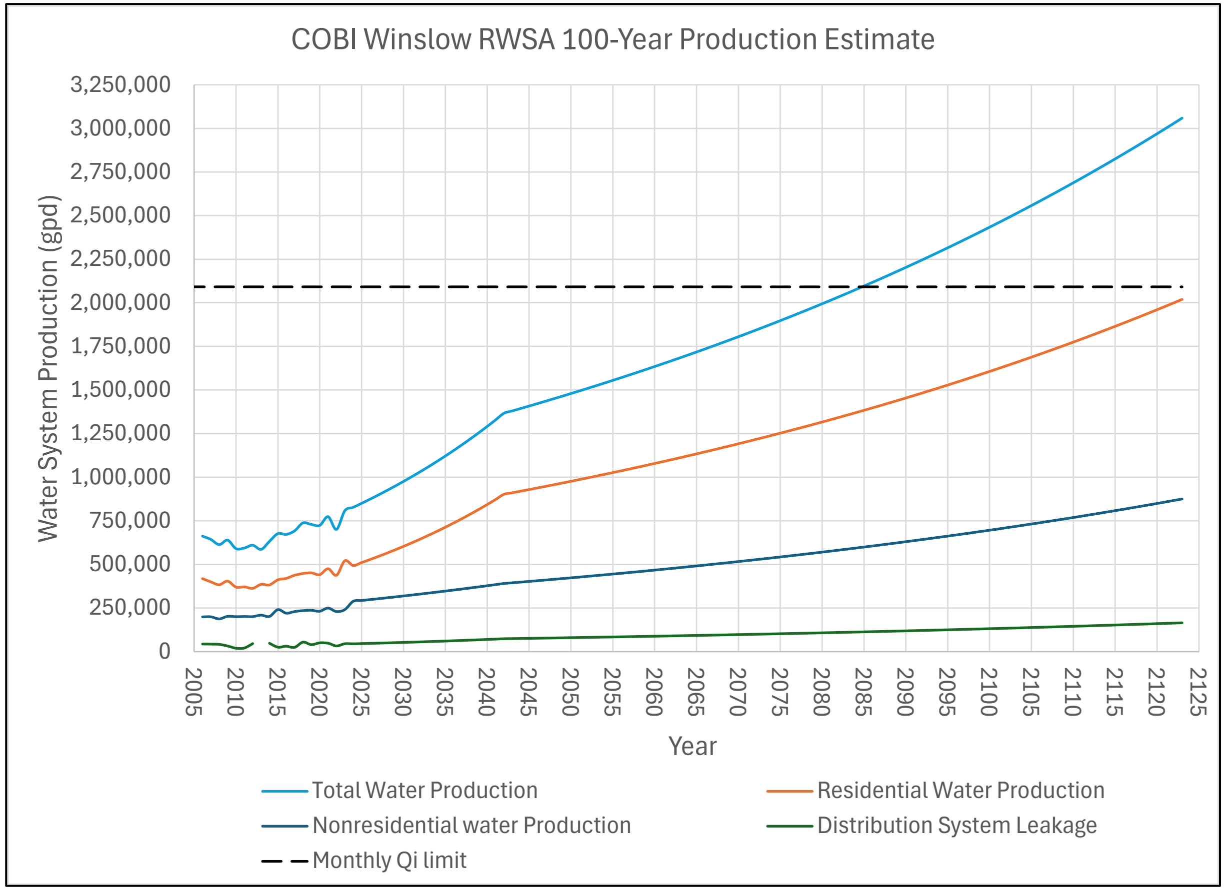
COBI Winslow RWSA 100-Year Service Population Increase Estimate

- Estimated annual service population increase rate
  - First 20 years
    - Residential increase rate = 3.2%
      - Single family residence = 3.6%
      - Multifamily residence = 2.9%
    - Nonresidential increase rate = 1.7%
  - Years 21-100
    - Residential increase rate = 1.0%
      - Single family residence = 1.0%
      - Multifamily residence = 1.0%
    - Nonresidential increase rate = 1.0%
- Service population
  - Residential
    - Year 1 (2023) – 7,787
    - Year 20 (2042) – 14,702
    - Year 100 (2122) – 32,590
  - Nonresidential
    - Year 1 (2023)– 4,624
    - Year 20 (2042)– 6,370
    - Year 100 (2122)– 14,120
  - Total
    - Year 1 (2023)– 12,411
    - Year 20 (2042)– 21,072
    - Year 100 (2122) – 46,710



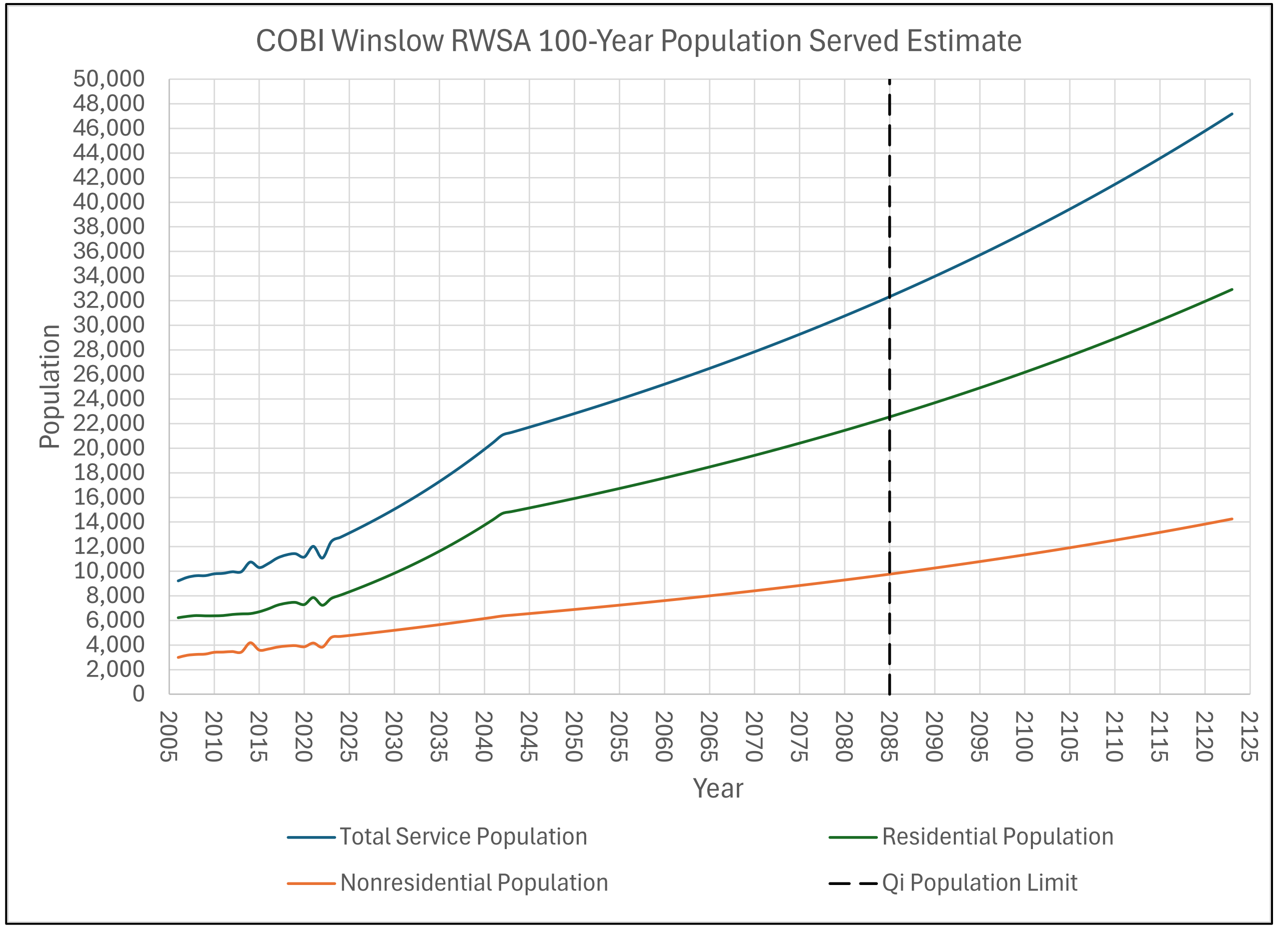
COBI Winslow RWSA 100-Year Production Estimate

- Total Water Production
  - Year 1 (2023) – 807,454 gpd
  - Year 100 (2122) – 3,028,618 gpd
  - 279% increase
- Authorized Consumption
  - Year 1 (2023)– 762,463 gpd
  - Year 100 (2122)– 2,865,438 gpd
  - 280% increase
- Distribution System Leakage
  - Year 1 (2023)– 44,991 gpd
  - Year 100 (2122)– 163,180 gpd
  - 266% increase
- Monthly instantaneous water right(Qi) limit
  - Annual pumping rate = 2,091,841 gpd
  - Water system pumping will meet the water right limiting rate of 3,398,400 gpd in summer months



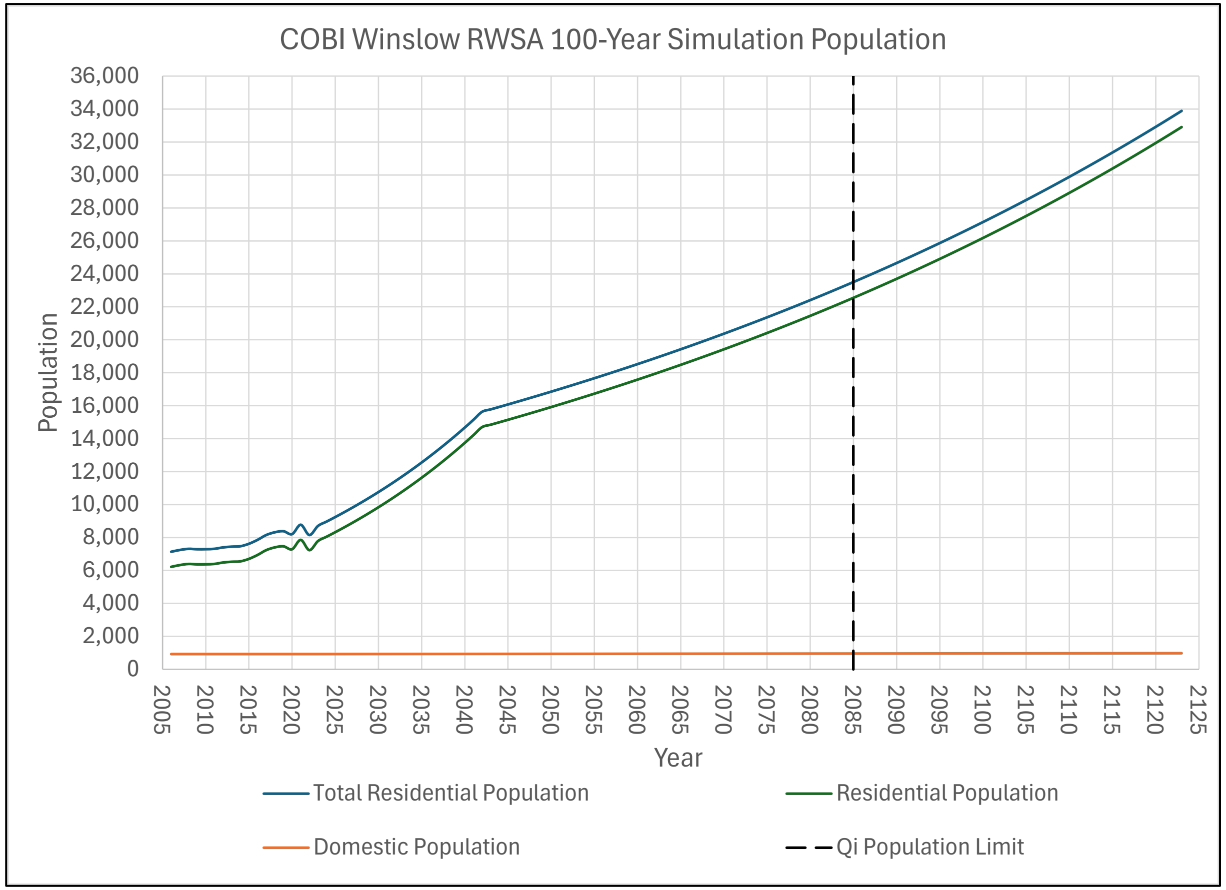
COBI Winslow RWSA 100-Year Service Instantaneous Water Right (Qi) Population

- Estimated annual service population increase rate
  - First 20 years
    - Residential increase rate = 3.2%
    - Nonresidential increase rate = 1.7%
  - Years 21-100
    - Residential increase rate = 1.0%
    - Nonresidential increase rate = 1.0%
- Service population
  - Residential
    - Year 1 (2023) – 7,787
    - Year 20 (2042) – 14,702
    - Year 63 (2085) -22,500 (Qi limit)
    - Year 100 (2122) – 32,916
  - Nonresidential
    - Year 1 (2023) – 4,624
    - Year 20 (2042) – 6,370
    - Year 63 (2085) – 9,770 (Qi limit)
    - Year 100 (2122) – 14,261
  - Total
    - Year 1 (2023) – 12,411
    - Year 20 (2042) – 21,072
    - Year 63 (2085) – 32,300 (Qi limit)
    - Year 100 (2122) – 47,177



COBI Winslow RWSA 100-Year Simulated Population

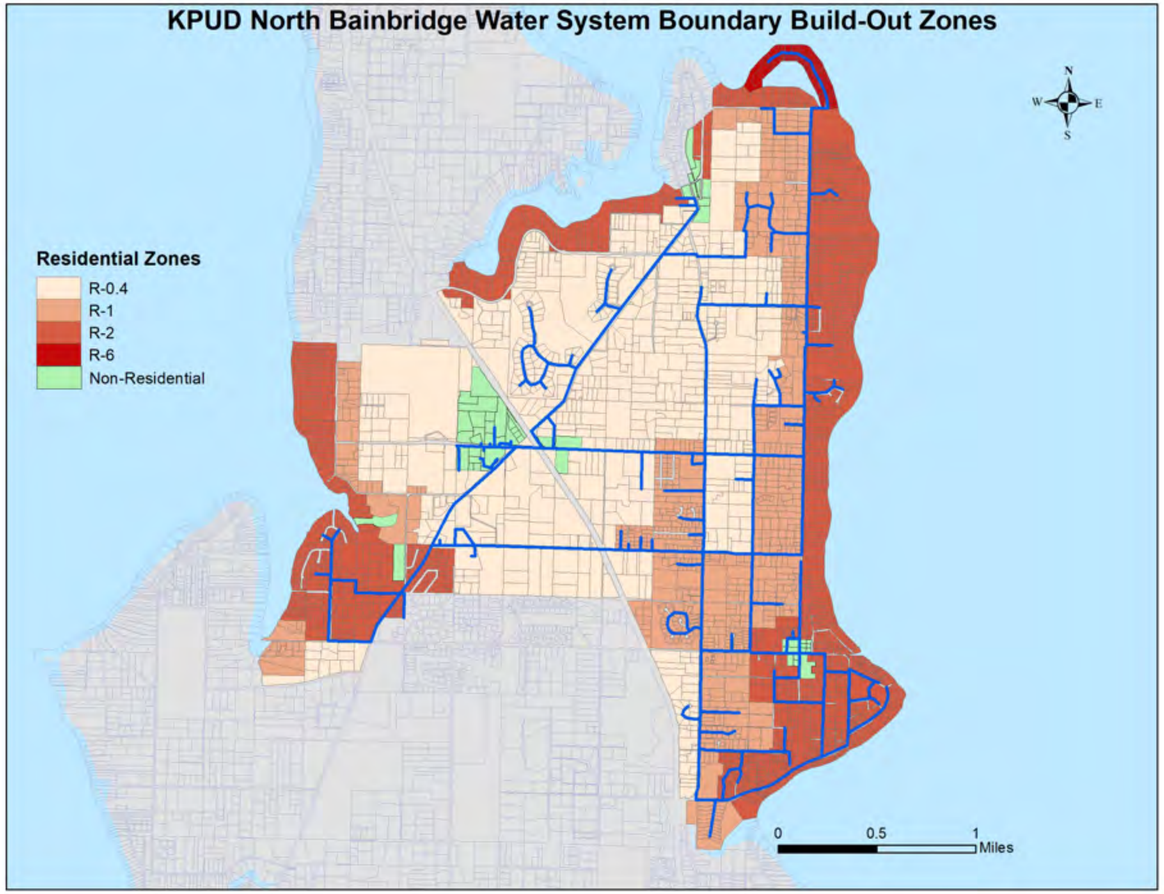
- Total service area population
  - Year 1 (2023) – 8,707
  - Year 20 (2042) – 15,633
  - Year 63 (2085) – 23,509
  - Year 100 (2122) – 33,895
- Residential (service) population
  - Year 1 (2023)– 7,787
  - Year 20 (2042) – 14,702
  - Year 63 (2085) – 22,553
  - Year 100 (2122)– 32,916
- Domestic (private) population
  - Year 1 (2023)– 920
  - Year 20 (2042) – 931
  - Year 63 (2085) – 956
  - Year 100 (2122)– 978



KPUD North Bainbridge Water System Area

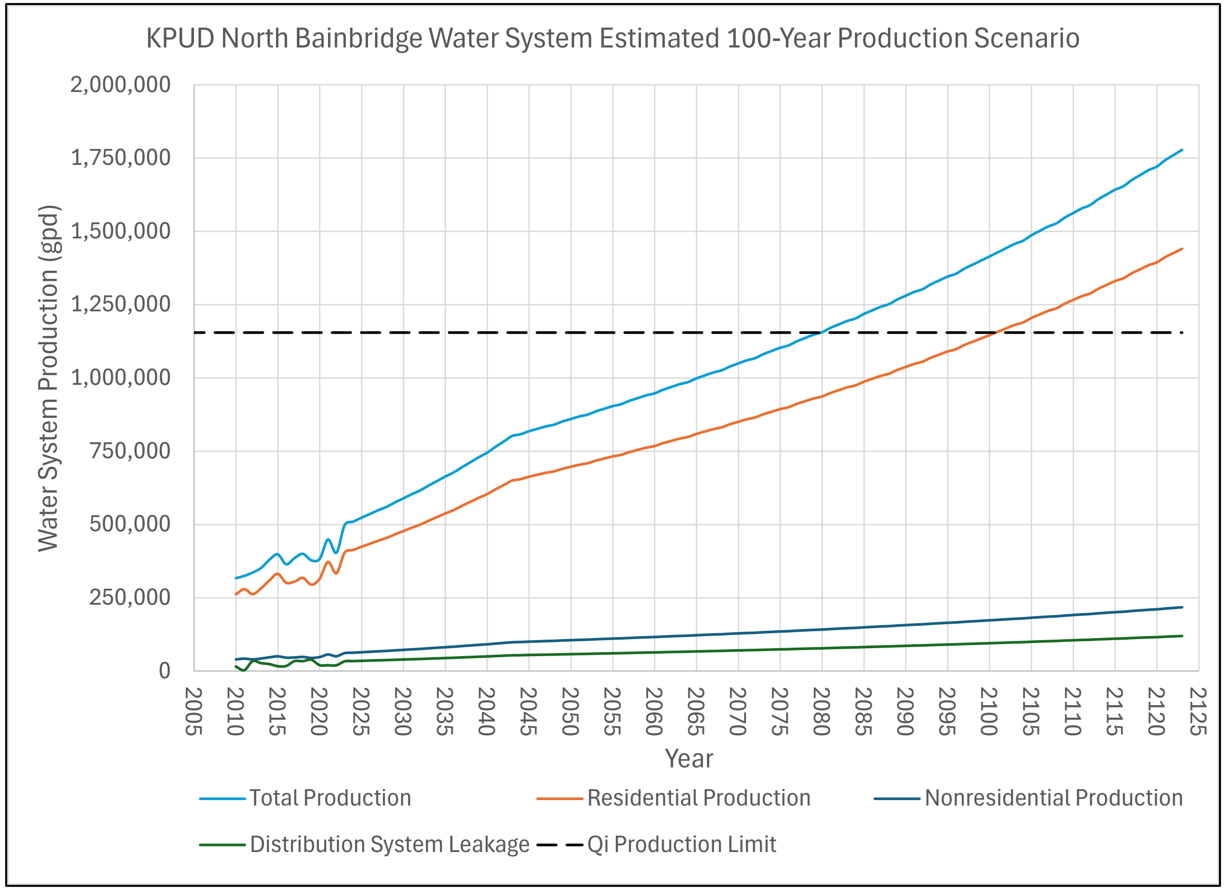
- KPUD North Bainbridge Water Company
  - 2023 Residential Service Population
    - 4,770
  - 2023 Nonresidential Service Population
    - 720

- KPUD North Bainbridge Water Service Area
  - Area – 173,109,747 square feet
  - Residential Area – 167,620,706 square feet (97%)
  - Estimated Maximum Residential Population
    - 19,531



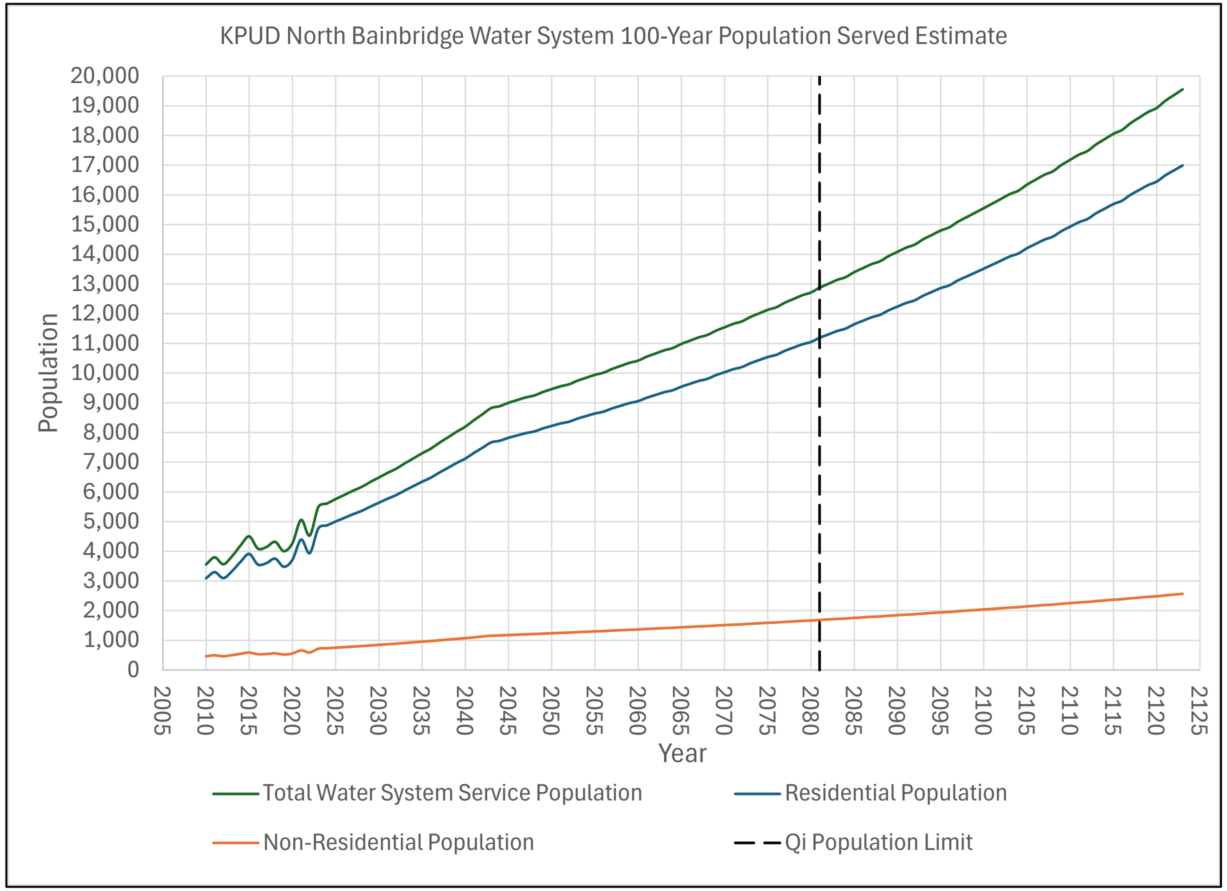
KPUD North Bainbridge WS 100-Year Production Increase Estimate

- Estimated annual production increase rate first 20 years = 2.4%
  - Based in best-fit annual growth rate using 2010 through 2022 production data
- Estimated annual production increase rate for years 21-100 = 1.0%
- Total production components
  - Authorized Consumption – 93.3%
    - Residential Demand – 87%
    - Nonresidential Demand – 13%
  - Distribution System Leakage – 6.7%
- Monthly instantaneous water right(Qi) limit
    - Annual pumping rate = 1,154,906 gpd
    - Water system pumping will meet the water right limiting rate of 2,124,000 gpd in summer months



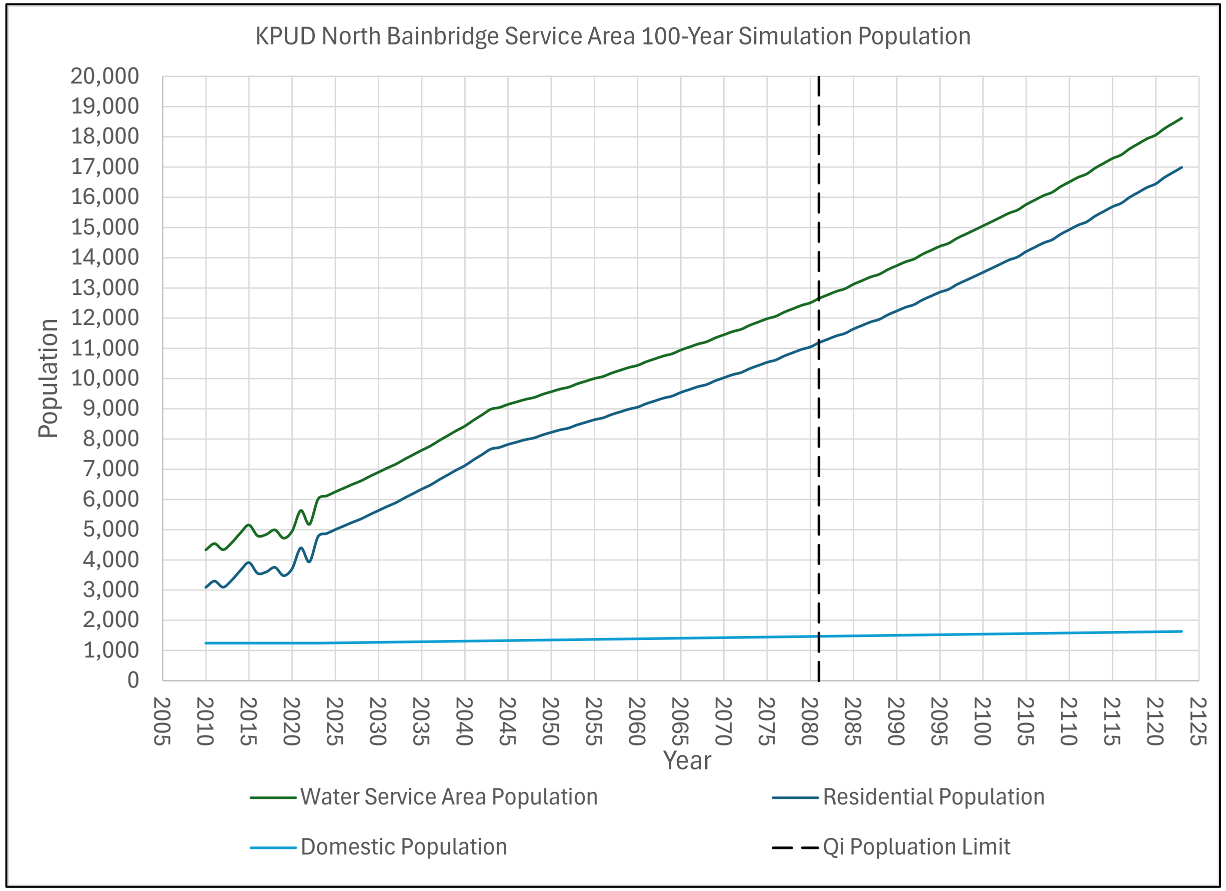
KPUD North Bainbridge WS 100-Year Population Increase Estimate

- Service population
  - Residential
    - Year 1 (2023) – 4,770
    - Year 20 (2042) – 7,485
    - Year 59 (2081) -11,187 (Qi limit)
    - Year 100 (2122) – 16,823
  - Nonresidential
    - Year 1 (2023) – 720
    - Year 20 (2042) – 1,130
    - Year 59 (2081) – 1,689 (Qi limit)
    - Year 100 (2122) – 2,539
  - Total
    - Year 1 (2023) – 5,490
    - Year 20 (2042) – 8,615
    - Year 59 (2081) – 12,876 (Qi limit)
    - Year 100 (2122) – 19,362



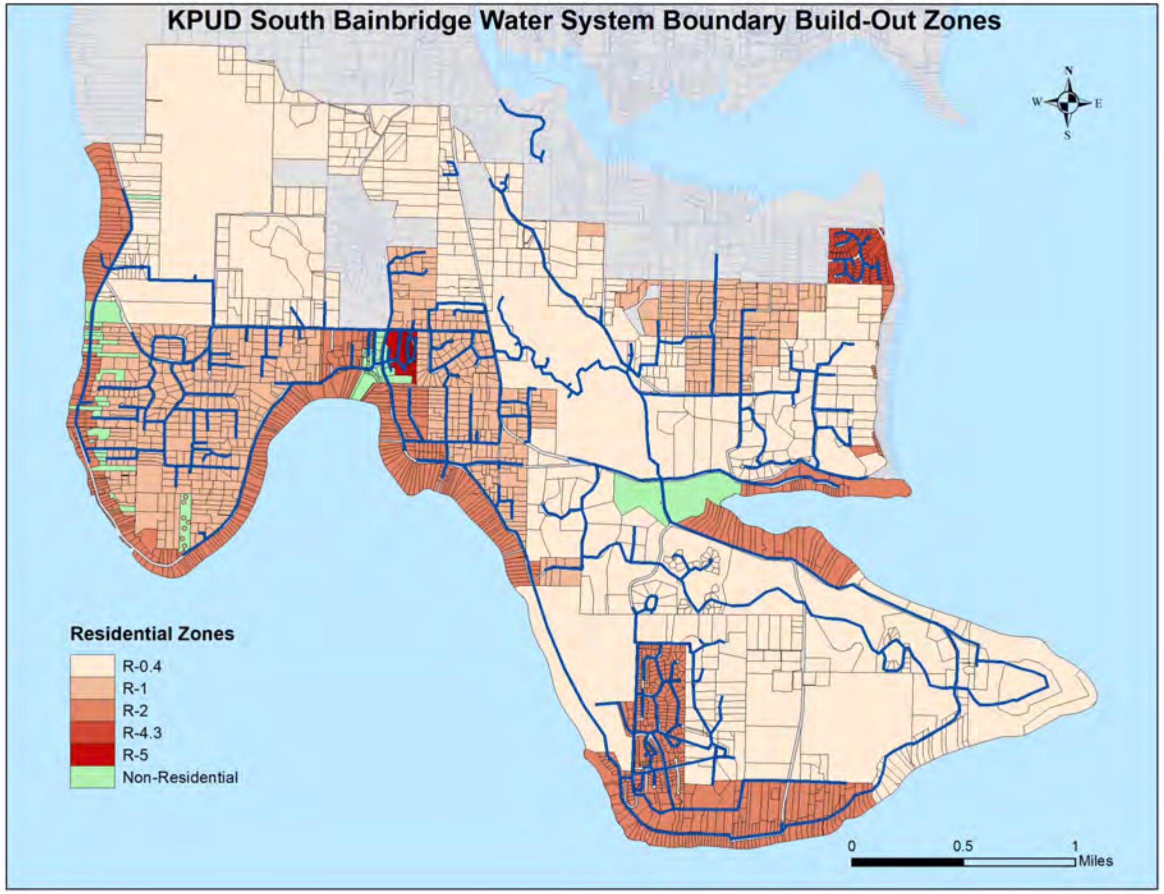
KPUD North Bainbridge Service Area 100-Year Simulated Population

- Total service area population
  - Year 1 (2023) – 6,014
  - Year 20 (2042) – 8,803
  - Year 59 (2081) – 12,654
  - Year 100 (2122) – 18,448
- Residential (service) population
  - Year 1 (2023)– 4,770
  - Year 20 (2042) – 7,485
  - Year 59 (2081) – 11,187
  - Year 100 (2122)– 16,823
- Domestic (private) population
  - Year 1 (2023)– 1,244
  - Year 20 (2042) – 1,317
  - Year 59 (2081) – 1,467
  - Year 100 (2122)– 1,625



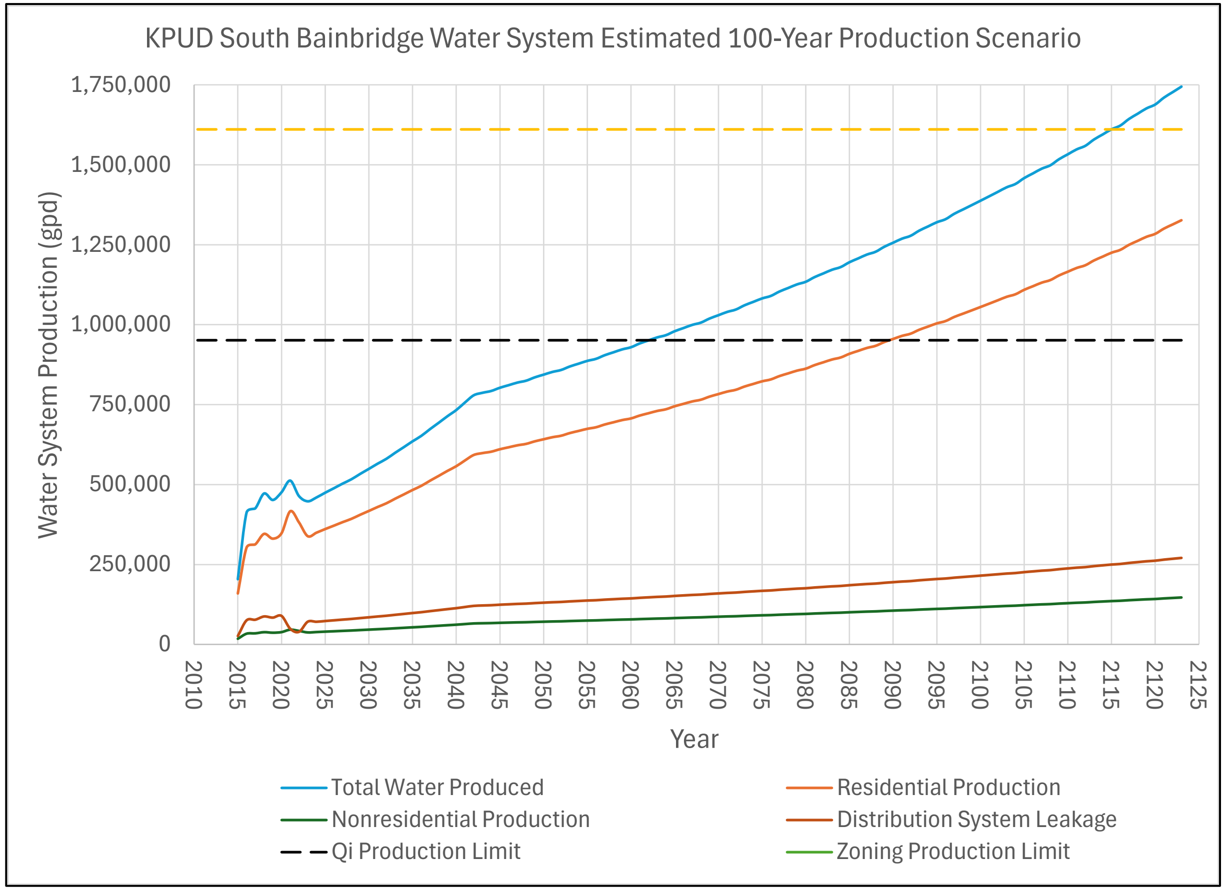
KPUD South Bainbridge Water System Area

- KPUD South Bainbridge Water Company
  - 2023 Residential Service Population
    - 3,973
  - 2023 Nonresidential Service Population
    - 441
- KPUD South Bainbridge Water Service Area
  - Area – 198,296,791 square feet
  - Residential Area – 193,284,377 square feet (97%)
  - Estimated Maximum Residential Population
    - 15,405



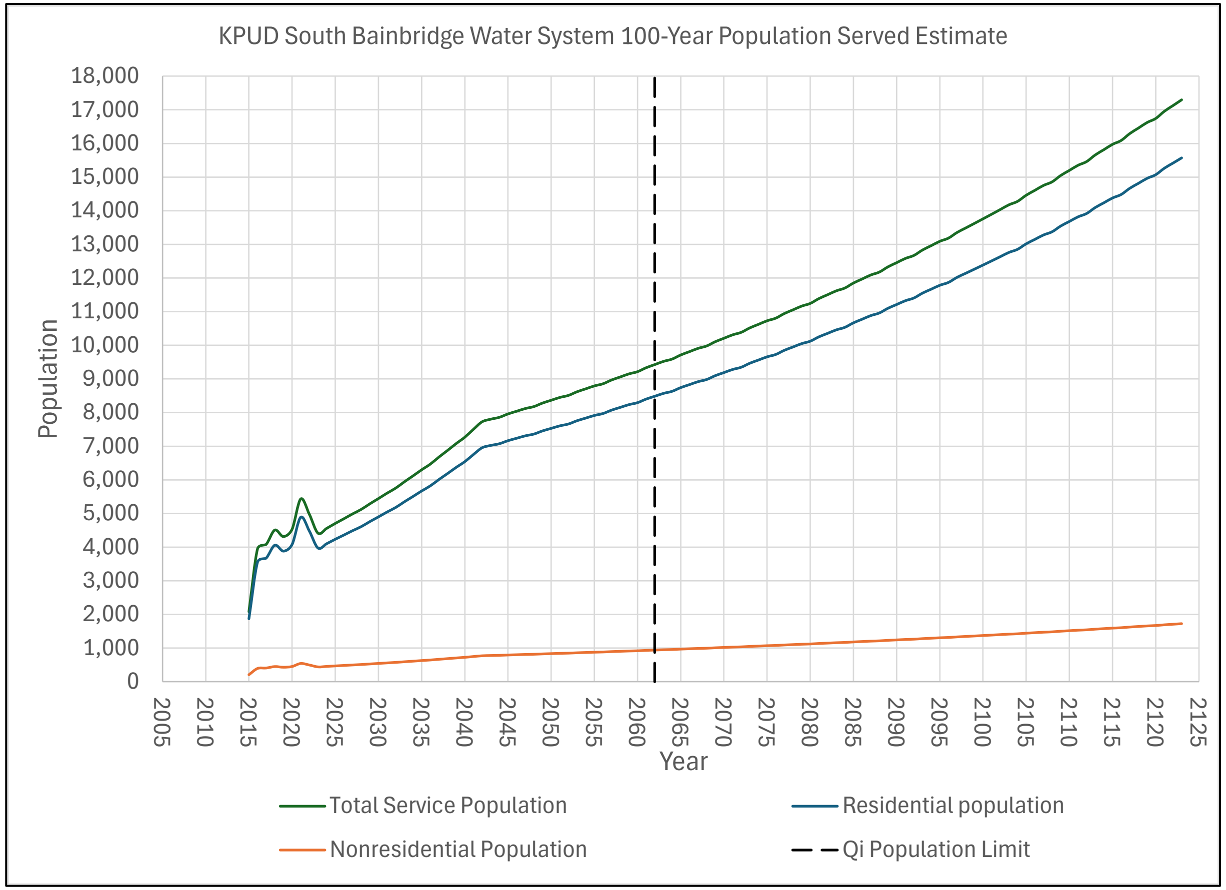
KPUD South Bainbridge WS 100-Year Production Increase Scenario

- Estimated annual production increase rate first 20 years = 3.0%
  - Based in best-fit annual growth rate using 2016 through 2022 production data
- Estimated annual production increase rate for years 21-100 = 1.0%
- Total production components
  - Authorized Consumption – 84.5%
    - Residential Demand – 90%
    - Nonresidential Demand – 10%
  - Distribution System Leakage – 15.5%
- Monthly instantaneous water right(Qi) limit
    - Annual Qi pumping rate = 950,600 gpd
    - Water system pumping will meet the water right limiting rate of 1,820,736 gpd in summer months Starting in Year 40 (2062)



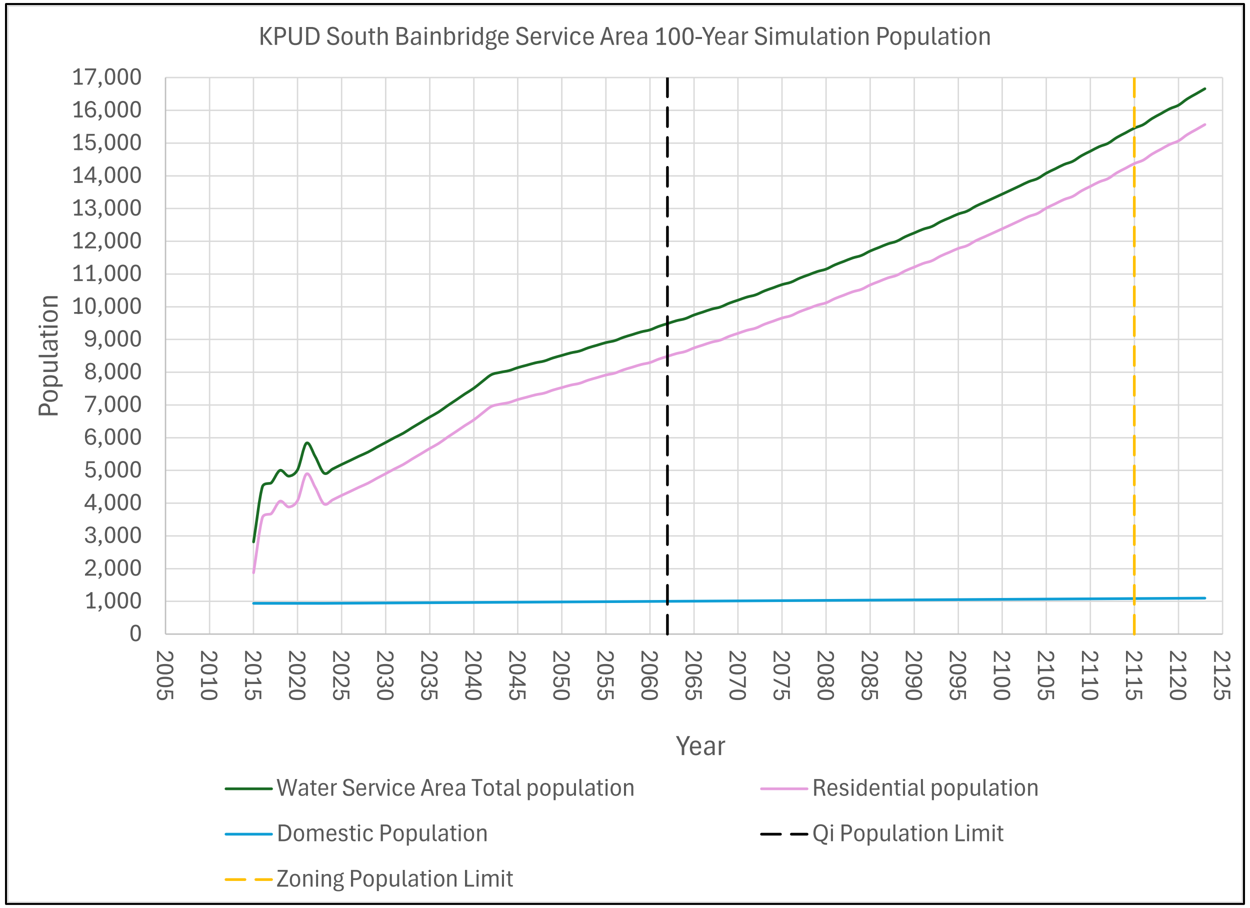
KPUD South Bainbridge WS 100-Year Population Increase Scenario

- Service population
  - Residential
    - Year 1 (2023) – 3,973
    - Year 20 (2042) – 6,953
    - Year (40) (2062) – 8,484 (Qi limit)
    - Year 100 (2122) – 15,413
  - Nonresidential
    - Year 1 (2023) – 441
    - Year 20 (2042) – 772
    - Year 40 (2062) – 942 (Qi limit)
    - Year 100 (2122) – 1,711
  - Total
    - Year 1 (2023) – 4,414
    - Year 20 (2042) – 7,725
    - Year 40 (2062) – 9,426 (Qi limit)
    - Year 100 (2122) – 17,124



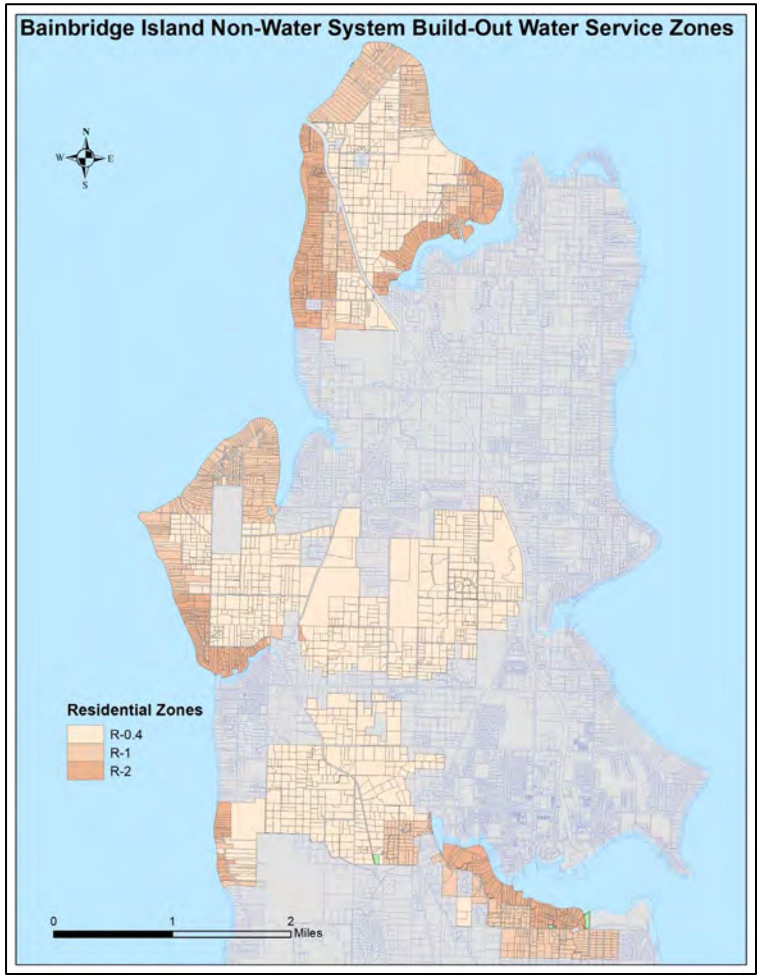
KPUD South Bainbridge Service Area 100-Year Population Increase Scenario

- Total service area population
  - Year 1 (2023) – 4,915
  - Year 20 (2042) – 7,925
  - Year 40 (2062) – 9,486
  - Year 93 (2115) – 15,460 (Zoning Limit)
  - Year 100 (2122) – 16,663
- Residential (service) population
  - Year 1 (2023)– 3,973
  - Year 20 (2042) – 6,953
  - Year 40 (2062) – 8,484
  - Year 93 (2115) – 14,376 (Zoning Limit)
  - Year 100 (2122)– 15,567
- Domestic (private) population
  - Year 1 (2023)– 942
  - Year 20 (2042) – 972
  - Year 40 (2062) – 1,002
  - Year 93 (2115) – 1,084 (Zoning Limit)
  - Year 100 (2122)– 1,096



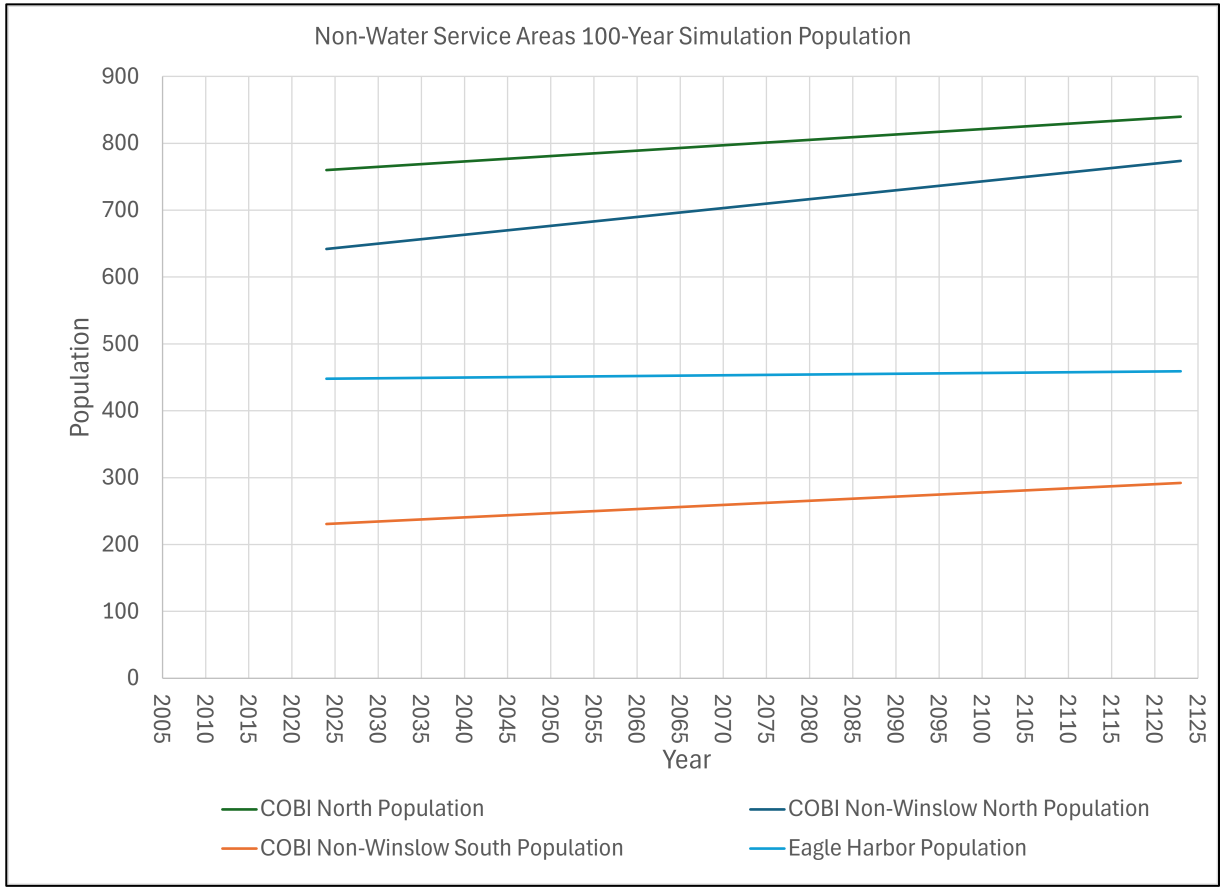
Bainbridge Island Non-Water System Area

- COBI North Service Area
  - 99.9% Residential
  - Maximum Residential Population – 6,245
- COBI Central-North Area
  - 100% Residential
  - Maximum Residential Population – 4,238
- COBI Central-South Area
  - 99.8% Residential
  - Maximum Residential Population – 1,677
- Eagle Harbor
  - 98.9% Residential
  - Maximum Residential Population – 2,167
- Total Potential Residential Population
  - 14,327



Bainbridge Island Non-Water System 100-Year Simulation Population

- COBI North Population
  - Year 1 (2023) – 759
  - Year 100 (2122) – 840
    - 100-year population increase - 11%
    - 13% of estimated maximum population
- COBI Non-Winslow North Population
  - Year 1 (2023) – 641
  - Year 100 (2122)– 774
    - 100-year population increase - 21%
    - 18% of estimated maximum population
- COBI Non-Winslow South Population
  - Year 1 (2023)– 230
  - Year 100 (2122)– 292
    - 100-year population increase - 27%
    - 17% of estimated maximum population
- Eagle Harbor Population
  - Year 1 (2023) – 448
  - Year 100 (2122)– 459
    - 100-year population increase - 3%
    - 17% of estimated maximum population



Model Simulated 100-Year Population Increase Summary

- Unlimited Growth
  - COBI Winslow RWSA
    - 2023 – 8,707
    - 2122 – 36,022
  - KPUD North Bainbridge
    - 2023 – 6,014
    - 2122 – 18,448
  - KPUD South Bainbridge
    - 2023 – 4,915
    - 2122 – 16,508
  - Bainbridge Island Non-Water Service
    - 2023 – 2,078
    - 2122 – 2,362
  - Bainbridge Island
    - 2023 – 21,714
    - 2122 – 73,340
- 238% increase

- Water Rights Limited Growth
  - COBI Winslow RWSA
    - 2023 – 8,707
    - 2122 – 23,509
  - KPUD North Bainbridge
    - 2023 – 6,014
    - 2122 – 12,654
  - KPUD South Bainbridge
    - 2023 – 4,915
    - 2122 – 9,486
  - Bainbridge Island Non-Water Service
    - 2023 – 2,078
    - 2122 – 2,362
  - Bainbridge Island Total
    - 2023 – 21,714
    - 2122 – 48,011
- 121% increase

Scenario Recommendations: Use the calibrated model to simulate the possible effects of increased groundwater pumping and changes to recharge due to changes in land use and climactic conditions between 2024 and 2124 under Minimal, Expected, and Maximum impact conditions. Based on USGS 2011 BI GW Model Report Scenario selection for evaluating water resources.

Tasks: Calculating Historic Population Growth and annual pumping increases for the top 20 producing wells on BI for proposed GW Model Scenario runs. Adequately account for changes in land use and climate change projections.

Reference USGS projected population and pumping calculations for 2011 report for minimal, expected and maximum impact conditions. 2006 COBI Water System Plan (WSP) and other COBI resources 1995-2024, Washington State Office of Financial Management (OFM).
https://ofm.wa.gov/washington-data-research/population-demographics
United States Census Bureau
https://www.census.gov/quickfacts/table/PST045216/53035,53

Task 1: Determine historic average annual growth rate for each year, to calculate a minimal, expected population growth range. Compare to Office of Commerce projected growth numbers for the 20-year horizon, and growth numbers assigned to Bainbridge by Kitsap County (name of the group?). Compare to projected population numbers used by Aspect to increase pumping 50%. How does this compare to EA numbers presented at March 11, 2024 subcommittee meeting for projected growth?

TABLE 2-1

City of Bainbridge Island Historical Population 1994 to 2004

Year	Population	Annual Growth Rate
1995	16,341	--
1996	17,009	4.1%
1997	17,663	3.8%
1998	18,342	3.8%
1999	19,479	6.2%
2000	20,308	4.3%
2001	20,740	2.1%
2002	20,920	0.9%
2003	21,350	2.1%
2004	21,760	1.9%
Average Annual Growth Rate 1995-2004		**3.2%**

Source: Washington State Office of Financial Management (OFM).

No population chart in the Carollo 2017 COBI WSP.

Bainbridge Island Historical Population

Year	Population	Change	Annual Growth Rate = % Change
1960	6404		
1970	8494	+ 2090 -10 yr	+ 33%
1980	12,314	+ 3820 - 10 yr	+ 45%
1990	15,850	+ 3536 - 10 yr	+ 29%
2000	20,308	+ 4458 – 10 yr	+ 28%
2001 est.	20,432	+124	+0.6%
2002	20,740	+308	+1.5%
2003	20,920	+180	+0.9%
2004	21,350	-430	+2%
2005	21,760	+410	+1.9%
2006	22,200	+440	+2%
2007	22,600	+400	+1.8%
2008	23,080	+480	+2.1%
2009	23,180	+100	+0.5%
2010	23,035	+145 (+ 2717-10 yr)	+0.6% (+ 13.3-10 yr)
2011 est.	23,194	+159	+0.7%
2012 est.	23,353	+159	+0.7%
2013 est.	23,512	+159	+0.7%
2014 est.	23,671	+159	+0.7%
2015 est.	23,830	+159	+0.7%
2016 est.	23,989	+159	+0.7%
2017 est.	24,148	+159	+0.7%
2018 est.	24,307	+159	+0.7%
2019 est.	24,466	+159	+0.7%
2020 est.	24,625	+159 (+1800 -10 yr)	+0.7% (+7.8% - 10yr)
2021 est.	24,560	-65	- 0.3%
2022 est.	24,494	- 66	- 0.3%
2023 est.	24,310	-184	- 0.8%
2024 est.	24,126	-184 (-368 since 2022)	-0.8% (-1.5% since 2022)

2001 thru 2010 http://www.ofm.wa.gov/pop/default.asp

Average Annual Growth Rate % from 2000-2024 (estimates) = 18.7/24 = 0.8%

Expected Scenario 20 year Population Growth = +0.8% annual growth starting 2024 at 24,126 = average increase 193/year x 20 years = +3,860 people in 2044.
Total Expected Population 2044 = 27,986.
0.8 % annual increases for remaining 80 years instead of proposed 1% (EA recommended).

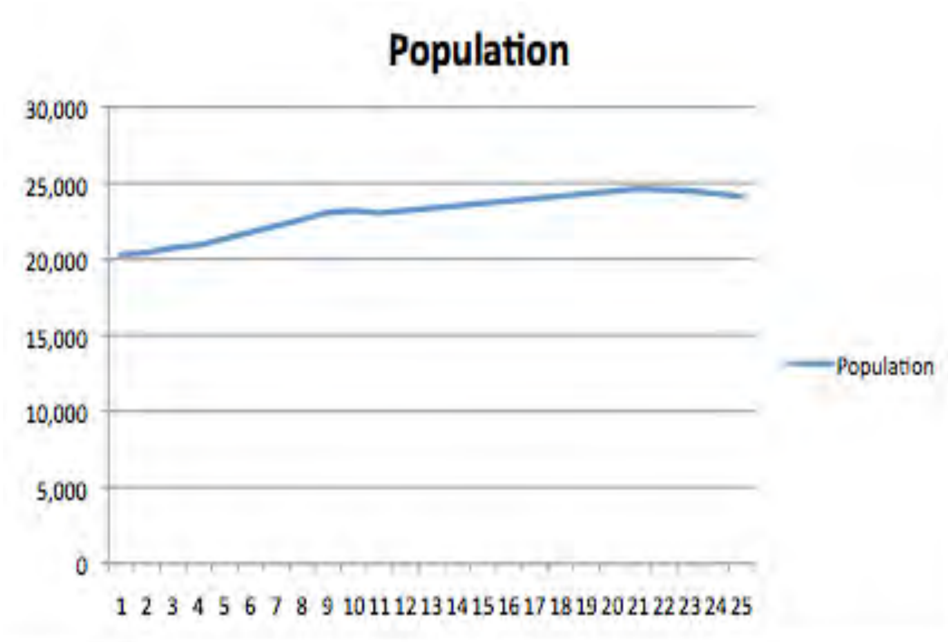
Task 2: Calculate estimated historic annual pumping for top 20 producing wells on BI for COBI and KPUD water systems (represents appox. 60% of BI water use). Compare percentage of pumping increases to increases in population for **Minimal, Expected, Maximum Impact Scenarios** etc. Data indicates increase population by 50% = increase pumping greater than 50%, increase population 200%, increase pumping greater than 200%. Estimate annual pumping for the remaining 30% of Small Water Systems and Private Exempt Wells on BI. There are limited results with conservation measures to reduce water use and pumping.

BI Wells	**Date Installed**
1. Fletcher Bay PW	1978
2. South Bainbridge #8 (add year installed)	1998
3. North Bainbridge #9	1992
4. Sands Road #2	1991
5. Sands Road #1	1992
6. South Bainbridge #7	1991
7. North Bainbridge #7	1982
8. Head of Bay #3	1974
9-11. Island Utilities #1-3 (no data except for 2020)	
12. North Bainbridge #3	1986
13. Head of Bay #2	1971
14. Taylor Road	1994
15. Head of Bay #1A	1983
16. Harbor Crest	1983
17. Head of Bay #4	1983
18. Head of Bay #6	1983
19. Hidden Cove	1985
20. Commodore (well no longer producing)	1954

Data 95% complete for selected years – difficulties obtaining public records as volunteer citizen. COBI and EA consultants should have access to annual well pumping and population data, and should be able to graph BI annual increases in pumping reflecting increases associated with growth and population for scenario projections. **Increases in population directly correlate with increases in pumping.** See graphs below.

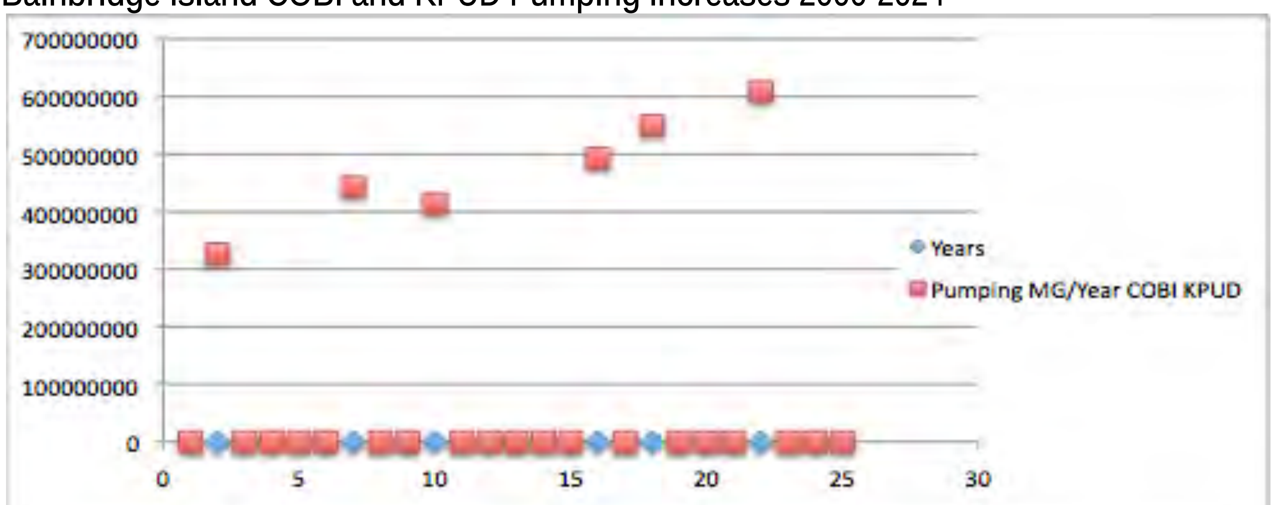
Year	**Population**	**Annual Pumping Million Gallons/year**
1990	15,850	
2000	20,308	
2001	20,432	327
2006	22,200	443
2009	23,180	414
2010	23,035	
2015	23,830	493
2017	24,148	550
2020	24,625	
2021	24,560	609
2024	24,126	

Draft Bainbridge Island Graphs 2000 - 2024



Year 2000 2010 2020 2024

Bainbridge Island COBI and KPUD Pumping Increases 2000-2024



Year 2000 2010 2020 2024

Task 3. Adequately represent projected changes in land use and climate change impacts based on peer reviewed reporting such as UW CIG and best science.
Sea level rise, increased temperatures, longer drier summer months, less rain events with increased intensity with more runoff and less recharge, projected increases in population and development resulting in increased impervious areas and less undisturbed recharge areas resulting in less recharge, and increased pumping with increase in population.

Concerns with statements in March 4, 2024, EA Consultant document for Subcommittee meeting. Decades of data and peer reviewed reporting documents Early Warning Level (EWL) actions for a 0.5' decrease in groundwater levels per year for 10 years for Bainbridge Island Aquifers is appropriate. Consultants have also recommended improvements in EWLs and better management to adequately protect aquifers.

Inappropriate to normalize mining the aquifers. On what basis does EA Consultants claim wells will automatically stabilize in 38 years after exceeding EWLs for decades in the model? Scientifically not responsible water resource management to increase pumping and effectively mine the aquifer, especially for water resource wells on a designated Sole Source Aquifer (SSA) Island surrounded by saltwater at risk for seawater intrusion. Along with peer reviewed projected climate changes, resulting in sea level rise, increased temperatures, longer drier summer months, less rain events with increased intensity = more runoff and less recharge, and projected increases in population and development = increased impervious areas and less undisturbed recharge areas resulting in less recharge, and increased pumping with increase in population. Discrepancy in modeling calibration?

Additionally for every year you extrapolate out with numerical Groundwater Modeling, the level of statistical uncertainty increases. Estimating aquifers will stabilize after they are pumped and mined for 38 years exceeding industry standard EWLs for drawdown is concerning. Likely some existing water supply wells will no longer be viable in 38 years. Example, the Commodore well was over-pumped and is no longer a viable water system well.

Page 12:

1. A second takeaway relates to the Early Warning Levels (EWLs) defined by Aspect, which state that a 0.5 decrease in groundwater levels per year for 10 years violates the EWLs. In the context of the second figure on Page 11, this means that in 2032, any groundwater level decline greater than 5 feet violates the EWL. In 2043, any groundwater level decline greater than 10 feet violates the EWL. In 2062, any groundwater level decline greater than 20 feet violates the EWL (this does not occur). **All of this is to say, in 2032 and within the Qva, nearly half of the island is in violation of the EWL under Scenario 0 conditions (the two darkest blue regions on the map).** By 2042 a smaller area of the island is exceeding the EWLs (the darkest blue regions). The same

interpretations can be made for the SLA (Sea Level Aquifer) and FBA Fletcher Bay Aquifer maps on Page 13.

Page 13:

Discussion

EA is using two metrics to evaluate the model runs: **groundwater levels** and **water budgets and fluxes**. Groundwater levels are assessed using the following:

• Changes in groundwater levels for the aquifer units under the island over time, evaluated in both space and time, relative to Early Warning Levels (EWLs). Water budgets are assessed by:

- Quantifying changes to fresh groundwater flux to saltwater Puget Sound.
- Quantifying changes to groundwater discharge to surface water on the Island.
- Reviewing overall water budget moving through the Island.

The second figure on Page 11 shows changes in simulation years 2032, 2042, and 2062 in the Qva (Vashon Advance Aquifer). **After 2062, groundwater levels stabilize,** reach a new steady state, and so groundwater elevation changes in 2062 are the same as the groundwater elevation changes in 2121 (the final simulation year).