



**CITY COUNCIL STUDY SESSION
TUESDAY, FEBRUARY 18, 2025**

COUNCIL CHAMBERS
280 MADISON AVENUE NORTH
BAINBRIDGE ISLAND, WA

AND

REMOTE MEETING ON ZOOM
[HTTPS://BAINBRIDGEWA.ZOOM.US/J/92947338351](https://bainbridgewa.zoom.us/j/92947338351)
OR TELEPHONE: US: +1 253 215 8782
WEBINAR ID: 929 4733 8351

AGENDA

- 1. CALL TO ORDER / ROLL CALL - 6:00 PM**
- 2. APPROVAL OF AGENDA / CONFLICT OF INTEREST DISCLOSURE - 6:05 PM**
- 3. REGULAR BUSINESS**
 - 3.A (6:10 PM) Discuss Policy Changes for South Island Sewer Connections - Public Works,** 30 Minutes:
[New Policy 2.14A South Island Sewer - Additional Connection Policy.docx](#)
[Old Policy 2.14 South Island Sewer Connection Procedures.pdf](#)
[South Island Sewer Slides 021825.pptx](#)
 - 3.B (6:40 PM) Present the Draft Report for the Wastewater Beneficial Re-Use Study - Public Works,** 30 Minutes
[BI Reuse Update 2025-02-06.pptx](#)
[Bainbridge Island WW Beneficial Reuse TM 2 2024-09-09.pdf](#)
[Appendix A Bainbridge Island WW Beneficial Reuse TM 1 2022-11-01.pdf](#)
[Appendix B Groundwater Recharge Analysis.pdf](#)
- 4. COMMITTEE REPORTS - 7:10 PM**
- 5. ADJOURNMENT - 7:20 PM**

GUIDING PRINCIPLES

Guiding Principle #1 - Preserve the special character of the Island, which includes downtown Winslow's small town atmosphere and function, historic buildings, extensive forested areas, meadows, farms, marine views and access, and scenic and winding roads supporting all forms of transportation.

Guiding Principle #2 - Manage the water resources of the Island to protect, restore and maintain their ecological and hydrological functions and to ensure clean and sufficient groundwater for future generations.

Guiding Principle #3 - Foster diversity with a holistic approach to meeting the needs of the Island and the human needs of its residents consistent with the stewardship of our finite environmental resources.

Guiding Principle #4 - Consider the costs and benefits to Island residents and property owners in making land use decisions.

Guiding Principle #5 - The use of land on the Island should be based on the principle that the Island's environmental resources are finite and must be maintained at a sustainable level.

Guiding Principle #6 - Nurture Bainbridge Island as a sustainable community by meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Guiding Principle #7 - Reduce greenhouse gas emissions and increase the Island's climate resilience.

Guiding Principle #8 - Support the Island's Guiding Principles and Policies through the City's organizational and operating budget decisions.



City Council meetings are wheelchair accessible. Assisted listening devices are available in Council Chambers. If you require additional ADA accommodations, please contact the City Clerk's Office at 206-780-8604 or cityclerk@bainbridgewa.gov by noon on the day preceding the meeting.



CITY OF
BAINBRIDGE ISLAND

City Council Study Session Agenda Bill

MEETING DATE: February 18, 2025

ESTIMATED TIME: 30 Minutes

AGENDA ITEM: (6:10 PM) Discuss Policy Changes for South Island Sewer Connections - Public Works,

SUMMARY: In response to the City Council discussion of South Island Sewer Connections on October 22, 2024, City staff will present a draft prioritization and process for the assignment of the 25 remaining equivalent residential units (ERUs) of sewer capacity. The capacity was established through an interlocal agreement with Kitsap County Sewer District #7 adopted by the Council at the aforementioned Regular Business Meeting.

AGENDA CATEGORY: Discussion

PROPOSED BY: Public Works

RECOMMENDED MOTION:

Discussion only.

COMMUNITY ENGAGEMENT AND OUTREACH:

None planned at this time.

FISCAL IMPACT:

Amount:	N/A
Ongoing Cost:	N/A
One-Time Cost:	N/A
Included in Current Budget?	true

BACKGROUND: The City contracts with Kitsap County Sewer District #7 for wastewater treatment associated with the City's South Island and Rockaway Beach sewer service area through an Interlocal Agreement. The District treats wastewater from both the District's Fort Ward service area, and the City's South Island/Rockaway service area, the latter of which represents approximately 70% of the District's total customer base. As part of the original agreement, the City retained 480 equivalent residential units (ERUS) of sewer connection capacity that is now either physically connected or "bound" for future use with a specific parcel.

On April 12, 2022, the City Council directed the City Manager to formally request additional sewer connection capacity from the District, and on October 22, 2024, the City Council approved an interlocal agreement with the District for 25 additional ERUs. The ERUs are to be prioritized for purchase and distribution in annual increments of up to 7 per year over a 4 year period.

City staff developed the attached draft ERU distribution policy (2.14A) in alignment with the City Council's October 24, 2024 discussion of their priorities for the distribution of the annual allotment of ERUs. This policy would supplant the existing policy (2.14 - attached) that was established for the original 480 ERUs. The new policy prioritizes existing homes with failing septic systems near critical areas, as well as deed restricted affordable units and existing commercial units with no other options for sewer capacity expansion.

City staff will finalize the new policy in accordance with feedback from the City Council, and present the final policy at a future meeting for adoption by resolution,

ATTACHMENTS:

[New Policy 2.14A South Island Sewer - Additional Connection Policy.docx](#)

[Old Policy 2.14 South Island Sewer Connection Procedures.pdf](#)

[South Island Sewer Slides 021825.pptx](#)



Public Works Administrative Procedures Manual

2.14A SUPPLEMENTAL SOUTH ISLAND SEWER CONNECTION PROCEDURE

Date of Approval:	Effective Date:
Approved by & Title:	City Council; City Manager
Responsible Division:	Public Works
Key Code and References:	COBI Comprehensive Plan, as amended, on file in the Department of Planning and Community Development Interlocal Agreement between COBI and Sewer District No. 7 (SD7) dated 10/3/1997 Interlocal Agreement between COBI and SD7 dated 09/24/2003 All interlocal agreements between COBI and SD7 that provide for sewer connections in the amount greater than the number of connections defined in the Interlocal Agreement dated 09/24/2003 Sewer Connection Analysis Form , as amended, on file in the Department of Public Works South Island Sewer Connections Guidance and Background Map of South Island Sewer Connections Map of City Contracted Sewer Service Areas
Effectiveness date:	XXX, 2025

Purpose: The purpose of this document is to outline the City of Bainbridge Island's (City's) policy and procedures associated with the analysis and distribution of available Equivalent Residential Units (ERUs) associated with the inter-local agreement between the City of Bainbridge Island and Kitsap Sewer District #7 (District) dated October 25, 2024.

The above-referenced agreement identifies 480 ERU's previously purchased by the City for use in the City's service area. All of those ERU's are presently physically connected, or "bound" for future use with an associated parcel in the service area. The agreement also now includes 25 additional ERUs, payment for which will be divided into four (4) annual installments of up to 7 ERUs for the years 2025-2027, and up to 4 ERUs in 2028. One (1) ERU is defined as one (1) sewer connection and is based upon the fixture unit values listed on the City's "Sewer Connection Analysis Form" (See link above).

As previously identified, as of the date of adoption of this policy, the 480 ERUs established in earlier versions of the ILA remain in effect as either connected or “bound.” However, the City may purchase back an unused or unwanted ERUs from the original holder at their request. The City is the only entity that may purchase unused or unwanted ERUs for re-distribution. This policy therefore applies to both the 25 additional ERUs, and any other ERUs purchased by the City from an original holder.

The policy and priority of the City of Bainbridge Island (City) is to manage the use of available Equivalent Residential Unit’s (ERUs) in a manner that follows the guidance provided in the City’s Comprehensive Plan, Sewer District No. 7 (SD7) policies and resolutions, and this connection procedure.

Policy:

Subject to the availability of ERUs the City shall:

1. Provide sewer service to projects in the Lynwood, Pleasant Beach, Rockaway Beach, Emerald Heights, Blakely Elementary and Point White sewer service areas as identified in Figure 1 that meet the following prioritized criteria:
 - a. Properties or development that serve a new or existing public facility including, but not limited to schools, parks, municipal facilities, publicly-owned amenities, etc.;
 - b. Properties with an existing residence served by a failing or soon-to-be failing septic system and that are within 100’ from established critical area buffers (or otherwise have a high probability of negatively affecting sensitive bodies of water). A failing septic system is defined as one that can no longer effectively treat and distribute wastewater, leading to untreated sewage potentially reaching the surface around the drain field, and causing contamination of groundwater and potentially surface water within a period of 30-days. A soon-to-be failing septic system is defined as being no more than 1-year from failing as defined above;
 - c. Properties with an existing residence served by a failing or soon-to-be failing septic system with no alternative for system repair or replacement. The cost of a repair or replacement will not be considered as part of the criteria for prioritization;
 - d. Properties with an existing commercial space that is currently served by a sewer connection that requires additional ERUs, or a portion of an ERU, to serve an approved new use (through

Planning and Community Development permitting) or to meet a new health and safety regulatory requirement;

- e. Properties that are planned for residential use at the maximum allowed density and will provide permanent affordable units at or below 80% of area median income through a deed restricted program adopted by the City;
 - f. Properties that are planned for residential use at less than the maximum allowed density and provide permanent affordable units at or below 80% of area median income through a deed-restricted program adopted by the City; and,
 - g. Any new or expanded residential development that does not qualify under the affordability criteria listed above, including a new accessory dwelling unit (ADU) on an existing parcel, are not eligible for this program.
2. Provide sewer service to projects in the adjacent open space areas identified in Figure 1 that meet the following prioritized criteria:
- a. Properties or development that serve a new or existing public facility including, but not limited to schools, parks, municipal facilities, publicly-owned amenities, etc; and,
 - b. Properties with an existing residence served by a failing or soon-to-be failing septic system and that are within 100' from established critical area buffers (or otherwise have a high probability of negatively affecting sensitive bodies of water).

Requirements:

- 1. ERUs are reserved for a single parcel or commercial establishment;
- 2. ERUs may not be transferred, sold, or otherwise committed through a binding legal agreement, to an owner of another parcel;
- 3. Unused or excess ERUs reserved for a parcel may be held for use, subject to the City's binding commitment for a reservation of sewer capacity;
- 4. If requested by the owner, unused or excess ERUs "bound" for a parcel may, at the City's option, be purchased by the City in an amount equal to the sum of all system participation (SD7 connection) and latecomer's fees paid by an

owner at the time the ERUs were reserved or allocated by the City, (City will not take possession until a new recipient is identified). As established in the Purpose section of this policy, unused or excess ERUs referenced in this subsection may have been established as part of the original 480 ERUs or the 25 additional ERUs established through the 2024 ILA. If an ERU is reclaimed by the City as per above, that ERU may be available as part of the next upcoming annual distribution process.

Procedure: The following procedure will be used to assign available ERUs per the policy above:

1. City staff will open a “call for sewer connections” annually on June 1st beginning in 2025. The call will be open for 30 days until June 30th. The call will be announced on a City Council Regular Business Meeting Consent Agenda at least 30 days prior to the opening.
2. Respondents to the call will submit the specified application form – included as an attachment to this document – to the front desk of City Hall or electronically to PWAdmin@bainbridgewa.gov prior to 4PM on the last day of the call. There is no fee for the application.
3. Application forms will be reviewed by City staff, and respondents contacted with requested questions or clarifications. Applications will be finalized by July 31st.
4. City staff will prepare an evaluation and prioritization of the application forms, along with a recommendation to the City Council for consideration of approval at a Regular Business Meeting in September or October.
5. Any connections remaining after 2028 may be distributed in accordance with this policy in subsequent years in coordination with Kitsap Sewer District #7.
6. Applicants who are approved through this process are required to submit the necessary connection and other associated fees within 30-days of notification of approval. Any available connection reviewed through the annual process that is not distributed in the annual cycle, or is associated with unpaid fees after 30-days, will be available for distribution in the following year’s process.
7. In each year of the open “call for sewer connections,” the City will consider purchasing and paying for 1 or more ERU’s for the purposes of addressing an emergency in the form of a failing septic system as defined previously in this policy, or an emerging issue in the form of serving an existing commercial

space as defined previously in this policy. Qualifying ERU's may be distributed outside of the annual approval process cycle

8. Applicants who do not receive a connection as part of an annual process must re-submit an application form in the subsequent annual approval process to be reconsidered. There is no appeal process for denied applications.

APPLICATION/
FORMS:

Sewer Connection Request Form (attached)

BIMC 15.12.050 Allows the Director to assign responsibility for the interpretation, application, and enforcement of specified procedures to department staff. It also allows the Director to administer provisions of the chapter.

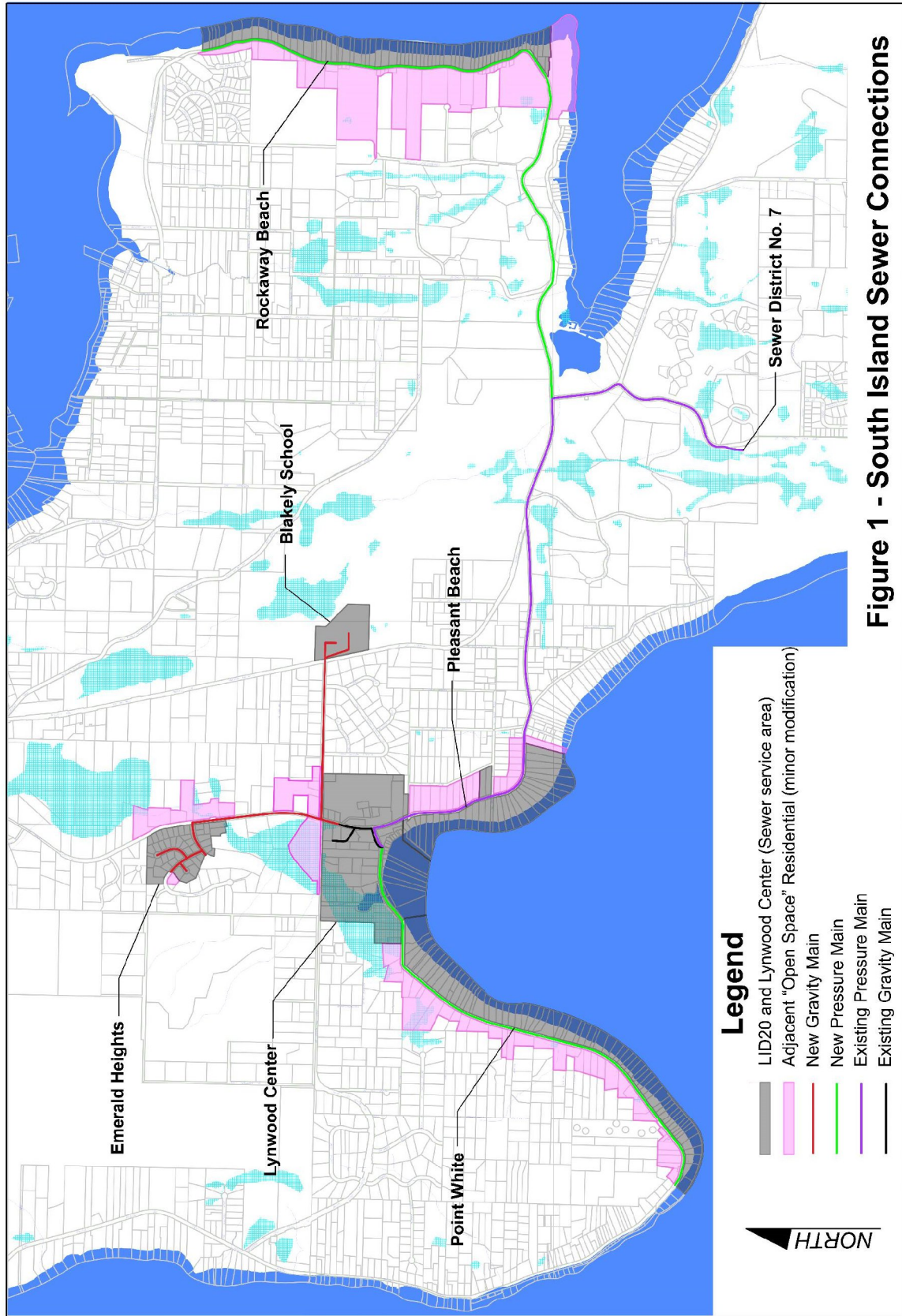


Figure 1 - South Island Sewer Connections

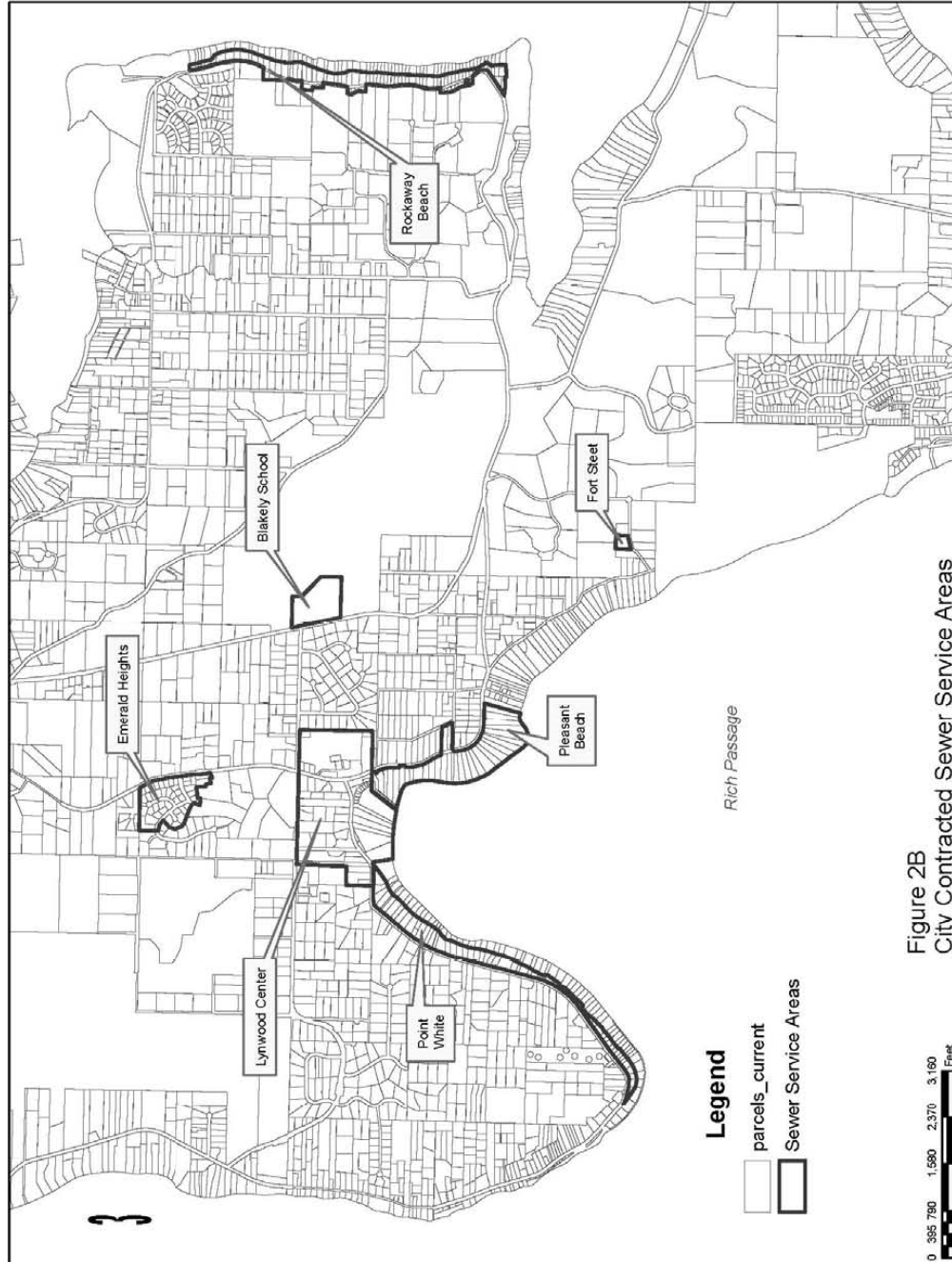


Figure 2B
City Contracted Sewer Service Areas



PUBLIC WORKS ADMINISTRATIVE PROCEDURES MANUAL

2.14 SOUTH ISLAND SEWER CONNECTION PROCEDURE

DATE OF APPROVAL:	EFFECTIVE DATE:
APPROVED BY & TITLE:	
RESPONSIBLE DIVISION:	Public Works; Department of Planning & Community Development
SUPPORTING DOCUMENT LOCATION:	G: PW Administration/Clerks/Admin Procedures G: PW Development Services
KEY CODE AND REFERENCES:	COBI Comprehensive Plan, as amended, on file in the Department of Planning and Community Development Interlocal Agreement between COBI and Sewer District No. 7 (SD7) dated 10/3/1997 Interlocal Agreement between COBI and SD7 dated 09/24/2003 All interlocal agreements between COBI and SD7 that provide for sewer connections in the amount greater than the number of connections defined in the Interlocal Agreement dated 09/24/2003 Sewer Connection Analysis Form , as amended, on file in the Department of Public Works South Island Sewer Connections Guidance and Background Map of South Island Sewer Connections Map of City Contracted Sewer Service Areas
LAST REVIEW/UPDATE:	
APWA	

PURPOSE: The policy and priority of the City of Bainbridge Island (City) is to manage the use of available Equivalent Residential Unit's (ERUs) in a manner that follows the guidance provided in the City's Comprehensive Plan, Sewer District No. 7 (SD7) policies and resolutions, and this connection procedure.

The City of Bainbridge Island South Island sewer capacity is defined as the number of ERUs reserved for wastewater treatment as established by an interlocal agreement between the City, and Kitsap County SD7. One (1) ERU is defined as one (1) sewer connection and is based upon the fixture unit values listed on the City's "Sewer Connection Analysis Form" (See link above).

Fulfillment of a sewer connection request is defined as the process where the City reviews a sewer availability request and makes available a 30-calendar day non-binding commitment for sewer service availability.

POLICY:

Subject to the availability of ERUs the City shall:

1. Reserve capacity for all requested connections in LID20.
2. Provide sewer service to projects in Lynwood Center that:
 - a. have failing septic systems,
 - b. that serve (or are planned for) a public need,
 - c. are planned for residential use at densities of four units per acre or greater,
 - d. are planned for commercial and mixed use, and
 - e. are planned for residential use at densities of less than four units per acre.
3. Provide sewer service to properties with failing septic systems that are approved by City Council as a "minor modification" to the sewer service area following the guidance of the City's Comprehensive Plan.
4. Avoid the creation of a secondary market for unused ERUs.

The above policy statements were approved by City Council on March 22, 2006.

Requirements:

1. ERUs are reserved for a single parcel,
2. ERUs may not be transferred, sold, or otherwise committed through a binding legal agreement, to an owner of another parcel,
3. Unused or excess ERUs reserved for a parcel may be held for use, subject to the City's binding commitment for a reservation of sewer capacity,
4. If requested by the owner, unused or excess ERUs reserved for a parcel may, at the City's option, be purchased by the City in an amount equal to the sum of all system participation (SD7 connection) and latecomer's fees paid by an owner at the time the ERUs were reserved or allocated by the City, (City will not take possession until a new recipient is identified) and,
5. Owners may utilize ERUs reserved for a parcel in any manner they choose to develop that parcel, subject to City, County, and State code, the City's current Comprehensive Plan, the City's zoning requirements, and plans that have been approved by Planning and Community Development.

PROCEDURE:

For more details see the ["South Island Sewer Connections Guidance and Background"](#) document. *(Attached)*

Assign a parcel to an area according to the definition of parcel areas I through III below. Fulfill requests for sewer connections according to the procedure within each parcel area.

- I. **Parcels located within the LID 20 contract sewer service area**

A total of 230 connections have been reserved for this area and consists of connected and un-connected parcels.

- A. Connect all parcels at a time of the owners choosing with the exception of the parcel located at 7936 NE Beck Road. (See below)
- B. The parcel (Parcel tax account #4164-003-013-0003) located at 7936 NE Beck Road shall be permitted to connect in the future provided that the following conditions, as stipulated in an agreement with the City, are met.
 - i. The parcel is within the City's sewer service area.
 - ii. Sufficient City sewer capacity is available as determined by the City.
 - iii. Payment of a charge in lieu of assessment (latecomer's) fee equal to the per lot assessment in the Pleasant Beach neighborhood plus annual interest at a rate of 1 ½ times the interest charged to the City on the Public Works Trust Fund Loan for construction of LID20.

II. Parcels located within the Lynwood Center contract sewer service area or within the adjacent "Open Space" residential area

Fulfill available sewer connections according to the following procedure subject to a requirement that the sewer system infrastructure must be able to handle the additional sewer flow; and must conform with City, County, and State code, the City's current Comprehensive Plan, current City zoning requirements, and plans approved by Planning and Community Development.

- A. Assign request for sewer connections to one of the following eight priority categories:
 - i. Parcels in Lynwood Center with building(s) that have failing septic systems
 - ii. Parcels in Lynwood Center with building(s) served by a septic system that are in proximity to sensitive bodies of water and that have a high probability of negatively affecting the quality of those bodies of water.
 - iii. Projects in Lynwood Center used, or planned for, that serve a public need
 - iv. Projects in Lynwood Center planned for residential use at densities of four units per acre or greater
 - v. Projects in Lynwood Center planned for commercial and mixed use
 - vi. Projects in Lynwood Center planned for residential use at densities of less than four units per acre
 - vii. Parcels in adjacent "Open Space" residential areas with building(s) that have failing septic systems
 - viii. Parcels in adjacent "Open Space" residential areas with building(s) served by a septic system that are in proximity to sensitive bodies of water and that have a high probability of negatively affecting the quality of those bodies of water
- B. Within each priority category, rank each request according to the date the City received the request with the oldest request ranking first.

- C. Use available connections to fulfill requests in priority categories A.1 through A.4 in numerical order with the lowest number fulfilled first following the date ranking procedure above.
- D. After requests in categories A.1 through A.4 are fulfilled, use available connections to fulfill requests in category A.5 through A.8 in numerical order with the lowest number fulfilled first following the date ranking procedure above.

III. Parcels that are not located in any of the above parcel areas

- A. Alternative wastewater treatment solutions should be pursued
- B. A Local Improvement District (LID) may be pursued

**APPLICATION/
FORMS:**

Sewer Connection Analysis Form
South Island Sewer Connections Guidance and Background

BIMC 15.12.050 Allows the Director to assign responsibility for the interpretation, application, and enforcement of specified procedures to department staff. It also allows the Director to administer provisions of the chapter and issuing necessary rules and procedures.

NOTE: Legal correspondence should be regarded as attorney-client privileged information and should be kept in a separate file for the City Attorney's Office to determine whether the records are subject to public disclosure.

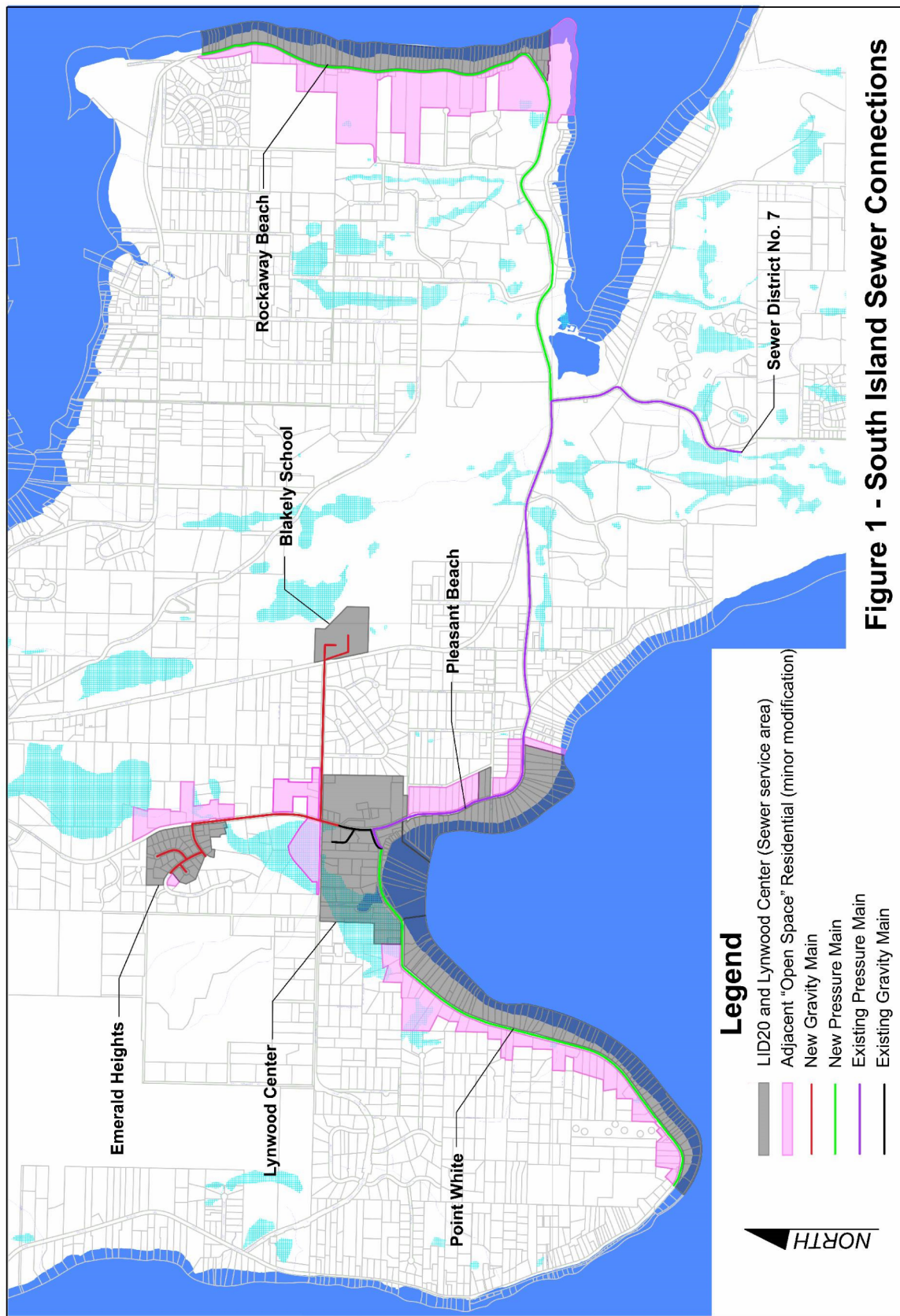


Figure 1 - South Island Sewer Connections

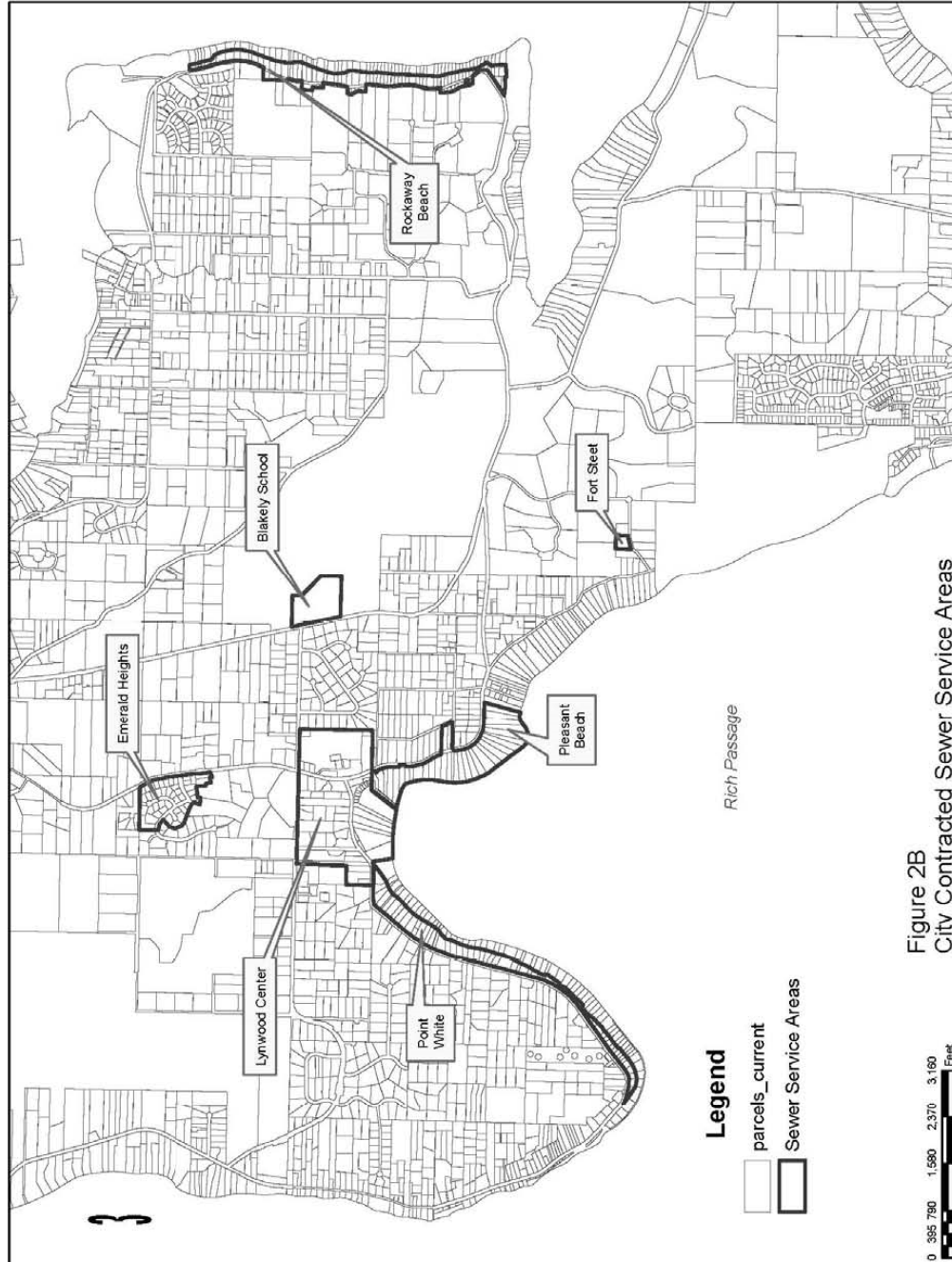


Figure 2B
City Contracted Sewer Service Areas



CITY OF BAINBRIDGE ISLAND

SOUTH ISLAND SEWER CONNECTIONS GUIDANCE AND BACKGROUND

The City's 2004 Comprehensive Plan Update provides guidance in how sewer service contracted with SD7 should be made available to properties located in the south end of Bainbridge Island. The following Comprehensive Plan policies largely govern the connection of properties:

FRW 1.3 (Framework of the Plan) provides guidance on managing population growth on the Island. Winslow is targeted to accommodate 50% of the population growth through the year 2012, Neighborhood Service Centers are targeted to accommodate up to 5%, and the balance of the growth (45%) would be absorbed throughout the remainder of the Island. The Comprehensive Plan intends that, if approved by Kitsap County Health District (KCHD), on-site wastewater treatment can adequately support the 45% population growth target area.

LU 1.3 (Land Use) provides guidance on development density on the Island. The Neighborhood Service Centers of Island Center, Rolling Bay, and Lynwood Center offer small-scale, commercial, and service activity outside of Winslow. These Neighborhood Service Centers may be allowed to develop at slightly higher densities to reinforce their roles as small-scale, community centers.

NSC 1.2 (Neighborhood Service Center) establishes the requirements for sewer connections in Lynwood Center. Any new development or expansion of existing development in Lynwood Center will be required to connect to public sewer, when available, or meet other KCHD requirements, when appropriate.

OS 1.7 (Residential Open Space) governs the development of sewer system infrastructure and capacity in residential open spaces. Water or wastewater infrastructure, which may contribute to system capacity exceeding local need, shall not be used to justify development counter to the City-wide land use policies.

SSP 1.1 (Sanitary Sewer On-site Systems) states that "on-site wastewater disposal systems...are a long-range solution to sewage disposal in most areas of the Island".

SSP 2.1 states that "Public sewer service should be provided for areas designated in the Comprehensive Plan...including the City-contracted service areas of Sewer District 7. Such public sewer service shall not be used to justify development counter to the Comprehensive Plan".

SSP 2.3 defines the City's contract sewer service area for the south end of Bainbridge Island and provides guidance for minor modifications to the sewer service area. Emergency service and other minor modifications to the sewer service area, which are within the existing sewer facility capacity, may be allowed with City Council approval.

SSP 2.7 provides guidance for a major expansion of a sewer service area and establishes the criteria to be used to evaluate a service area expansion. A comprehensive plan amendment and City Council approval will be necessary if new sewer service areas are proposed for a new public sewer facility or major expansion of an existing public sewer facility.

Available sewer system capacity in South Island is limited by the number of sewer connections that can be made available by SD7. Allocation of available capacity must be managed and planned for in a manner that conforms with the guidance provided in the City's Comprehensive Plan. That guidance suggests that sewer connection areas in South Island may reasonably be classified into three distinctly different areas

based upon different growth development objectives and different sewer connection decision making criteria. These areas are Lynwood Center, LID20, and Adjacent "Open Space" Residential.

Lynwood Center is a defined sewer service area in the 2004 Comprehensive Plan that falls within one of the three Neighborhood Service Center (NSC) areas that together are targeted for a 5% population growth. This area is defined by the boundaries shown in 2004 Comprehensive Plan Update, Water Element Figure 2B (attached.) This area may be developed at a higher density and requires a connection to public sewer when available for commercial development. Eighty sewer connections were allocated to parcels within this area in an Interlocal Agreement between the City and Sewer District No. 7 (SD7) dated October 3, 1997. Current zoning in Lynwood Center will allow 117 additional residential connections. The commercial portion of the mixed-use development in the area zoned NSC/R-2 and NSC/R-12 could add more.

LID20 is a defined sewer service area in the 2004 Comprehensive Plan with a defined number of approved sewer connections. This area is defined by the boundaries shown in 2004 Comprehensive Plan Update, Water Element Figure 2B (attached.) An Interlocal Agreement between the City and SD7 dated September 24, 2003 provides for the treatment of 250 connections for LID20. The number of parcels eligible for connection in the LID area is set at 231. One party opposed the LID formation and filed suit. In an agreement with the City the parcel remains in the LID with a \$0.00 assessment but with no guarantee of a future connection. The remaining twenty connections are available for use in Lynwood Center and in any area added pursuant to SSP 2.3 of the Comprehensive Plan and this procedure.

Adjacent "Open Space" Residential is an area in South Island containing parcels that meet the "minor modification" criteria defined in 2004 Comprehensive Plan Policy SSP 2.3 and that individually may be permitted to connect with City Council approval. This area is defined by the boundaries shown in Figure 1 (attached) and falls within the 45% population growth target area. It is defined as any property in South Island not included in Lynwood Center or LID20 that:

1. is adjacent to an existing sewer main serving Lynwood Center or any LID20 area excluding Blakely School and Fort Street,
2. is adjacent to and contiguous with Lynwood Center or any LID20 area excluding Blakely School and Fort Street, and
3. has an existing residential building with a failing septic system and has no opportunity to develop an alternative on-site sewer treatment area or drain field, or
4. has an existing residential building with septic system located with a proximity to sensitive bodies of water, has a high probability of negatively affecting the quality of those bodies of water, and has no opportunity to develop an alternative on-site sewer treatment area or drain field.

The requirements for adjacent and contiguous properties as outlined above are established to avoid a patchwork of properties served by sewer service throughout South Island. Vacant properties meeting adjacent and contiguous requirements will be expected to utilize on-site wastewater disposal systems as a long-range solution to sewage disposal following the guidance in Comprehensive Plan Policy SSP 1.1. Properties with existing buildings and failing septic systems outside of this area will be expected to develop alternative solutions for wastewater treatment.

South Island/Rockaway Sewer Connection Policy Update

February 18, 2025



Agenda

1. Background and previous City Council discussions
2. Review sewer connection policy
3. Review sewer connection procedure
4. Next Steps / Discussion

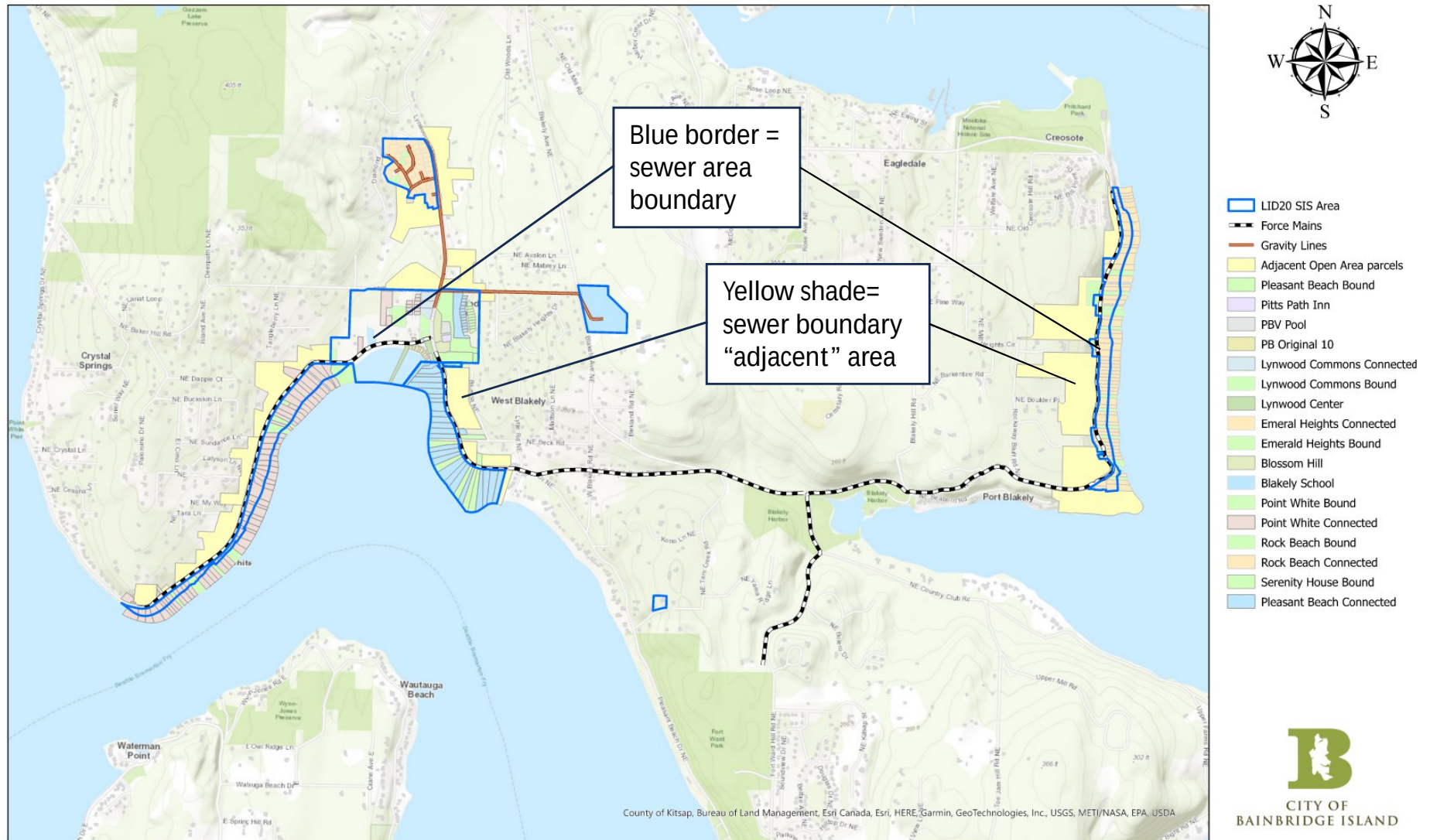
Background



Background

- South Island/Rockaway Sewer system constructed in early 2000's through a Local Improvement District
- City owns the collection and pumping system; wastewater is treated via an Interlocal Agreement (ILA) with Kitsap Sewer District 7

Background – Sewer Boundary



South Island/Rockaway Sewer Connection Policy

February 18, 2025

Background - Connections

- Current agreement with the District limits sewer connections to 480 equivalent residential units (ERUs)
- All 480 ERUs are either physically connected (350) or were reserved through LID 20 (130)
- Revised agreement allows for 25 new connections over 4 years (up to 7 per year)

Background – City Council Discussion Fall 2024

Limit connections to:

- Existing development
- Failing septic systems
- Environmental protection
- Affordable housing

Draft Connection Policy



Draft Connection Policy – In sewer area boundary

- a) New or existing public facility
- b) Existing residence with failing septic within 100' of critical area buffer
- c) Existing residence with failing septic not near critical area and no alternatives
- d) Existing commercial space needs

Draft Connection Policy – In sewer area boundary

- e) New residential at maximum density and deeded affordable
- f) New residential at less than maximum density and deeded affordable
- g) New accessory dwelling units only if deeded affordable

Draft Connection Policy – In adjacent open space area

- a) New or existing public facilities
- b) Existing residence with failing septic within 100' of critical area buffer

Draft Connection Procedure



Draft Connection Annual Procedure

1. Open call for connections in June
2. Applications submitted and reviewed by staff – complete by July 31
3. Staff evaluation and recommended prioritization of up to 7 per year
4. City Council consideration in Sept/Oct

Draft Connection Annual Procedure

5. Connections approved but unpaid are redistributed in a subsequent year
6. Connections remaining after 2028 distributed in subsequent years
7. Each year the City considers purchase of 1 connection for unspecified commercial use or imminent emergency – may be distributed out of cycle with notice to City Council
8. Denied applicants may re-apply – no appeal

Next Steps

1. City Council discussion
2. Adopt by Resolution at future meeting

South Island/Rockaway Sewer Connection Policy Update February 18, 2025

Discussion





CITY OF
BAINBRIDGE ISLAND

City Council Study Session Agenda Bill

MEETING DATE: February 18, 2025

ESTIMATED TIME: 30 Minutes

AGENDA ITEM: (6:40 PM) Present the Draft Report for the Wastewater Beneficial Re-Use Study - Public Works,

SUMMARY: A representative from the City's consultant team, HDR, Inc. will present a summary of the draft Wastewater Beneficial Re-Use Study. The study provides a high-level analysis of the potential for wastewater re-use as a substitution for irrigation and/or groundwater recharge.

AGENDA CATEGORY: Presentation

PROPOSED BY: Public Works

RECOMMENDED MOTION:
Presentation only.

COMMUNITY ENGAGEMENT AND OUTREACH:
None planned at this time.

FISCAL IMPACT:

Amount:	N/A
Ongoing Cost:	N/A
One-Time Cost:	N/A
Included in Current Budget?	true

BACKGROUND: The wastewater beneficial re-use study was funded by the City Council with American Rescue Plan Act (ARPA) funding in fall 2021. The first phase of this effort, presented to the City Council on November 15, 2022, resulted in identification of potential sources and uses of reclaimed water. The second phase of this effort built upon that preliminary work by further evaluating the technical feasibility of two reclaimed water system options.

The attached technical memorandum summarizes the analysis conducted in the second phase, including refined analysis of potential reclaimed water use volumes, conceptual-level costs of the infrastructure required to implement the two analyzed options, and identification of future steps that could be taken to advance evaluation and implementation of this type of program.

The memorandum explores two potential opportunities related to the beneficial reuse of wastewater and the feasibility of implementing a reclaimed water program:

Option 1: Centralized. Upgrading the Winslow Wastewater Treatment Plant (WWTP) to produce Class A reclaimed water.

Option 2: Decentralized. Development of a small, satellite treatment facility in the northwest portion of the Winslow sewer-shed, to intercept a portion of the City's sewer flows where they could be treated to Class A reclaimed water.

The City's consultant team, HDR, Inc., will present an overview of the study for City Council discussion.

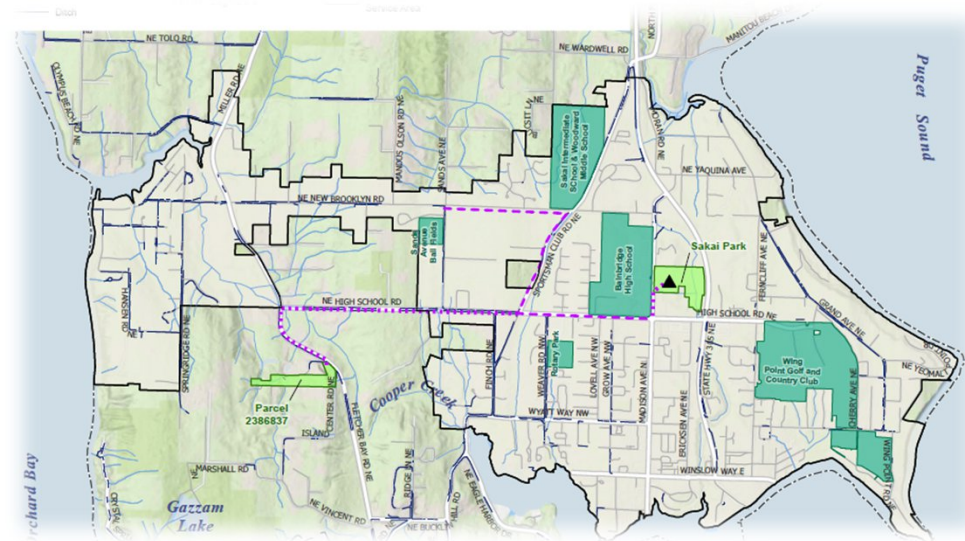
ATTACHMENTS:

[BI Reuse Update 2025-02-06.pptx](#)

[Bainbridge Island WW Beneficial Reuse TM 2 2024-09-09.pdf](#)

[Appendix A Bainbridge Island WW Beneficial Reuse TM 1 2022-11-01.pdf](#)

[Appendix B Groundwater Recharge Analysis.pdf](#)



Wastewater Beneficial Reuse Project Update

City of Bainbridge Island



February 18, 2025

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Outline

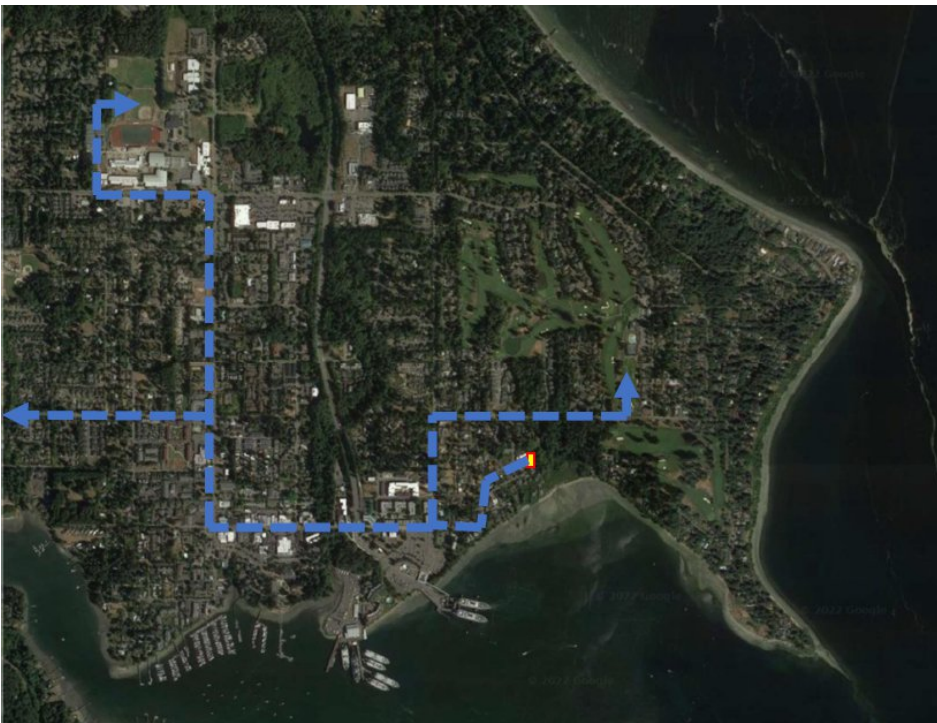
- Recap of prior work
 - Potential sources and uses of reclaimed water
 - Alternatives to explore further
- Update on recent work
 - Groundwater recharge feasibility
 - Satellite treatment facility feasibility
 - Further definition/costs of alternatives
- Next steps

Potential Sources of Reclaimed Water

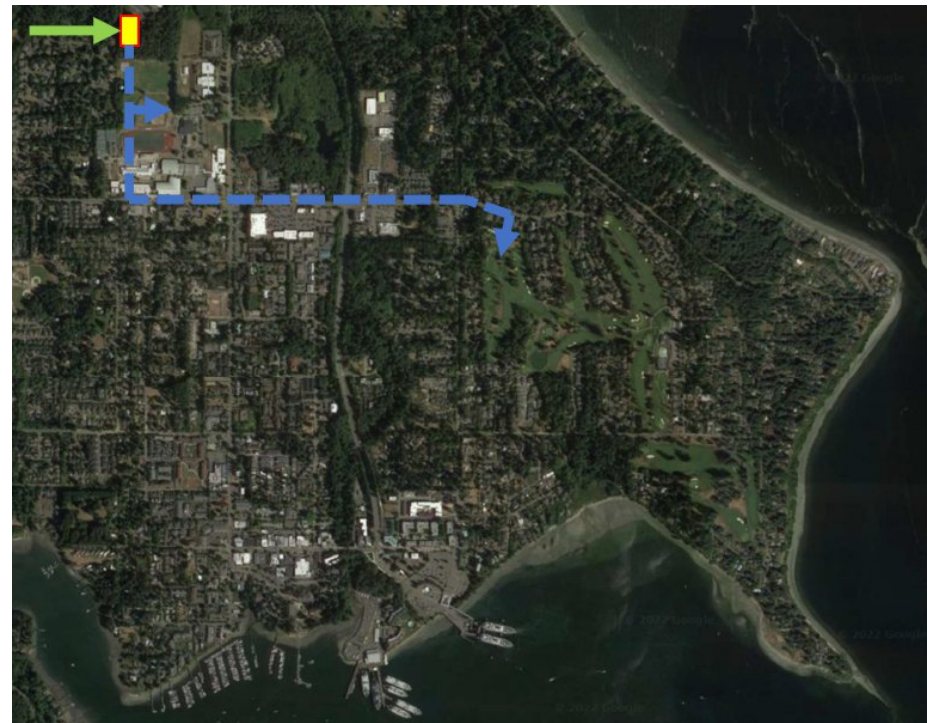
- Winslow
 - Centralized
 - Winslow Wastewater Treatment Plant
 - Decentralized
 - New, small facility in upper part of sewershed
- South Island
 - Sewer District #7

Potential Sources of Reclaimed Water

1. Centralized



2. Decentralized



Potential Uses of Reclaimed Water

- Irrigation
 - Wing Point Golf Course
 - City parks and school fields
- Groundwater recharge
 - Limited assessment done previously
- Other uses
 - More limited and capital intensive
 - E.g., toilet/urinal flushing, commercial uses

Irrigation

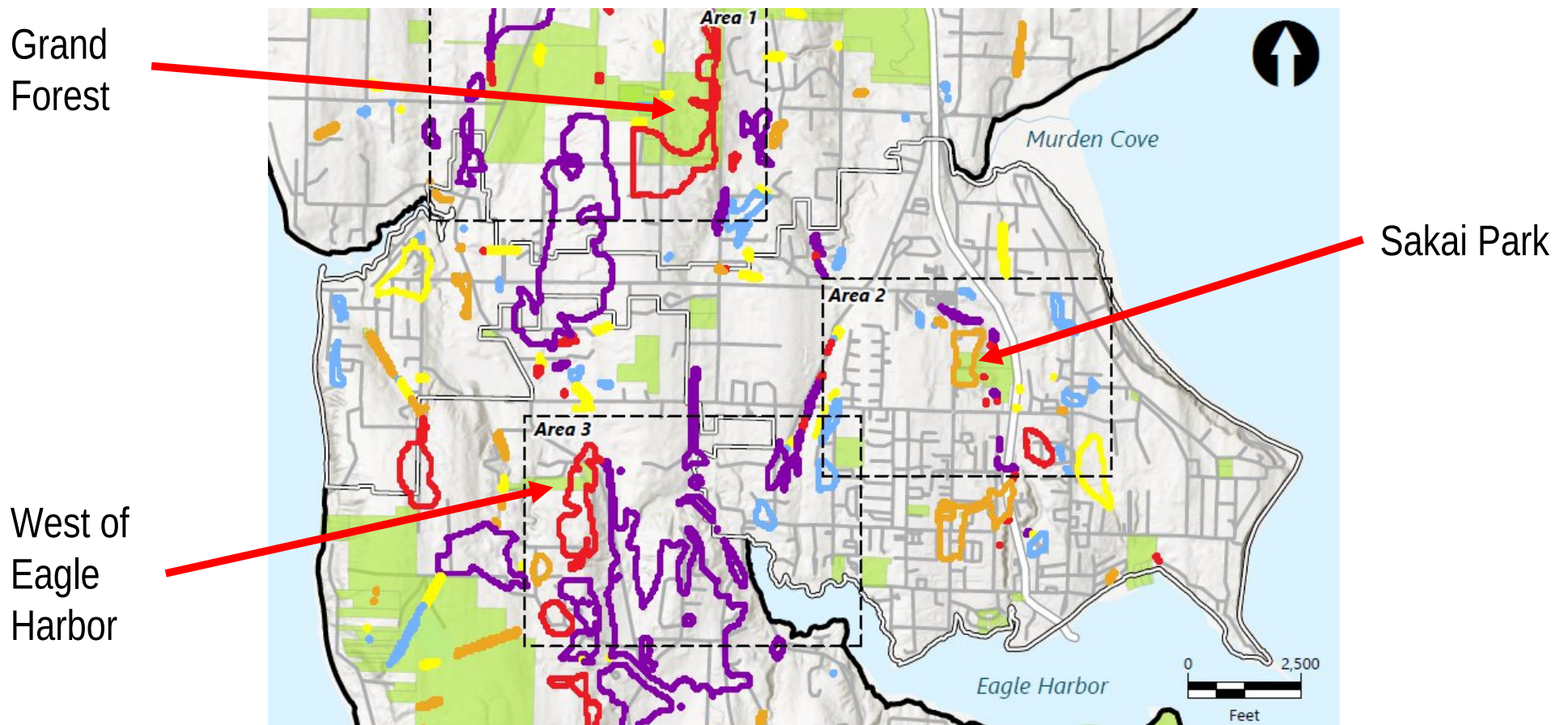
- Focus is on large irrigated areas
- Seasonal use

Potential Irrigation User	Annual Water Use (gallons)	Max Month Use (gpd)
<i>City Water Users</i>		
Bainbridge Island High School	2,027,000	33,300
Rotary Park	615,000	9,600
Sakai Intermediate School	563,000	8,400
Woodward Middle School	2,386,000	32,400
<i>Non-City Water Users</i>		
Wing Point Golf and Country Club	33,540,000	562,000
Sands Avenue Ball Fields	1,677,000	28,100
TOTALS	40,810,000	674,000

Groundwater Recharge Feasibility

- Desktop review of available data
- Development of a Groundwater Recharge Favorability Mode
- Key factors considered:
 - Geology (e.g., presence/absence of till layer near surface)
 - Hydrogeology (e.g., depth to aquifers)
 - Soil characteristics (e.g., infiltration potential)
 - Slope stability and other potential hazards

Groundwater Recharge Feasibility – Areas with Highest Favorability Rating



Alternative 1 – Centralized Treatment

Two Sub-Alternatives

- 1A – Golf Course Irrigation
 - Treatment: WWTP UV Upgrades, Booster Chlorination
 - Distribution: Pump Station, Minimal Piping
 - Cost: ~\$6.2M

- 1B – Other City Irrigation and Groundwater Recharge
 - Treatment: Same as 1A, but with additional treatment
 - Distribution: Pump Station, Extensive Piping, Storage Tank
 - Cost: ~\$19.4M

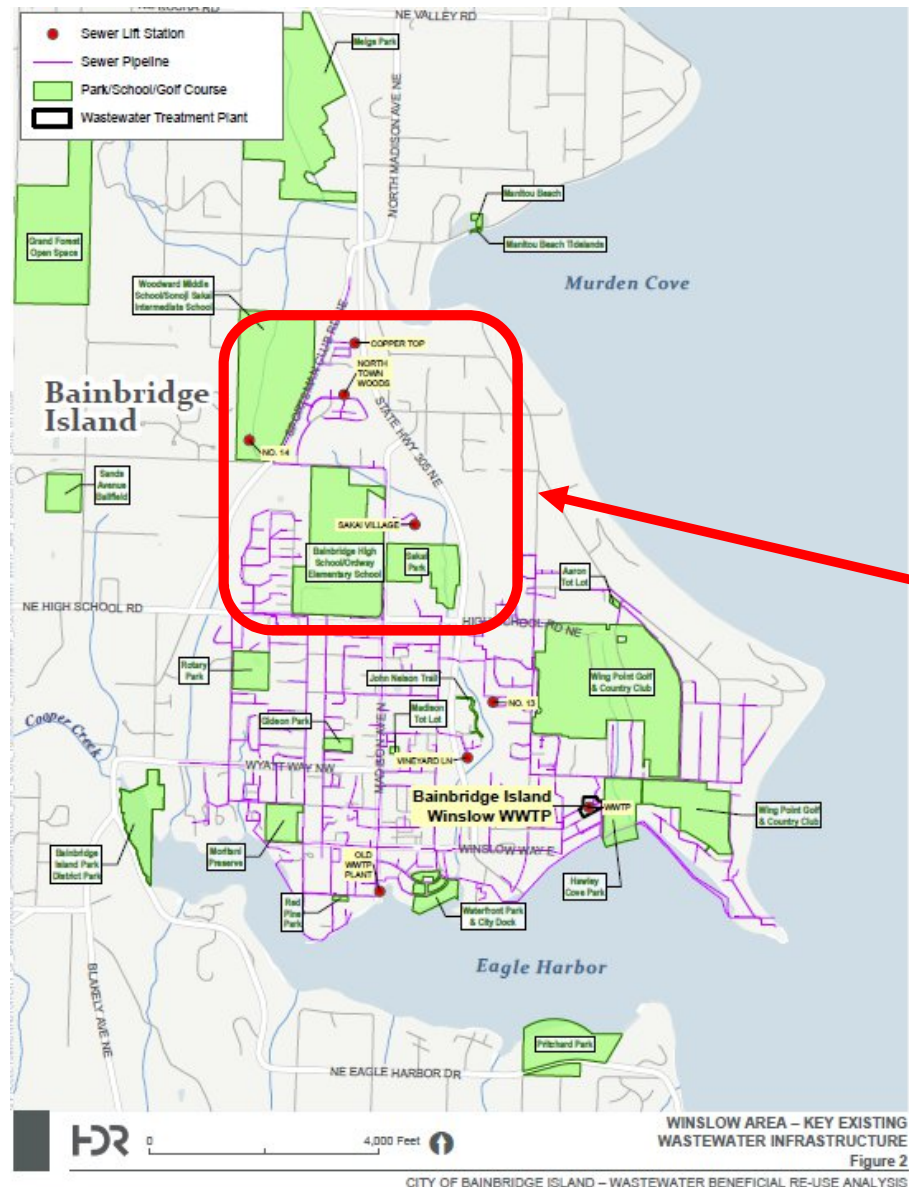


Decentralized Treatment (Satellite Plant)

Concept is to intercept, treat, and locally reuse wastewater before it reaches the WWTP

Focus on northern portion of the sewershed:

- Locations in proximity to potential reclaimed water use sites



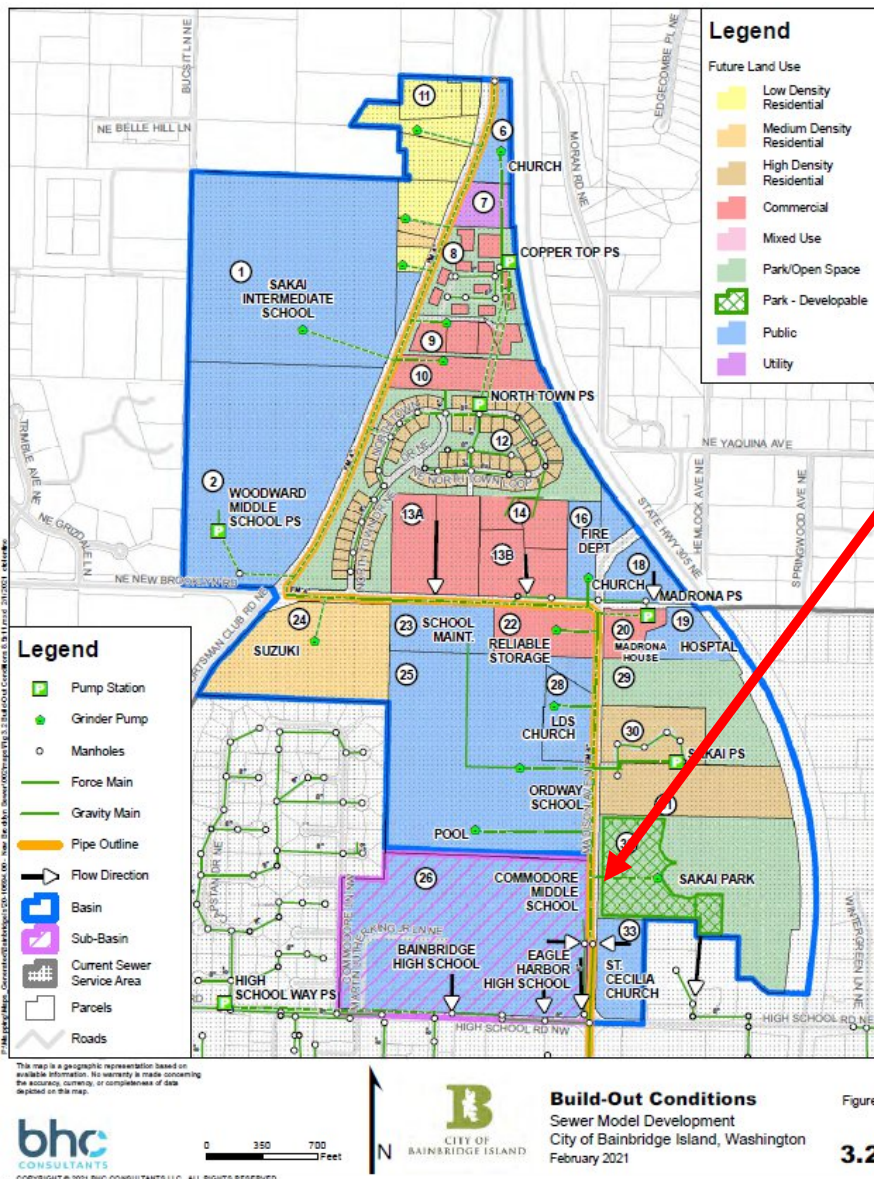
Decentralized Treatment (Satellite Plant)

Investigated the New Brooklyn Sewer Basin
(upstream of Sakai Park)

Prior study (2021) identified flows:

- Existing ~ 54,000 gpd
- Future ~ 67,000 gpd

Equates to ~2/3 of identified City irrigation
(excluding golf course)



Source: New Brooklyn Sewer Basin Study, Preliminary Design Report, BHC Consultants (March 2021)

Alternative 2 – Decentralized Treatment

Two Sub-Alternatives

- 2A – Irrigation Only
 - Treatment: Satellite Treatment Facility (MBR), Booster Chlorination
 - Distribution: Pump Station, Moderate Piping, Storage Tank
 - Cost: ~\$11.7M

- 2B –Irrigation and Groundwater Recharge
 - Treatment: Same as 2A, but with addition treatment
 - Distribution: Pump Station, Moderate Piping, Storage Tank, Recharge Basin
 - Cost: ~\$14.9M

Summary of Alternatives

Alternative	Cost (\$M)	Annual Reuse (MG)	Unit Cost (\$/gal)	Notes
1A – Centralized, Golf Course	\$6.2M	33.5	\$0.18	Lowest cost; simplest implementation; summer use only
1B – Centralized, Other Irrigation + Recharge	\$19.4M	14.6	\$1.33	Highest cost; year-round use; uncertainty around recharge
2A – Decentralized, Irrigation Only	\$11.7M	4.5	\$2.57	Lowest reuse benefit
2B – Decentralized, Irrigation + Recharge	\$14.9M	11.8	\$1.26	Potential additional benefit in reducing flows to WWTP

Next Steps

- Key areas likely recommended for further evaluation/consideration:
 - Additional analysis of groundwater recharge:
 - Site-specific hydrogeological field work
 - » Monitoring wells
 - » Deep borings
 - » Dye tracing
 - Consideration of future plans for Sakai Park
 - Quantitative assessment of groundwater recharge
 - Continued discussions with golf course and School District regarding future irrigation needs

Technical Memorandum - DRAFT



To: Chris Wierzbicki (City of Bainbridge Island)
From: Jeff Hansen, PE (HDR)
Project: Wastewater Beneficial Reuse Analysis
Date: September 9, 2024
Subject: Reclaimed Water Feasibility Analysis

Executive Summary

The City of Bainbridge Island is exploring opportunities related to the beneficial reuse of wastewater and the feasibility of implementing a reclaimed water program. The first phase of this effort, completed in 2022, resulted in identification of potential sources and uses of reclaimed water. The second phase of this effort built upon that preliminary work by further evaluating the technical feasibility of two reclaimed water system options. This technical memorandum summarizes the analysis conducted in the second phase, including refined analysis of potential reclaimed water use volumes, conceptual-level costs of the infrastructure required to implement the two analyzed options, and identification of future steps that could be taken to advance evaluation and implementation of this type of program.

Key findings and highlights of this analysis are:

- The two reclaimed water system options explored, each with two sub-options, are defined as:
 - Option 1: Centralized. Upgrading the Winslow Wastewater Treatment Plant (WWTP) to produce Class A reclaimed water.
 - Option 1A: Golf Course Irrigation. Wing Point Golf Course represents the sole use of reclaimed water.
 - Option 1B: City Irrigation and Groundwater Recharge. Reclaimed water is conveyed to City parks and schools for irrigation, as well as potential groundwater recharge locations.
 - Option 2: Decentralized. Development of a small, satellite treatment facility in the northwest portion of the Winslow sewershed, to intercept a portion of the City's sewer flows where they could be treated to Class A reclaimed water.
 - Option 2A: Irrigation Only. Reclaimed water is used at the same irrigation locations as considered in Option 1B.
 - Option 2B: Irrigation and Groundwater Recharge. Reclaimed water is used in the same irrigation and recharge locations as in Option 1B.
- Option 1A is the lowest cost option, but has the fewest benefits to the City in terms of reduced potable water demands and reduced flows to the WWTP. Option 1B is the highest cost option. Option 2B holds the potential for highest benefit to the City from both the potable water and wastewater perspectives.

- Sakai Park represents a location in proximity to existing infrastructure and potential irrigation sites that also has moderate to high favorability for groundwater recharge. Additional hydrogeologic evaluation is required to confirm the feasibility of this use at this location.
- Reclaimed water benefits associated with avoided costs to the potable water and wastewater utilities have not yet been quantified. Additional work could be undertaken to monetize these benefits and compare them to the estimated costs.

Details of the analysis conducted for this phase of work are described in the sections below.

1.0 Introduction

The City of Bainbridge Island (City) is analyzing the feasibility of implementing a reclaimed water program. Having completed Phase 1 of this effort in 2022, Phase 2 focuses on the Winslow area of the island, where the City's sewer and water systems are most developed (see Figure 1). This technical memorandum (TM) summarizes the Phase 2 analysis, and provides:

- A summary of the outcomes of Phase 1 of the analysis.
- A more detailed exploration of groundwater recharge favorability than was conducted in Phase 1.
- Detailed analysis of the infrastructure requirements needed to implement the two analyzed reclaimed water system options: centralized and decentralized.
- A summary of the costs and benefits of the options.
- Identification of next steps in the evaluation and planning of a reclaimed water program.

The information presented in this TM is based in part upon review of other planning efforts, which have previously explored the concept of wastewater reuse on the island from various perspectives. Documents related to these previous efforts include:

- City of Bainbridge Island Water System Plan; July 2017 (WSP).
- City of Bainbridge Island General Sewer Plan; July 2015 (GSP).
- WRIA 15 Watershed Restoration and Enhancement Plan; March 1, 2022 (WRIA 15 Plan). [This version is the Final Draft Plan submitted for Salmon Recovery Funding Board review, though technical analyses completed as part of earlier draft are also referenced in this TM.]
- City of Bainbridge Island Draft Technical Memorandum: CEC Treatment Technology Options and Performance Literature Review; January 26, 2021 (2021 WWTP CEC Review).
- City of Bainbridge Island Draft Technical Memorandum: Winslow WWTP Capacity Evaluation and Upgrade Alternatives; March 16, 2021 (2021 WWTP Capacity Evaluation).
- UV Disinfection Predesign Report, Nov 6, 2023 (2023 UV Predesign Report).
- New Brooklyn Sewer Basin Study, Preliminary Design Report; March 2021 (2021 New Brooklyn Basin Study).

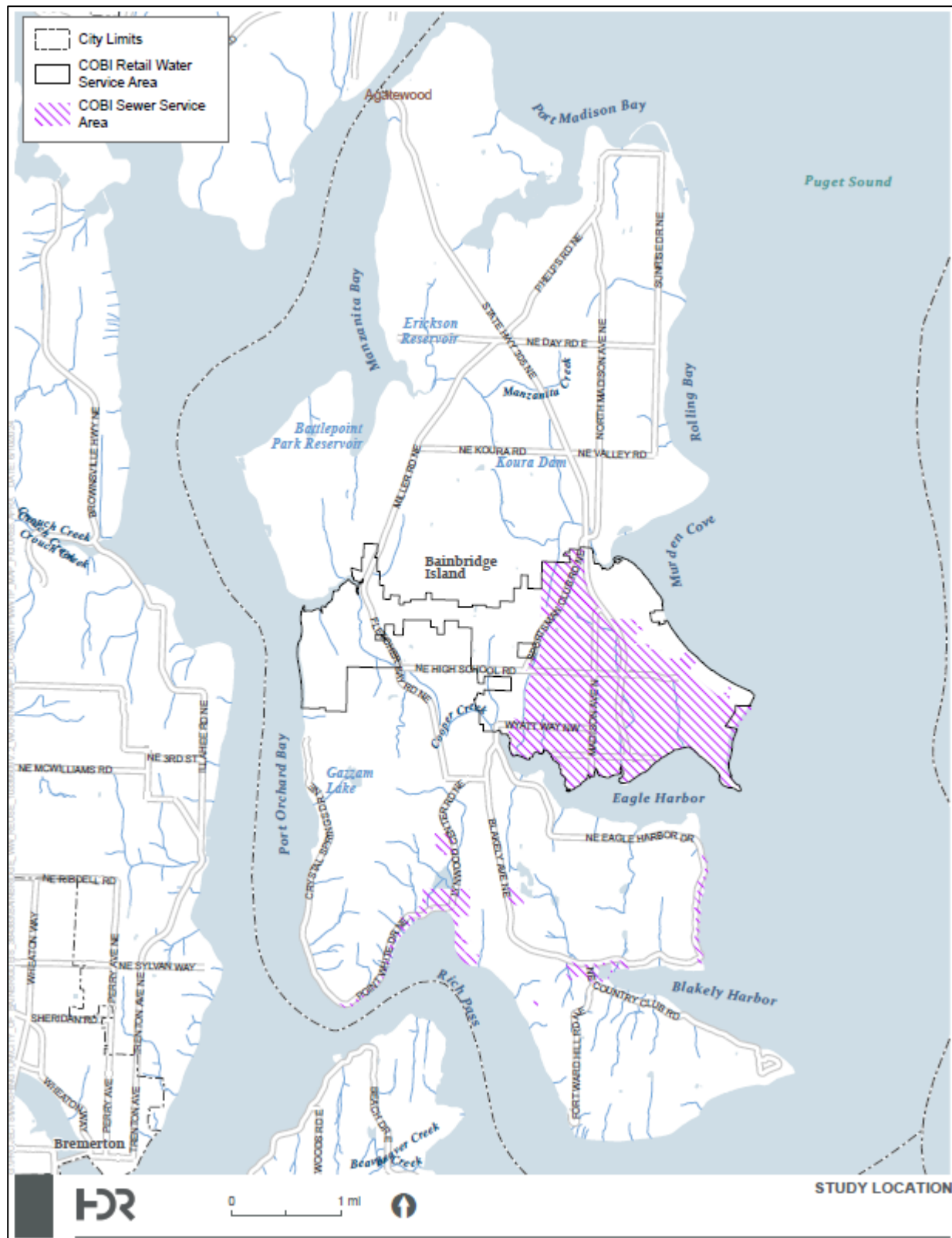


Figure 1. Study Location

2.0 Outcome of Analysis Phase 1

The Phase 1 analysis, documented in Appendix A, resulted in selection of two reclaimed water system alternatives for further evaluation:

- Option 1: Centralized – Upgrading the Winslow Wastewater Treatment Plant (WWTP) to produce Class A reclaimed water, for distribution to irrigation and potential groundwater recharge sites.
- Option 2: Decentralized – Development of a small, satellite treatment facility in the northwest portion of the Winslow sewershed, to intercept a portion of the City’s sewer flows where they could be treated to Class A reclaimed water and used for irrigation and groundwater recharge.

The potential irrigation uses to be considered in these options are summarized in Table 1. This includes the largest irrigation users served by the City as well as Wing Point Golf and Country Club, which has its own water supply.

Table 1. Winslow Area – Potential Irrigation Uses of Reclaimed Water

Potential Irrigation User	Estimated Irrigation Demand ^a		
	Average Annual (gallon)	Max Month Average Day (gpd) ^b	Max Instantaneous (gpm) ^c
City Water User			
Bainbridge Island High School	2,027,102	33,315	139
Rotary Park	614,689	9,618	40
Sakai Intermediate School	562,821	8,433	35
Woodward Middle School	2,385,691	32,440	135
Non-City Water User			
Wing Point Golf and Country Club ^d	33,542,287	562,319	2,343
Sands Avenue Ball Fields ^e	1,677,114	28,116	117
TOTALS	40,809,704	674,241	2,809

Notes:

- Based on City billing system data, 2019-2021.
- Meters are read bi-monthly, therefore Max Month Average Day Demand (ADD) represents the maximum two months of consumption. For all years for all customers, this was the meter read from mid- to late-August, which represents consumption from mid-June through mid-August. A conversion factor was used to reduce the number of days from the full two months to 18 days per month (36 days in a two-month billing period), as irrigation does not normally occur every day.
- Assumes approximately 4 hours of irrigation per irrigation day in the maximum month. = Max Month ADD / 4 hours per day / 60 minutes.
- Estimated based on 75 irrigated acres, defined in the Country Club's water rights, and assumptions regarding irrigation requirements on Bainbridge Island from the Washington Irrigation Guide, 1997.
- Estimated based on 3.75 irrigated acres, using a measurement mapping tool on the aerial image of Sands Avenue Ball Field, and assumptions regarding irrigation requirements on Bainbridge Island from the Washington Irrigation Guide, 1997.

The other potentially significant use of reclaimed water in these options is shallow groundwater recharge. As identified in the Phase 1 TM, further evaluation is required to determine specific locations with suitable hydrogeologic conditions for this application, but previous studies including the WRIA 15 Plan have identified a potential annual recharge volume of up to 22.5 acre-feet per year (or 7.3 MG) in the Winslow area.

This second phase of the feasibility evaluation explored the selected options and their uses of reclaimed water in greater detail.

3.0 Groundwater Recharge Favorability Analysis

Anchor QEA conducted a preliminary groundwater recharge favorability evaluation for the City, resulting in identification of favorable sites for potential groundwater recharge. This was completed by compiling the geologic and hydrogeologic attributes of the island into a geospatial database that included data on measured physical, geologic, and hydrogeologic properties. Incorporated data include items such as geologic formations, structures, slopes, geohazards, topography, hydrogeologic properties, and soil types. Also included in the database were anthropogenic features such as contaminated sites, property use types, and infrastructure considerations.

The TM in Appendix B provides the detailed results of this analysis. In summary, three sites in proximity to the core Winslow Area were identified as having moderate to high favorability for groundwater recharge, based on the factors assessed. These are summarized in Table 2 and shown in Figure 2. Because of its proximity to existing infrastructure and potential irrigation sites, Area 2 (Sakai Park) was considered the most feasible potential recharge location for the system alternatives evaluated in this analysis. However, as noted in Appendix B and in Section 8 below, additional steps are needed to fully determine the feasibility of using this site for recharge.

Table 2. Summary of Areas with Moderate/High Groundwater Recharge Favorability

Area Name	Selection Basis	Key Uncertainties
1 – Grand Forest East/West	High score; public land	Easements; geohazards
2 – Sakai Park / Bainbridge Island High School	Moderate to high score; public land; proximity to infrastructure	Till thickness; mapped aquifer characteristics
3 – Eagle Harbor West	High score; public land; proximity to infrastructure	Land use; wellfield considerations

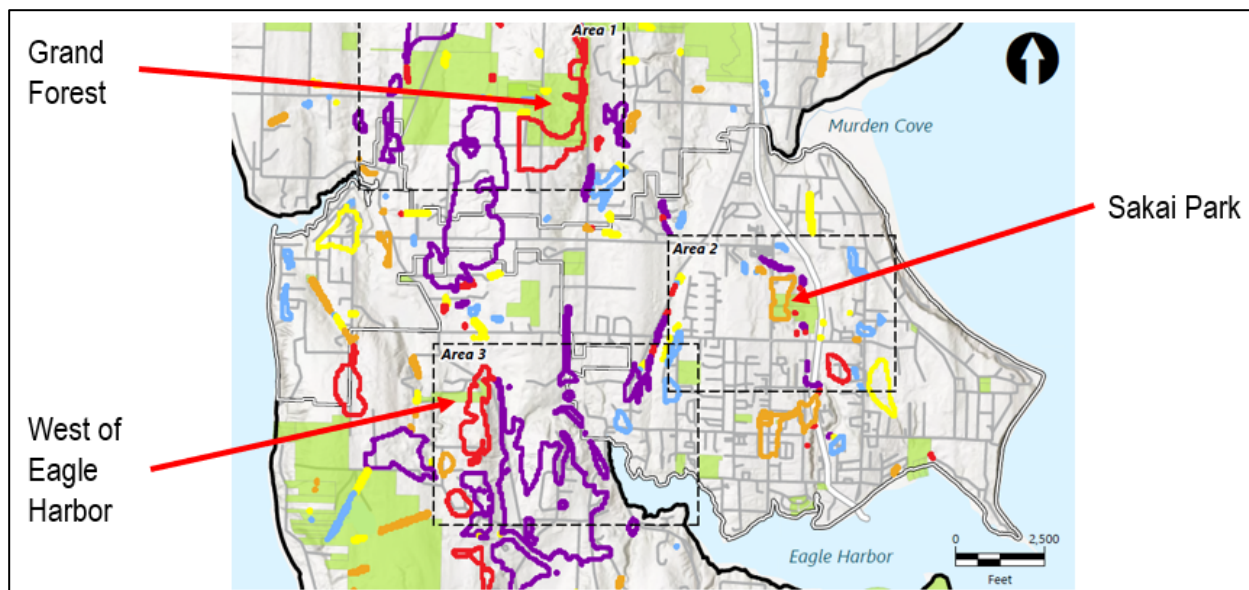


Figure 2. Areas with Moderate to High Groundwater Recharge Potential

4.0 Reclaimed Water System Option 1: Centralized

Option 1 involves upgrading the Winslow WWTP to produce Class A reclaimed water that could be used for a variety of applications. Two sub-options are considered:

- 1A – Golf Course Irrigation. This involves the lowest investment in treatment upgrades and distribution infrastructure, as the sole use of reclaimed water is at nearby Wing Point Golf Course.
- 1B – City Irrigation and Groundwater Recharge. This involves a higher level of treatment upgrades and more extensive distribution infrastructure to convey reclaimed water to other use sites throughout the City.

Figure 3 shows the locations of key infrastructure elements required to implement Option 1. The treatment and conveyance infrastructure needs are described below, along with estimates of cost.

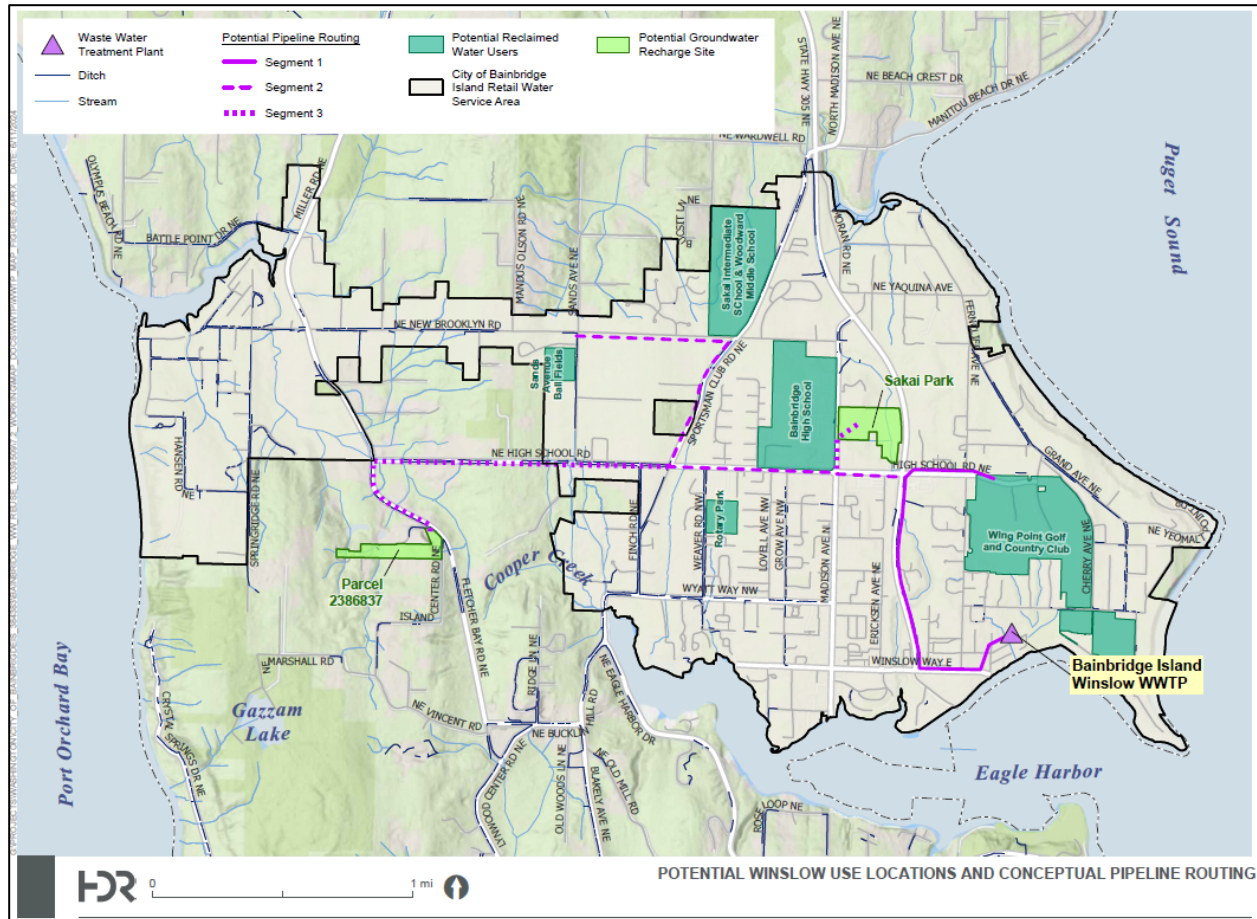


Figure 3. Option 1 – Centralized Treatment

4.1 Treatment

As originally identified in Phase 1 (see Appendix A), there are two levels of treatment upgrades required at the Winslow WWTP to produce Class A reclaimed water suitable for the identified uses: UV disinfection upgrades and granular activated carbon.

- UV Disinfection.** The Winslow WWTP currently utilizes ultraviolet light to achieve its disinfection requirements. An upgrade is currently under design for this system (2023 UV Predesign Report); however, this upgrade is intended to achieve the current levels of disinfection, which are based on producing secondary effluent for marine water discharge. The requirements for Class A reclaimed water are greater and would require installation of a different system. The requirements for Class A include meeting a total coliform 7-day median count of 2.2 MPN/100mL and a sample maximum of 23 MPN/100mL. Additionally, a UV system to produce Class A reclaimed water needs to provide sufficient capacity for a 5-log reduction of poliovirus. The typical UV design criteria, based on the National Water Research Institute (NWRI) Guidelines for Water Recycling, to achieve these Class A water recycling requirements include a UV dose of 100 millijoules per square centimeter of cross-sectional flow area (mJ/cm²) and a UV transmittance (UVT) of 55%. By contrast, the existing system operates with a dose of 36 mJ/cm²

at a UVT of 60%. The planned upgrade may involve reducing the UV dose to 30 mJ/cm². As such, UV system modifications beyond the planned upgrades would be required to produce Class A reclaimed water. Booster chlorination would also be included to maintain a chlorine residual in the conveyance system.

- *Granular Activated Carbon (GAC)*. With increased attention to contaminants of emerging concern (CECs) and the potential risks they pose to human and ecological health, including the recent regulatory actions related to per- and polyfluoroalkyl substances (PFAS), it is likely that the permitting of a reclaimed water system that includes introduction of reclaimed water into the environment through groundwater recharge or streamflow augmentation will require additional treatment designed to remove such contaminants. This is what is referred to in the Washington State Reclaimed Water Rule as “Class A+” reclaimed water, and which is defined on a case-by-case basis, driven by the specifics of a given proposal’s treatment system and potential uses of reclaimed water. In this case, previous work documented in the Phase 1 TM noted that GAC was likely the most feasible additional unit treatment process capable of removing trace amounts of CECs like PFAS. As such, Option 1B, which involves the potential for groundwater recharge, includes the addition of GAC treatment at the Winslow WWTP. The GAC system would be comprised of two vessels likely located on the northeastern edge of the existing plant, requiring about 600 square feet of land area and potentially some tree removal.

4.2 Conveyance

The key conveyance infrastructure elements required for Option 1 include the following:

- Option 1A – Golf Course Irrigation
 - Booster pump station. A 10 horsepower (hp) duplex booster pump station is required to convey flows to the golf course.
 - Distribution piping. Approximately 0.5 miles of piping is required to convey water from the WWTP to the golf course. This is shown as pipeline Segment 1 on Figure 3.
- Option 1B – City Irrigation and Groundwater Recharge
 - Booster pump station. A 10 hp duplex booster pump station is required to convey flows to the western portion of the City.
 - Distribution piping. Approximately 3.5 miles of piping is required to convey water from the WWTP to the western portion of the City, as far as Sands Avenue Ball Fields. This is shown as pipeline Segment 2 on Figure 3. Additional piping would be required (Segment 3) if suitable recharge areas were only identified further west, away from the Winslow core.
 - Distribution storage tank. A tank sized to provide a full day’s worth of irrigation demand (approximately 120,000 gallons) would be needed to meet diurnal fluctuations in demand. Such a tank would be located on public property near one of the irrigation sites.
 - Recharge basin. Approximately 1 acre of subsurface rapid infiltration gallerie would be constructed to accept flows not used for irrigation, up to the hydrogeologic capacity identified at the site. Such a facility is conceptually located at Sakai Park, or in the City-owned property just to the south of the park. If constructed subsurface, the above-ground functionality of the park space could be retained.

4.3 Costs

Class 5¹ opinions of probable construction cost have been developed for Options 1A and 1B, as summarized in Table 3 and Table 4.

Table 3. Option 1A (Centralized; Golf Course Irrigation) Cost Estimate

Item	Quantity	Unit	Unit Cost	Total Cost
UV Upgrade - full plant	1	LS	\$1,500,000	\$1,500,000
Booster Chlorination System	1	LS	\$250,000	\$250,000
Booster Pumping	1	LS	\$250,000	\$250,000
Distribution Piping	2,640	FT	\$250	\$660,000
Subtotal			---	\$2,660,000
Electrical/Controls Installation			15%	\$300,000
Contingency			50%	\$1,330,000
Mobilization			8%	\$213,000
Contractor's Overhead and Profit			15%	\$399,000
Contractor's Bonds and Insurance			2.5%	\$67,000
Engineering Design and Services During Construction			25%	\$665,000
Subtotal				\$5,634,000
Sales Tax			10%	\$563,000
Total				\$6,197,000

¹ Based on American Association of Cost Engineers (AACE) Class 5 definition, with contingency of 30-100%

Table 4. Option 1B (Centralized; City Irrigation and Groundwater Recharge) Cost Estimate

Item	Quantity	Unit	Unit Cost	Total Cost
UV Upgrade - full plant	1	LS	\$1,500,000	\$1,500,000
Booster Chlorination System	1	LS	\$250,000	\$250,000
GAC System	1	LS	\$600,000	\$600,000
Booster Pumping	1	LS	\$250,000	\$250,000
Distribution Piping	18,480	FT	\$250	\$4,620,000
Distribution Storage Tank	120,000	GAL	\$3	\$360,000
Recharge Basin	1	LS	\$918,000	\$918,000
Subtotal			---	\$8,498,000
Electrical/Controls Installation			15%	\$582,000
Contingency			50%	\$4,249,000
Mobilization			8%	\$680,000
Contractor's Overhead and Profit			15%	\$1,275,000
Contractor's Bonds and Insurance			2.5%	\$213,000
Engineering Design and Services During Construction			25%	\$2,125,000
Subtotal				\$17,622,000
Sales Tax			10%	\$1,762,000
Total				\$19,384,000

In addition to the above capital costs, annual operating and maintenance costs will be incurred. These have not been quantified as part of this analysis, but would include: staff time for operation/maintenance of new treatment trains, energy consumption (e.g., for booster pumping), chemical usage (e.g., for booster chlorination), and periodic equipment replacement.

5.0 Reclaimed Water System Option 2: Decentralized

Option 2 involves siting a small, satellite treatment facility in the northwestern portion of the sewershed to produce Class A reclaimed water that could be used for a variety of applications. Two sub-options are considered:

- 2A –Irrigation Only. Reclaimed water is used only to irrigate City-owned sites in the vicinity of the satellite facility.
- 2B –Irrigation and Groundwater Recharge. Reclaimed water is also used for groundwater recharge, particularly during the non-irrigation season.

Figure 4 shows the locations of key infrastructure elements required to implement Option 2. The treatment and conveyance infrastructure needs are described below, along with estimates of cost.

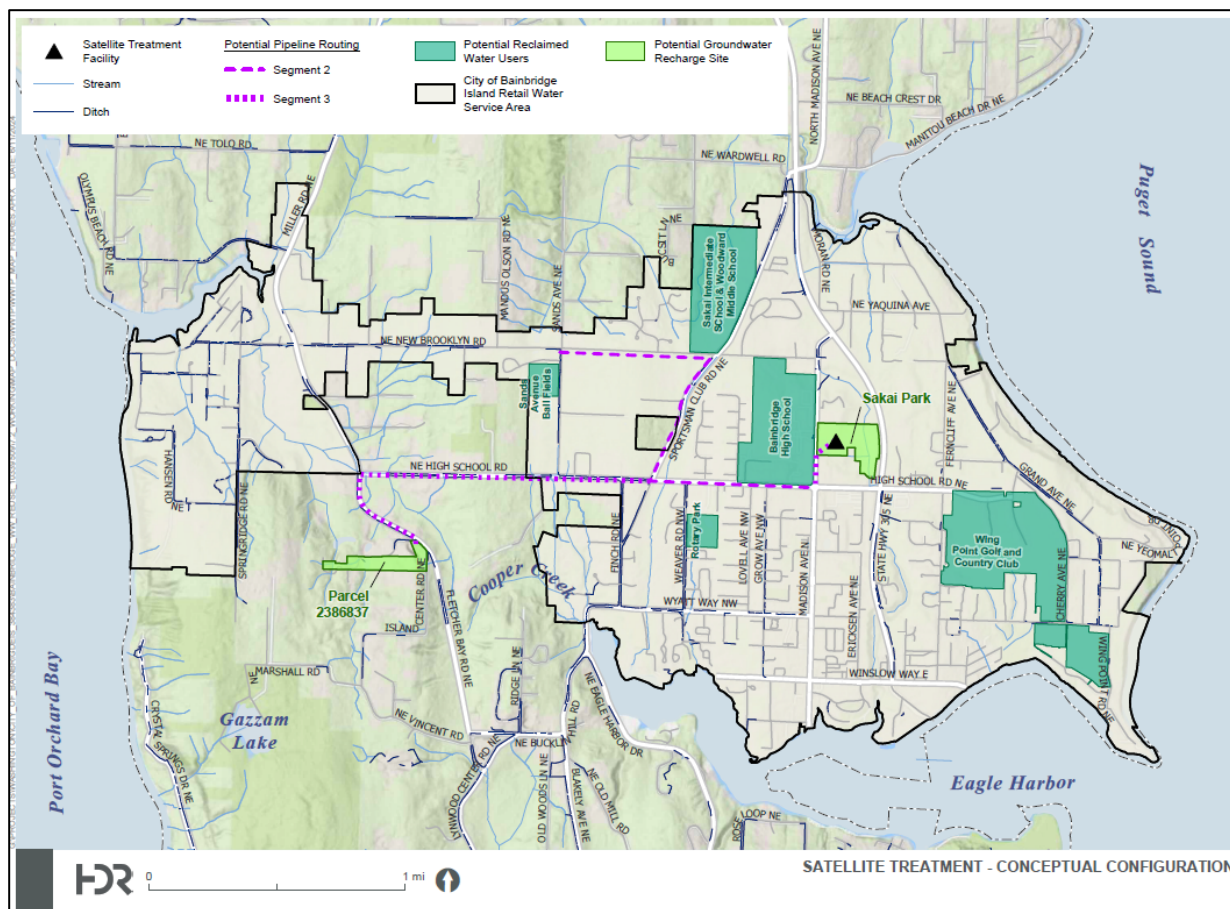


Figure 4. Option 2 – Decentralized Treatment

5.1 Treatment

Analysis of this option began with identification of areas remote from the Winslow WWTP that would have suitable volumes of raw wastewater flow that could be converted to reclaimed water at sufficient quantities to satisfy identified potential reclaimed water demands. A review of the GSP and the City's sewer system hydraulic model resulted in a focus on the northwestern portion of the Winslow sewershed where there are multiple sewer lift stations, anticipated growth in flows, proximity to potential reclaimed water use sites, and publicly-owned properties that could potentially be used for decentralized treatment facilities. This general area is shown on Figure 5.

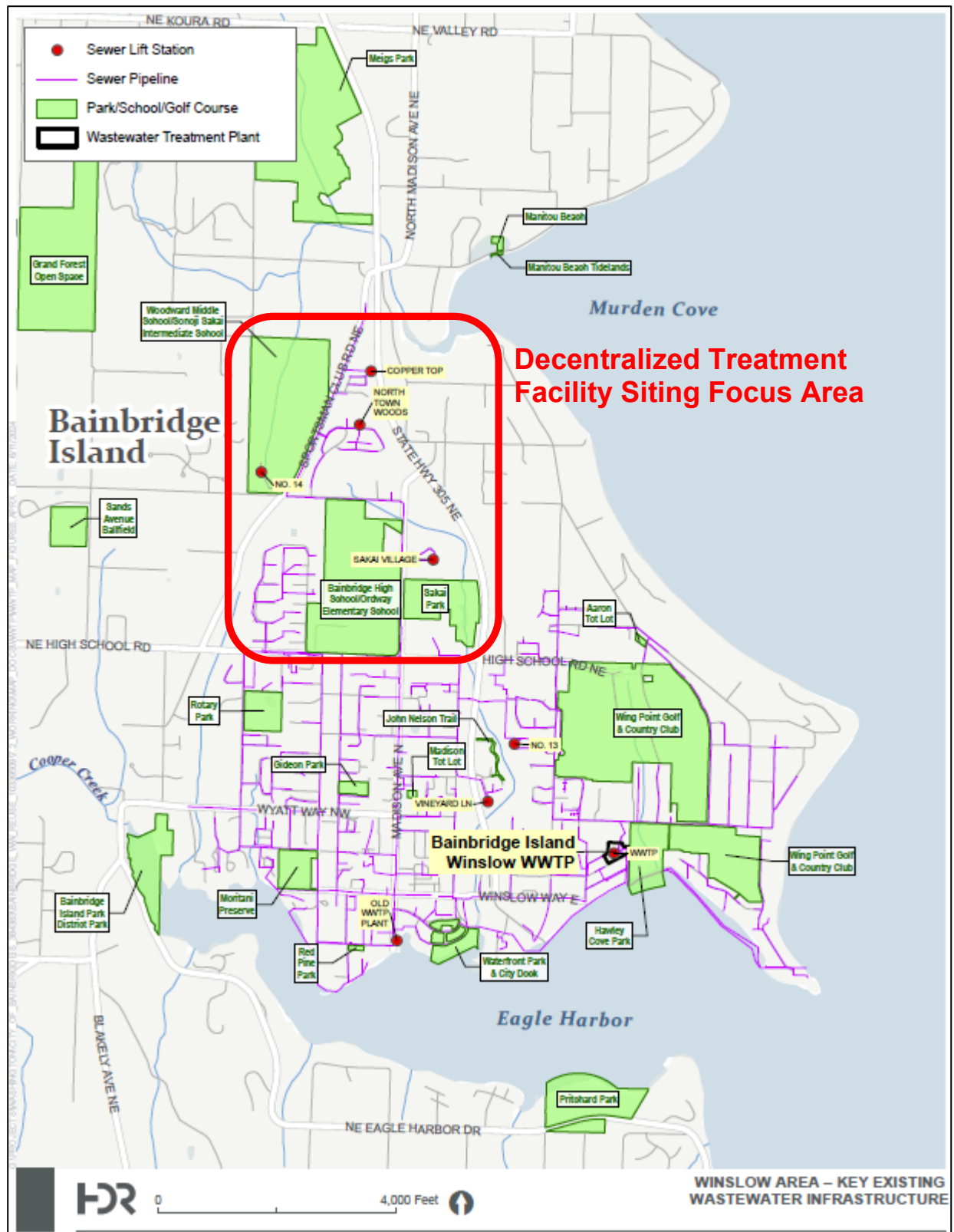


Figure 5. Option 2 – Focus Area for Potential Decentralized Treatment Facility Location

A detailed analysis of existing and future sewer flows associated with this area is documented in the 2021 New Brooklyn Basin Study. That information was reviewed in the context of potential for conversion of sewer flow to reclaimed water. The specific area analyzed in the 2021 Study is shown in Figure 6, and Table 5 summarizes the identified sewer flows.

In total, this area represents an average daily sewer flow of approximately 186,000 gpd currently, increasing to 208,000 gpd in the future. However, a significant amount of this flow is comprised of schools, which are not in operation during the majority of the irrigation season. Thus, school flows were subtracted from the overall total. This adjusted total was further reduced by 15% to reflect low flow conditions during the summer. Of this total, it is assumed that only 75% is available for conversion to reclaimed water, with the remaining 25% of sewer flow needed to convey solids to the WWTP for treatment there. Given these reductions, the total flow available from this area is currently 54,000 gpd, increasing to 67,000 gpd at buildout. This represents about 10% of the total average flow to the WWTP.

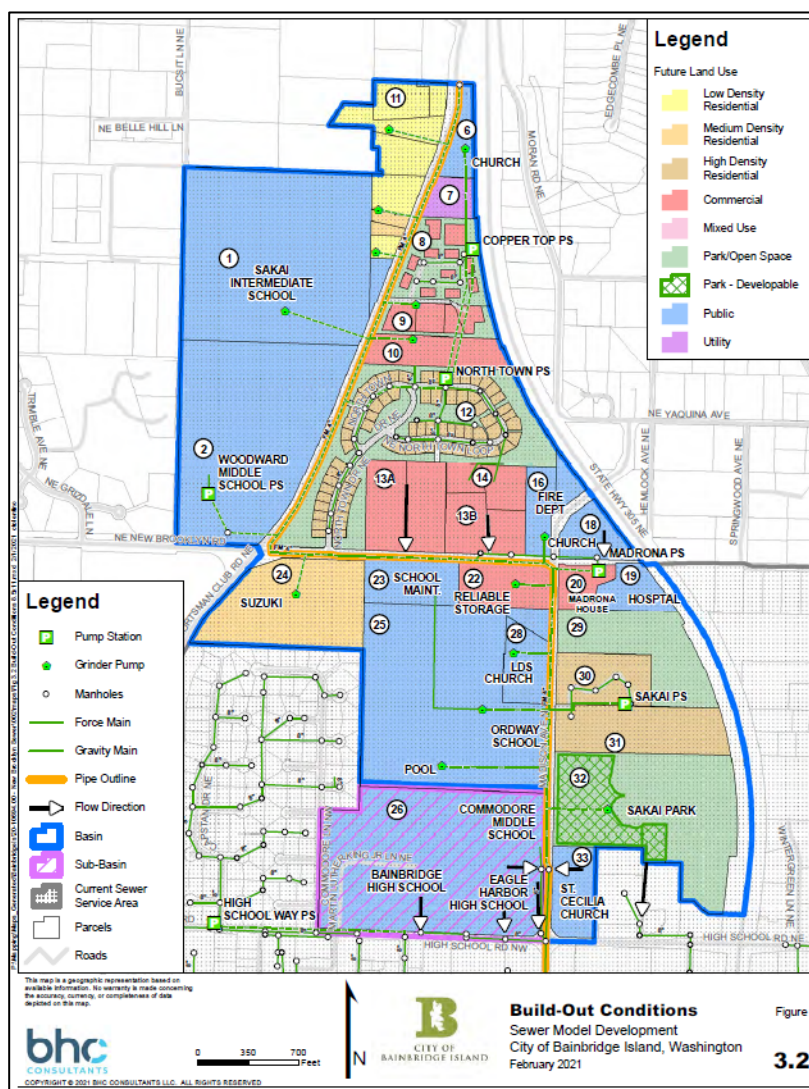


Figure 6. New Brooklyn Sewer Basin Study Area (Source: 2021 New Brooklyn Basin Study)

Table 5. Existing and Projected Sewer Flows in Northwest Winslow Sewershed

Subarea	Description	Unit	Existing Units	Buildout Units	Unit Flow (gpd/unit)	Existing Flow (gpd)	Buildout Flow (gpd)
1 - Sakai Intermediate School		Students	528	528	10	5,280	5,280
2 - Woodward Mid School		Students	589	590	10	5,890	5,900
6 - Island Church		Seats	220	220	5	1,100	1,100
7 - Utility		Acres		2.13	50	0	107
8 - Copper Top Business Park		Acres	7.27	7.27	300	2,181	2,181
9 - Sportsman Business Park	Ex-Glassworks	Employees	20		25	500	0
	Ex-Bainbridge Disposal	Employees	20		25	500	0
	Buildout - Comm	Acres		2.89	300	0	867
10 - Sportsman Business Park	Ex-Storage	People	5		15	75	0
	Buildout - Comm	Acres		4.84	300	0	1,452
11 - Res Housing NW Subbasin	Ex-10 DU	People/DU	2.5		100	250	0
	Buildout - Low Density	Acres		10.48	200	0	2,096
	Buildout - Med Density	Acres		0.89	700	0	623
12 - North Town Dev		DU	78	78	250	19,500	19,500
13 - Coultas						0	0
	13A Ex - Vacant					0	0
	13A Buildout - Comm	Acres		8.06	300	0	2,418
	13B Ex - Vacant					0	0
	13B Buildout - Comm	Acres		4.71	300	0	1,413
14 - Artisan Caves and the Barn		Students	200	200	15	3,000	3,000
16 - Fire Station		Employees	25	25	100	2,500	2,500

Subarea	Description	Unit	Existing Units	Buildout Units	Unit Flow (gpd/unit)	Existing Flow (gpd)	Buildout Flow (gpd)
		Mtg Attend	50	50	3	150	150
18 - First Baptist Church		Seats	325	325	5	1,625	1,625
19 - Harrison Med Center	East Bldg	Sq Ft	25700	25700	0.5	12,850	12,850
	Floors 1&2	Beds	23	23	100	2,300	2,300
		Beds	56	56	300	16,800	16,800
20 - Madrona House (51 apts)		Beds	82	82	100	8,200	8,200
22 - Storage Facility		People	5	5	15	75	75
23 - School Maint		Acres	4.56	4.56	70	319	319
24 - Suzuki Property	High Density Res	Acres	13.83	13.83	70	968	968
25 - School Site (to Madison)	Ordway School	Students	383	383	10	3,830	3,830
25A - Pool School		Visitors	225	450	10	2,250	4,500
		Pool	60	60	1440	86,400	86,400
28 - LDS Church		Seats	325	325	5	1,625	1,625
30 - Sakai Village (Sakai PS)	Buildout	Acres	5.46	5.46	1350	7,371	7,371
31 - Sakai South	Buildout	Acres		8.98	1350		12,123
TOTAL						185,539	207,573
TOTAL (less schools)						84,779	104,563
TOTAL (less schools) x 85% (Low Flow)						72,062	88,878
ABOVE TOTAL x 75% (retain 25% for solids conveyance)						54,047	66,659

Given this, a “package plant” treatment facility was sized to treat up to 100,000 gpd (average flow) and up to 200,000 gpd (peak flow). Such facilities are modular in nature and are built around membrane bioreactor (MBR) technology. When coupled with chlorine disinfection, such facilities can produce water of a quality that meets Class A requirements. The facility would require less than a quarter of an acre of land area and would treat only the liquid stream. Solids resulting from the process would be conveyed on to the WWTP in the existing sewer system.

5.2 Conveyance

The key conveyance infrastructure elements required for Option 2 include the following:

- Option 2A –Irrigation
 - Booster pump station. A 5 hp duplex booster pump station is required to convey flows to the irrigation sites.
 - Distribution piping. Approximately 2 miles of piping is required to convey water from the satellite facility to the irrigation sites. This is shown as pipeline Segment 2 on Figure 4.
- Option 2B – Irrigation and Groundwater Recharge
 - Booster pump station. A 5 hp duplex booster pump station is required to convey flows to the irrigation sites and recharge basin.
 - Distribution piping. Approximately 2 miles of piping is required to convey water, as in Option 2A.
 - Distribution storage tank. A tank sized to provide a full day's worth of irrigation demand (approximately 75,000 gallons) would be needed to meet diurnal fluctuations in demand. Such a tank would be located on public property near one of the irrigation sites.
 - Recharge basin. Approximately 1 acre of subsurface rapid infiltration galleries would be constructed to accept flows not used for irrigation, up to the hydrogeologic capacity identified at the site. Such a facility is conceptually located at Sakai Park, or in the City-owned property just to the south of the park. If constructed subsurface, the above-ground functionality of the park space could be retained.

5.3 Costs

Class 5 opinions of probable construction cost have been developed for Options 2A and 2B, as summarized in Table 6 and Table 7.

Table 6. Option 2A (Decentralized; Irrigation) Cost Estimate

Item	Quantity	Unit	Unit Cost	Total Cost
Satellite MBR Facility	1	LS	\$1,800,000	\$1,800,000
Booster Chlorination System	1	LS	\$250,000	\$250,000
Booster Pumping	1	LS	\$200,000	\$200,000
Distribution Piping	10,560	FT	\$250	\$2,640,000
Distribution Storage Tank	75,000	GAL	\$3	\$225,000
Subtotal			---	\$5,115,000
Electrical/Controls Installation			15%	\$372,000
Contingency			50%	\$2,558,000
Mobilization			8%	\$410,000
Contractor's Overhead and Profit			15%	\$768,000
Contractor's Bonds and Insurance			2.5%	\$128,000
Engineering Design and Services During Construction			25%	\$1,279,000
Subtotal				\$10,630,000
Sales Tax			10%	\$1,063,000
Total				\$11,693,000

Table 7. Option 2B (Decentralized; Irrigation and Groundwater Recharge) Cost Estimate

Item	Quantity	Unit	Unit Cost	Total Cost
Satellite MBR Facility	1	LS	\$1,800,000	\$1,800,000
Booster Chlorination System	1	LS	\$250,000	\$250,000
GAC System	1	LS	\$450,000	\$450,000
Booster Pumping	1	LS	\$200,000	\$200,000
Distribution Piping	10,560	FT	\$250	\$2,640,000
Distribution Storage Tank	75,000	GAL	\$3	\$225,000
Recharge Basin	1	LS	\$918,000	\$918,000
Subtotal			---	\$6,483,000
Electrical/Controls Installation			15%	\$577,000
Contingency			50%	\$3,242,000
Mobilization			8%	\$519,000
Contractor's Overhead and Profit			15%	\$973,000
Contractor's Bonds and Insurance			2.5%	\$163,000
Engineering Design and Services During Construction			25%	\$1,621,000
Subtotal				\$13,578,000
Sales Tax			10%	\$1,358,000
Total				\$14,936,000

In addition to the above capital costs, annual operating and maintenance costs will be incurred. These have not been quantified as part of this analysis, but would include: staff time for operation/maintenance of the new satellite treatment facility, energy consumption (e.g., for treatment and booster pumping), chemical usage (e.g., for booster chlorination), and periodic equipment replacement.

6.0 Avoided Costs of Reclaimed Water System Implementation

Phase 1 of this effort identified the various categories of benefits of implementing a reclaimed water program, including benefits to the drinking water utility, the wastewater utility, and more broadly to the environment. Some of those benefits can be viewed as avoided costs that would otherwise be incurred by the City, and these can ultimately be quantified and monetized. Examples of these types of avoided costs are listed below. These have not yet been quantified as part of this analysis, due primarily to their likely small impact from a financial perspective.

- **Deferred Water Supply.** The use of reclaimed water for non-potable applications reduces the amount of potable water required for such purposes and if significant enough, can result in deferment of additional potable water supply development.
- **Avoided Water Supply O&M Costs.** Similar to the benefit above, relaxed use of potable water supplies for non-potable purposes reduces water supply O&M costs for the City.
- **Deferred Wastewater Capacity Increase Costs.** As identified in Phase 1, the Winslow WWTP is nearing its operational capacity. The City is evaluating improvements to expand capacity. Option 2 described in this analysis would have the effect of reducing sewer flows to the WWTP, and as such could defer capacity improvements in time. More confidence is required in understanding the potential volumes of water that could be used for groundwater recharge prior to estimating the effect of this benefit.

7.0 Summary of Options

Table 8 provides a summary of the costs and key features of the options considered in this analysis.

Table 8. Options Summary

Alternative	Capital Cost (\$M)	Annual Reuse (MG)	Unit Cost (\$/gal)	Notes
1A – Centralized, Golf Course Irrigation	\$6.2 M	33.5	\$0.18	Lowest cost; simplest implementation; summer use only; no benefit to the City in reduced potable water demand or reduced WWTP flows
1B – Centralized, City Irrigation + Recharge	\$19.4 M	14.6	\$1.33	Highest cost; year-round use; uncertainty around recharge
2A – Decentralized, Irrigation Only	\$11.7 M	4.5	\$2.57	Lowest reuse benefit
2B – Decentralized, Irrigation + Recharge	\$14.9 M	11.8	\$1.26	Potential additional benefit in reducing flows to WWTP; uncertainty around recharge

Option 1A is the lowest cost option but has the fewest benefits to the City in terms of reduced potable water demands and reduced flows to the WWTP. Option 1B is the highest cost option.

Option 2B holds the potential for highest benefit to the City from both the potable water and wastewater perspectives.

8.0 Next Steps

A key next step in considering feasibility of a reclaimed water program is further work to confirm feasibility of groundwater recharge in the areas of interest near the Winslow core. Recharge is key to year-round use of reclaimed water and would be the primary way in which benefits could be realized associated with reduced flows to the WWTP (i.e., in terms of deferring capacity improvements). Specific next steps in this regard, with a focus on the Sakai Park area, are:

Site-Specific Desktop Review

- Detailed examination of site-specific geotechnical data
 - This approach will aid in supporting a more focused evaluation of each area of interest in the Winslow core and advance the understanding of the geotechnical constraints at each potential site.
- Review of available geotechnical and hydrological boring data in the vicinity of potential sites
 - This objective is geared toward understanding the subsurface conditions, unit thicknesses, hydrogeologic units, and hydraulic gradients.
- Data gaps evaluation
 - Once select locations have been identified, a data gaps evaluation should be performed to determine how the existing data support use of the location for infiltration and to identify any potential data gaps that will be required to fulfill pilot test and/or design requirements.

Site-Specific Geotechnical Investigation

Following a site-specific desktop review, a site-specific geotechnical and hydrogeologic investigation for selected potential siting locations should be conducted to provide detailed information on local geohazards and subsurface conditions. Potential investigative steps to fulfill identified data gaps may include the following:

- Installation of paired monitoring wells (shallow and deep) and subsequent aquifer testing to provide better understanding of vertical hydraulic gradients and hydraulic conductivities
- Deep exploratory borings
 - Limited deep borings are available for reference. The majority of water well borings only penetrate the uppermost confining layer or are within the unconfined aquifer.
 - Site-specific deep subsurface data may aid in identifying the presence of confining units and potentially identify unsuitable subsurface conditions.
- Geophysical exploration techniques
 - Borehole geophysical surveys
 - Surface geophysical surveys
- Dye tracing of groundwater may help inform groundwater movement to look for artesian conditions or surface water interaction locations

Either upon completion of the above steps, or in parallel, further consideration of Option 1A could be explored by determining any additional benefits the City could realize by delivering reclaimed water to the golf course. If that option were to be viewed as beneficial by both the golf course and the City it does represent the lowest cost option, although the benefits with respect to WWTP capacity are only seasonal.

As the City considers next steps like these, the other program implementation considerations identified in Phase 1 (e.g., regulatory requirements, funding options, and public outreach) should also continue to be evaluated.

Appendix A. Phase 1 Technical Memorandum: Reuse Needs/Drivers and Potential Opportunities

Appendix B. Groundwater Recharge Favorability Evaluation

Technical Memorandum



To: Chris Wierzbicki (City of Bainbridge Island)
From: Dan Graves and Jeff Hansen, PE (HDR)
Project: Wastewater Beneficial Reuse Analysis
Date: November 1, 2022
Subject: Reuse Needs/Drivers and Potential Opportunities

Executive Summary

This technical memorandum summarizes the first step in a process that the City of Bainbridge Island has initiated to explore opportunities related to the beneficial reuse of wastewater. This first phase provides a discussion of the regulatory context regarding water reuse, needs and drivers, potential sources and uses of reuse water, conceptual-level costs of select alternatives, and identification of program implementation considerations.

Key findings and highlights of this preliminary effort are:

- Generally, Class A reclaimed water is required for the majority of beneficial uses of wastewater that are contemplated by a municipal entity like the City. “Class A” refers to water that is generated from wastewater using specific treatment processes and that meets stringent water quality requirements. While opportunities for reuse of lower quality water may exist, these are anticipated to be few in number with very limited benefit being received, based upon the experience of other Puget Sound municipalities. Therefore, this analysis is focused on the use of Class A reclaimed water as the source water for beneficial uses.
- A range of opportunities exist for the use of reclaimed water on the island, with the most feasible including irrigation of landscape and turf areas (such as golf courses, sports fields, and parks) and groundwater recharge (with the purpose of augmenting shallow groundwater aquifers while also supporting base flows in streams and enhancing wetland areas).
- The costs of producing Class A reclaimed water, either through upgrades to existing wastewater treatment plants like the City’s Winslow facility or by constructing new and smaller treatment facilities in presently unsewered portions of the island, can be significant. Such costs must be considered in conjunction with the costs of pumping and piping infrastructure needed to deliver the resource to potential use areas when comparing investments with the benefits that can be realized.
- This analysis evaluated six hypothetical reuse alternatives, considering various combinations of reclaimed water sources and uses. The annual amount of reclaimed water to be beneficially reused under these options ranges from 2.0 to 40.8 million gallons. The capital costs associated with the alternatives ranges from \$5.5 million to \$12 million.
- As the City continues exploring the feasibility of reuse on the island, key implementation considerations to take into account, beyond technical feasibility, costs, and water quantity/quality benefits, include items such as evolving water quality regulations, grant/loan funding options, and the need for continued public outreach.

Details of the analysis conducted for this phase of work are described below.

1.0 Introduction

The City of Bainbridge Island (City) is conducting an initial review regarding opportunities and constraints related to beneficial reuse of wastewater. A phased approach to this effort is being taken, with the objective of this initial step being to determine what opportunities may be worth exploring in greater detail. This technical memorandum (TM) summarizes the first step in this process, and provides:

- A summary of the regulatory context surrounding water reuse.
- Discussion of needs and drivers that might lead the City to consider implementing reuse.
- Identification of potential sources and uses of reuse water on the island.
- Description of example reuse implementation alternatives.
- Identification of other considerations that can inform reuse program development.
- A summary of next steps.

The information presented in this TM is based in part upon review of other planning efforts, which have previously explored the concept of wastewater reuse on the island from various perspectives. Documents related to these previous efforts include:

- City of Bainbridge Island Water System Plan; July 2017 (WSP).
- City of Bainbridge Island General Sewer Plan; July 2015 (GSP).
- WRIA 15 Watershed Restoration and Enhancement Plan; March 1, 2022 (WRIA 15 Plan).
[This version is the Final Draft Plan submitted for Salmon Recovery Funding Board review, though technical analyses completed as part of earlier draft are also referenced in this TM.]
- City of Bainbridge Island Draft Technical Memorandum: CEC Treatment Technology Options and Performance Literature Review; January 26, 2021 (2021 WWTP CEC Review).
- City of Bainbridge Island Draft Technical Memorandum: Winslow WWTP Capacity Evaluation and Upgrade Alternatives; March 16, 2021 (2021 WWTP Capacity Evaluation).

2.0 Regulatory Context

Wastewater that is reused for beneficial purposes in a municipal context must meet certain regulatory and water quality requirements. Throughout this document, such water is referred to as reclaimed water (also known as recycled water). In Washington, reclaimed water is defined in Washington Administrative Code (WAC) 173-219 as: “water derived in any part from a wastewater with a domestic wastewater component that has been adequately and reliably treated to meet the requirements of WAC 173-219, so that it can be used for beneficial purposes.” As such, reclaimed water is no longer considered a wastewater once it is put to use.

WAC 173-219 defines the requirements and constraints pertaining to the use of reclaimed water for a wide range of purposes. Reclaimed water permits are issued by the Washington State Departments of Ecology (Ecology) and Health (DOH). Ecology is generally the lead permitting agency, with the primary exception being when the source water is generated by an on-site sewage system with a design flow of less than or equal to 100,000 gallons per day (gpd).

There are three classes of reclaimed water defined in WAC 173-219: Class B, Class A, and Class A+. These are defined by varying degrees of treatment and water quality, and are each applicable for various uses. Examples are:

- Class B (meets oxidation and disinfection requirements) reclaimed water can be used for some construction and industrial purposes, and certain irrigation uses where access to the general public is restricted.
- Class A (meets Class B requirements, plus coagulation and filtration, or use of membrane filtration) reclaimed water can be used for a wide range of commercial uses (such as toilet/urinal flushing and street sweeping) and irrigation of areas that have open access to the public. This can also be used for groundwater recharge, assuming additional requirements are met, such as nitrogen limits.
- Class A+ (meets Class A requirements, plus additional needs to be health protective, as defined on a case-by-case basis) is required for direct potable reuse (i.e., drinking or direct ingestion).

Generally, Class A reclaimed water is required for the majority of uses contemplated by a municipal entity like the City. Therefore, it is water of this quality that is considered in this TM when evaluating potential reuse opportunities. While opportunities for use of lower quality water may exist, they are anticipated to be few in number with very limited benefit being received, based upon the experience of other Puget Sound municipalities.

3.0 Needs and Drivers

Water reuse can provide multiple benefits, which can be organized according to the following perspectives.

- **Wastewater Utility.**
 - **Relieve capacity constraints.** For some utilities facing capacity constraints at centralized wastewater treatment plants (WWTPs) or in specific portions of their collection/conveyance systems, the reuse of reclaimed water produced at smaller “satellite” plants located higher up in the watershed can divert the amount of wastewater being processed at a central facility, thereby deferring or avoiding capacity-related improvements. The City’s 2021 WWTP Capacity Evaluation notes that during the spring of 2020, the City’s Winslow WWTP exceeded 85% of its design capacity for two months, indicating that planning for capacity expansion may need to be begin soon. In the event wastewater flows within the Winslow sewer service area, particularly in the northwest portions located furthest away from the WWTP, are projected to increase to a point where significant capital would be required to upgrade conveyance or WWTP infrastructure, the retaining of wastewater in those areas could reduce centralized treatment costs. Such reductions would be offset by reuse infrastructure costs and the increased operational costs of having an additional facility to manage, and so would have to be evaluated to determine if the trade-off is cost-effective.
 - **Reduce marine discharge.** Reuse is being increasingly explored around Puget Sound as a means to reduce wastewater discharge to marine waters and comply with more restrictive wastewater discharge permit requirements, such as those

established by the recently enacted Puget Sound Nutrient General Permit (PSNGP). Categorized in the PSNGP as a small discharger, the City will ultimately need to meet a total inorganic nitrogen (TIN) effluent limit of 10 mg/L. The City's Winslow WWTP already meets this requirement and is projected to do so into the near future. The 2021 WWTP Capacity Evaluation indicates that at a flow rate of 1.0 million gallons per day (mgd), the WWTP is modeled to have effluent TIN values of 1 mg/L and 3.5 mg/L under dry and wet weather conditions, respectively. Therefore, it is likely that diversion of marine discharge to reuse would be beneficial from a permitting perspective only if permit requirements become more restrictive in the future.

However, the broader environmental benefit of reducing marine water discharge is reflected in Kitsap County's "Water as a Resource" policy which includes in its guiding principles the concept of reducing pollutant loadings to water bodies. Therefore any reduction in loading to Puget Sound can be viewed as imparting an environmental benefit and being protective of local area water resources.

- **Water Utility.**

- **Reduce peak demand.** Using reclaimed water for non-potable applications can reduce the stress placed upon the island's groundwater supplies, especially during peak use times, and reduce/defer investments in water delivery infrastructure.
- **Augment groundwater aquifers.** Using reclaimed water for groundwater recharge can directly benefit the groundwater system by offsetting future decreases in recharge by precipitation and increases in groundwater pumping to meet expanded water supply demands. This has been specifically identified as a recommendation by the City's Environmental Technical Advisory Committee (ETAC) for consideration in development of the City's Groundwater Management Plan (GWMP).

- **General Water Resource Management.**

- **Supporting Streams and Wetlands.** Reclaimed water can be used to directly augment streams and wetlands, and can be used to indirectly influence them through recharge of groundwater that supports such features. Such actions are in alignment with the County's "Water as a Resource" policy.
- **Climate Resilience.** Using reclaimed water for irrigation and groundwater recharge may mitigate potential negative impacts on the island's water resources due to climate change. The City's Climate Action Plan, published in November 2020, indicates that increasing temperatures and reduced rainfall during summer months will result in increasing irrigation demands for island vegetation. Utilizing reclaimed water for outdoor use can prevent significant additional groundwater withdrawals during the dry season allowing the aquifer and connected streams to maintain their supply. Additionally, groundwater recharge will further help aquifers sustain their capacities.

4.0 Wastewater Sources

Evaluating reuse opportunities requires first understanding where possible sources of reclaimed water currently exist and where they may be feasible in the future. The potential sources on the island include:

- **Existing Central Wastewater Treatment Plants.** Figure 1 shows the locations of the two existing WWTPs located on the island. Both of these facilities currently discharge secondary treated effluent to Puget Sound, and would require improvements to produce Class A reclaimed water.
 - **Winslow WWTP.** This facility was originally constructed in 1978, and last upgraded in 2005. It currently provides secondary treatment through screening, grit removal, aeration basins, secondary clarifiers, and ultraviolet light (UV) disinfection. The plant is rated at a maximum month flow of 1.2 mgd. Average annual flows are currently 0.55 mgd, with maximum month wet weather flows of 0.90 mgd.
 - **Kitsap County Sewer District No. 7 (SD7) Water Reclamation Facility.** This facility was first built in 1996. The facility was expanded in 2009, and provides secondary treatment through screening, aeration basins, clarifiers and UV disinfection. It treats wastewater from Fort Ward, Lynwood Center, and Rockaway Beach. The plant is rated at 0.28 mgd. Average flow rates are on the order of 0.09 mgd, with maximum day values up to 0.43 mgd, based on the facility's NPDES permit fact sheet.
- **Satellite “Package” Plant Opportunities.** Decentralized wastewater treatment options offer opportunities to produce reclaimed water in areas remote from the island's central treatment plants. For example, in the City's GSP, two neighborhood service centers in the middle portion of the Island (i.e., the Mid Island Study Area) that are not currently sewered by the City were identified for potential future sewer service. The two areas are referred to as the eastern and western pockets based on their relative position to each other. The eastern pocket would produce approximately 2,570 gallons per day (gpd) during average dry weather flows (ADWF) and up to 7,710 gpd during peak hour flows (PHF). Sources of wastewater in the eastern pocket are all commercial. The western pocket would produce 13,020 gpd during ADWF and up to 39,060 during PHF. Sources of wastewater from the western pocket are from commercial, low density residential, and public users.

The City considered membrane bioreactor (MBR) “package plants” with groundwater percolation ponds as an option for wastewater management in these areas. MBR package plants typically treat between 20,000 to 150,000 gpd. As described in the GSP, the eastern pocket is likely too small to warrant an MBR package plant; the western pocket is more appropriately sized for this type of treatment.

A situation where this type of package plant may be particularly beneficial is in areas where there are dense clusters of failing septic systems, which would require investment to address identified public or environmental health concerns, that also happen to be located in proximity to potential reuse sites. An initial review of the County's assessment of failed septic systems indicates no obvious area where these conditions are met. As shown on Figure 4, the majority of failed septic systems on the island are located along the shoreline, at distance from where use of reclaimed water would be most beneficial.

5.0 Potential Reuse Opportunities

This section identifies a range of potential uses for reclaimed water on the island, based on a preliminary review of available data.

5.1 Irrigation

A common beneficial use of reclaimed water is for landscape and turf irrigation. This is typically deemed cost-effective when large areas of irrigation are located in fairly close proximity to each other. As an initial step in evaluating the potential for this use, a high-level assessment was made of the largest uses of landscape/turf irrigation water in these locations:

- Winslow Service Area.** This includes the largest irrigation users served by the City as well as Wing Point Golf and Country Club, which has its own water supply. A summary of the potential reclaimed water volume that could be utilized by these uses is provide in Table 1, and reflects similar analyses completed previously in the City's WSP and in the WRIA 15 Plan. Locations are provided on Figures 2 and 3. The majority of this irrigation demand is associated with the golf course, though that of the City's largest water users is also not insignificant.

Table 1. Winslow Area – Potential Irrigation Uses of Reclaimed Water

Potential Irrigation User	Estimated Irrigation Demand ^a		
	Average Annual (gallon)	Max Month Average Day (gpd) ^b	Max Instantaneous (gpm) ^c
City Water User			
Bainbridge Island High School	2,027,102	33,315	139
Rotary Park	614,689	9,618	40
Sakai Intermediate School	562,821	8,433	35
Woodward Middle School	2,385,691	32,440	135
Non-City Water User			
Wing Point Golf and Country Club ^d	33,542,287	562,319	2,343
Sands Avenue Ball Fields ^e	1,677,114	28,116	117
TOTALS	40,809,704	674,241	2,809

Notes:

- Based on City billing system data, 2019-2021.
- Meters are read bi-monthly, therefore Max Month Average Day Demand (ADD) represents the maximum two months of consumption. For all years for all customers, this was the meter read from mid-to late-August, which represents consumption from mid-June through mid-August. A conversion factor was used to reduce the number of days from the full two months to 18 days per month (36 days in a two-month billing period), as irrigation does not normally occur every day.
- Assumes approximately 4 hours of irrigation per irrigation day in the maximum month. = Max Month ADD / 4 hours per day / 60 minutes.
- Estimated based on 75 irrigated acres, defined in the Country Club's water rights, and assumptions regarding irrigation requirements on Bainbridge Island from the Washington Irrigation Guide, 1997.

- e. Estimated based on 3.75 irrigated acres, using a measurement mapping tool on the aerial image of Sands Avenue Ball Field, and assumptions regarding irrigation requirements on Bainbridge Island from the Washington Irrigation Guide, 1997.
- **Rockaway Beach Service Area.** Some residential properties in the Rockaway Beach Service Area exert a higher maximum day demand/average day demand (MDD/ADD) peaking factor than for the rest of the system. The WSP documents this peaking factor as averaging 3.0, but recent data indicate it may be as high as 4.0 at times. Therefore, this service area represents a concentrated area of high irrigation use. Without reviewing specific account data, a high-level estimate of potential irrigation demand for this area was derived as follows:
 - Average water consumption from the 2006-2015 period, as documented in the WSP, is characterized as: total annual consumption = 6 million gallons (MG); ADD = 16,000 gpd; MDD = 48,000 gpd.
 - From HDR's experience, western Washington water utilities with high summertime peaking factors use approximately 30-35% of total water consumption for outdoor purposes. A value of 33% (1/3) is assumed for this high-level calculation. Applying this to the total annual consumption of 6 MG yields a total annual irrigation usage of 2 MG.
 - Averaging the remaining 4 MG over 365 days, this results in total average daily indoor water usage of 11,000 gpd. With a MDD of 48,000 gpd, this indicates maximum daily irrigation usage of approximately 37,000 gpd for the area as a whole.
- **Kitsap PUD (KPUD) Service Areas.** KPUD operates multiple water systems on the island and is assessing its largest water users, to support this effort of exploring potential irrigation uses of reclaimed water. This information will be included in future phases of this analysis, once available from KPUD.

5.2 Groundwater Recharge and Streamflow Augmentation

Groundwater provides most of the late summer flow to area streams and is the source of all drinking water on the island. The two most heavily pumped aquifer layers for drinking water are the Sea Level Aquifer (QA1) and the Fletcher Bay Aquifer (QA3). Private, permit-exempt wells primarily access the Vashon Advance Aquifer (Qva) and the Sea Level Aquifer. The upper three units, Qvr, Qva, and QC1 are the main source of direct recharge for surface water baseflow. Most of the island surface is Qvt (Vashon Till confining unit) on top of Qva or exposed Qva. The Qvt is a confining unit that, when thin enough, allows recharge to the Qva layer below.

Recharge for groundwater systems comes as precipitation and septic system returns except for about 5% which flows under the Port Orchard Bay from the Kitsap Peninsula. Reclaimed water can provide additional recharge opportunities. The WRIA 15 Plan identifies managed aquifer recharge (MAR) as a potential use for reclaimed water throughout the County. While the plan focuses on several potential groundwater recharge projects on the island involving stormwater capture, it is also possible to utilize reclaimed water as the source water for recharge. As part of the technical work conducted to inform the plan, the WRIA 15 committee identified areas where the Qvt confining layer is less than 10 ft thick and the underlying Qva layer is greater than 50 ft thick as being the most likely land areas for groundwater recharge (see Figure 4). Within the City's water retail service area, there are approximately 10 acres of land that fit this criterion. Areas of most interest will be those that are

located generally in the middle of the island that are suitable for recharge, where the positive impact of recharge can extend radially outward to the greatest extent. Specific recharge projects would need additional hydrogeologic analysis to determine the total groundwater recharge potential and feasibility of recharging at that site.

Direct streamflow augmentation is also a possible use of reclaimed water, though it can be significantly more challenging to permit, typically requiring an additional National Pollution Discharge Elimination System (NPDES) permit.

5.3 Indoor Uses

Indoor uses of reclaimed water include commercial toilet and urinal flushing, cooling tower use, and industrial process water use. Of these types of uses, toilet/urinal flushing holds the most promise for implementation on the island, but is likely only worth considering in the context of new construction as the costs for retrofitting of existing buildings with dual plumbing systems has typically been found to be prohibitively expensive.

5.4 Other Uses

Stormwater ponds represent another area where recharge with reclaimed water may be possible. Applying reclaimed water to stormwater ponds could keep the facilities active throughout the year, particularly during dry period of low stormwater flows in the summer. This approach is being explored by Kitsap County and Silverdale Water District in other portions of the County. The most likely candidate ponds for reclaimed water application would be those near a proposed reclaimed water pipeline and/or large irrigation sites where reclaimed water may already be put to use. Based on City GIS data, there are 24 stormwater ponds in proximity to other potential facilities that may be used for reclaimed water irrigation (Figure 3). Further hydrogeologic investigation would be needed to determine feasibility, along with evaluation of stormwater permit compliance.

Similarly, wetland enhancement is a potential use. In western Washington, most utilities explore such uses in conjunction with shallow aquifer recharge. Through augmenting groundwater resources, benefits can often be realized in nearby wetland areas and streams.

6.0 Example Alternatives

To aid in identifying what opportunities may warrant further exploration, it can be instructive to contemplate what an entire system would be comprised of, for the purpose of understanding costs and benefits. The following are potential reclaimed water system alternatives that consider combinations of possible reclaimed water sources and the uses that could be served by them. This list is by no means exhaustive, but was developed to illustrate a range of costs and benefits associated with varying reclaimed water system arrangements. The costs shown below are conceptual-level, pre-Class 5 estimates, based on: previous estimates generated in other City planning efforts, recent bid tabulations for other similar work, and engineering judgement. These are project-level capital costs, including design, permitting, and contingencies. Annual operations and maintenance costs are not included.

- **Alternative 1 – Winslow Area (Centralized Treatment)**
 - **Source.** In this alternative, it is assumed that the Winslow WWTP is upgraded to produce Class A reclaimed water. Multiple options exist for such upgrades. The City's 2021 WWTP CEC Review explored various treatment technologies that would

remove contaminants of emerging concern (CECs) and yield water quality that meets reclaimed water requirements. The preferred option resulting from that analysis was the addition of granular activated carbon (GAC) to the treatment train. If coupled with upgrades to the existing UV disinfection system, Class A reclaimed water could be generated.

Treatment Cost – The total cost of these upgrades is assumed to be on the order of \$4,500,000. This is based on the estimate of \$1,400,000 for GAC (from the 2021 WWTP CEC Review) plus approximately \$3,000,000 for UV system upgrades (based on costs for new systems of the WWTP’s size). It should be noted that per the 2021 WWTP CEC Review and 2021 WWTP Capacity Evaluation, both documents prepared by Murraysmith, these treatment facility upgrades are assumed to be located within the existing footprint of the Winslow WWTP property. The GAC system would be comprised of two vessels located on the northeastern edge of the existing plant, requiring about 600 square feet of land area. An associated pre-filtration building of approximately the same size, could potentially be located adjacent to the clarifiers on the southeastern edge of the property.

○ **Uses.**

- 1a – Golf Course Irrigation. The largest nearby irrigation user is Wing Point Golf and Country Club, as shown in Table 1. This sub-alternative minimizes distribution infrastructure by assuming delivery only to the golf course.

Conveyance Cost – \$1,000,000. Based on ~2,500 feet of pipe (at \$350/ft) and a small pump station.

- 1b – City Area Irrigation. This sub-alternative involves a purple pipe distribution network to serve all potential irrigation customers identified in Table 1.

Conveyance Cost - \$7,500,000. Based on ~20,000 feet of pipe (at \$350/ft) and a pump station.

- 1c – Head-of-the-Bay Groundwater Recharge. This sub-alternative involves conveyance to a recharge area upgradient of the Head-of-the-Bay wellfield. More evaluation is required to determine a specific area that has suitable hydrogeologic conditions, though the mapping in Figure 4 suggests such areas do exist in the vicinity. The WRIA 15 Plan development process identified a potential annual recharge volume of 22.5 acre-feet per year (or 7.3 MG).

Conveyance Cost - \$6,500,000. Based on previous cost estimates developed during the WRIA 15 Plan process. Includes ~10,000 feet of pipe, recharge basins, and a pump station.

• **Alternative 2 – Winslow Area (Satellite Treatment)**

- **Source.** This alternative assumes development of a small MBR package plant located in the central to northwest portion of the Winslow WWTP sewershed. As a satellite treatment facility, its purpose would be to capture wastewater generated in that area of the sewer system, and treat and use it locally; thereby reducing the total

wastewater flow that is conveyed to the WWTP. Solids would be transported to the WWTP for processing at that central location. One of the objectives of this alternative is to defer capacity related improvements required in the future at the WWTP. The satellite facility would be designed to treat up to approximately 85,000 gpd, to meet the primary summer irrigation uses described below. The alternative also includes groundwater recharge in an area upgradient of the Head-of-the-Bay wellfield during non-irrigation times, similar to Alternative 1c. Through these combined uses the total annual volume of reclaimed water generated would be approximately 12.9 MG (5.6 MG for irrigation and 7.3 MG for recharge). It should be noted that one of the potential challenges of this satellite treatment option is the additional operational complexities and considerations regarding management of an additional treatment facility. Such factors should be considered in the ongoing operational costs if this option is advanced and compared in more detail against centralized treatment alternatives.

Treatment Cost – Assumed to be \$9,000,000. This is based on \$6,500,000 for the MBR treatment facility (derived from an equipment cost of approximately \$2,600,000, based on a similarly sized system design for Jefferson County; with a multiplier of 2.5 to account for design, permitting, contingencies, etc.), and \$2,500,000 for the recharge basins (same as costs for recharge basins associated with Alternative 1c).

- **Uses.** The generated reclaimed water would be used for irrigation by the City water use customers identified in Table 1 (i.e., the schools and park), as well as for groundwater recharge.

Conveyance Cost – \$1,750,000. Based on ~5,000 feet of pipe (at \$350/ft).

- **Alternative 3 – Mid Island Area**

- **Source.** This alternative assumes development of a small MBR package plant, as described in Section 4, to generate approximately 13,000 gpd of average dry weather flow (or approximately 7.5 MG of reclaimed water annually).
- **Uses.** The generated reclaimed water would be used for groundwater recharge.

Treatment/Conveyance Cost – Assumed to be \$8,000,000. This is based on \$6,000,000 for the package plant and recharge basins, and \$2,000,00 for collection system piping. Costs are derived from the GSP estimates, escalated to 2022 dollars.

- **Alternative 4 – South Island Area**

- **Source.** This alternative assumes the SD7 Water Reclamation Facility is upgraded to produce reclaimed water. Alternatively, a small package plant could be built on the south part of the island, but the cost would likely be similar to or more than upgrading this existing facility. More analysis of the SD7 facility is needed to determine appropriate upgrades, but for conceptual planning purposes, it is assumed that they are similar to what would be required at Winslow, in terms of adding GAC filtration and upgrading disinfection.

Treatment Cost – Assumed to be approximately half of the Winslow WWTP upgrade costs, or \$2,300,000.

- **Uses.** The most likely use of reclaimed water in the southern portion of the island will be irrigation, as the surficial geology is likely not conducive to groundwater recharge. This alternative assumes use for irrigation of residential properties in Rockaway Beach. This could be expanded to include similar uses at Lynwood Center.

Conveyance Cost – \$4,000,000. Based on ~10,000 feet of pipe (at \$350/ft) and a pump station.

Table 2 provides a summary comparison of the above alternatives. This type of comparison can be expanded upon, with greater enumeration of benefits and challenges, once the initial list of alternatives is reviewed and refined.

Table 2. Reclaimed Water Alternative Comparison

Alternative ^a	Annual Reuse Volume (MG)	Total Capital Cost (\$M)	Cost per Annual Gallon (\$/gal) ^b	Notes/Challenges
1a – Winslow Area / Wing Point Irrigation	33.5	\$5.5	\$0.16	Requires coordination with non-City water user.
1b – Winslow Area / City Irrigation	40.8	\$12	\$0.29	Most complex/ extensive infrastructure.
1c – Winslow Area / Groundwater Recharge	7.3	\$11	\$1.51	Potential significant benefit in groundwater sustainability.
2 – Winslow Area (Satellite Treatment)	12.9	\$10.8	\$0.83	Operational challenges with multiple facilities.
3 – Mid Island	4.8	\$8.0	\$1.67	Extensive new collection system required.
4 – South Island	2.0	\$6.3	\$3.15	Extensive infrastructure to multiple users.

Notes:

- Alternative 1 refers to Centralized Treatment (i.e., upgrades to the Winslow WWTP to produce reclaimed water). The sub-alternatives relate to different uses of this same source water.
- Total Capital Cost divided by Annual Reuse Volume.

7.0 Other Considerations

As the City continues exploring the feasibility of reuse on the island, key implementation considerations to take into account, beyond technical feasibility, costs, and water quantity/quality benefits, include those described briefly below. These items will be explored in greater depth as the City advances in its planning process.

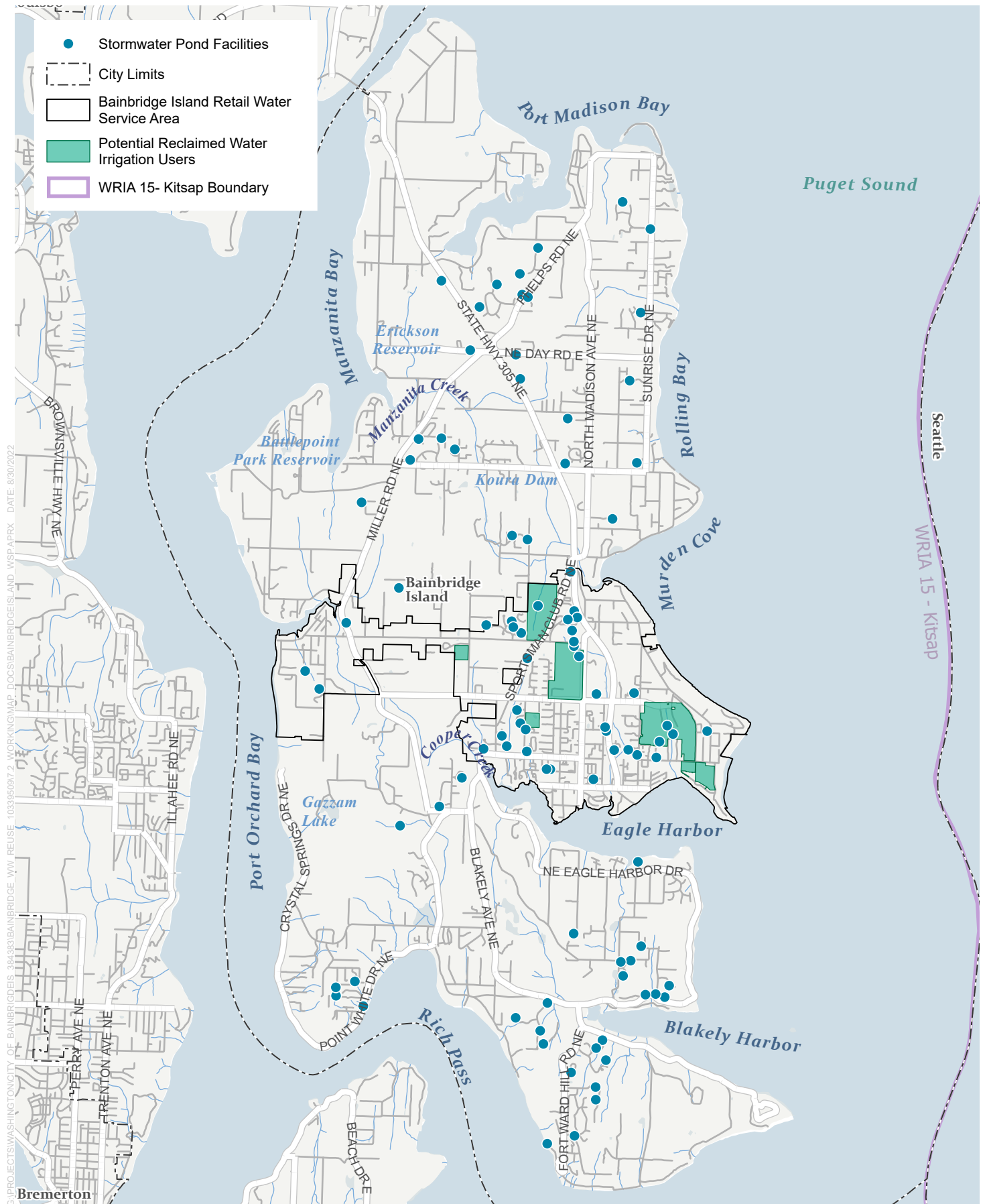
- **Regulatory Requirements.** One of the more rapidly changing elements that will shape future reclaimed water programs are water quality requirements related to currently unregulated chemicals. In particular, the water industry’s current focus on per- and polyfluoroalkyl substances (PFAS) will likely yield State or federal drinking water limits that are lower than the State Action Levels established for five PFAS compounds in 2021. As

evaluated in the City's 2021 CEC Review, this may lead to certain forms of treatment being required to produce reclaimed water suitable for purposes such as groundwater recharge or streamflow augmentation. The City can look to recent risk assessment work conducted by others in the region, such as the LOTT Clean Water Alliance and King County, to consider how these factors may inform reuse planning.

- **Funding.** As shown in the preliminary analysis summarized in Section 6, the capital investment to implement reuse can be significant and is greater than what can be realistically recouped through reclaimed water rates. Most utilities seek low-interest loans or grant money from the State or federal government to support reuse implementation. At the State level, this includes funding through the Centennial Clean Water Fund, while at the federal level this can include funding through the Title XVI (WaterSMART) program.
- **Public Outreach.** Public involvement is critical to the success of a reclaimed water program, largely connected to the above two topics. The public will want assurance that proposed reuse practices are protective of public and environmental health. In addition, the full range of benefits must be articulated so that the community can truly assess costs versus benefits, and understand how investment in reuse relates or compares to other priorities the City is facing.
- **Implementation Policies and Procedures.** Reuse programs require much more than the upfront capital infrastructure. City policies and ordinances will be needed to establish when, where, and how reclaimed water can or must be used and what the applicable rates are for customers who would use the resource. Depending on the extent of infrastructure that may be needed in the future, development standards may be required, including maintenance procedures specific to purple pipe distribution systems, water quality monitoring/reporting, and backflow prevention.

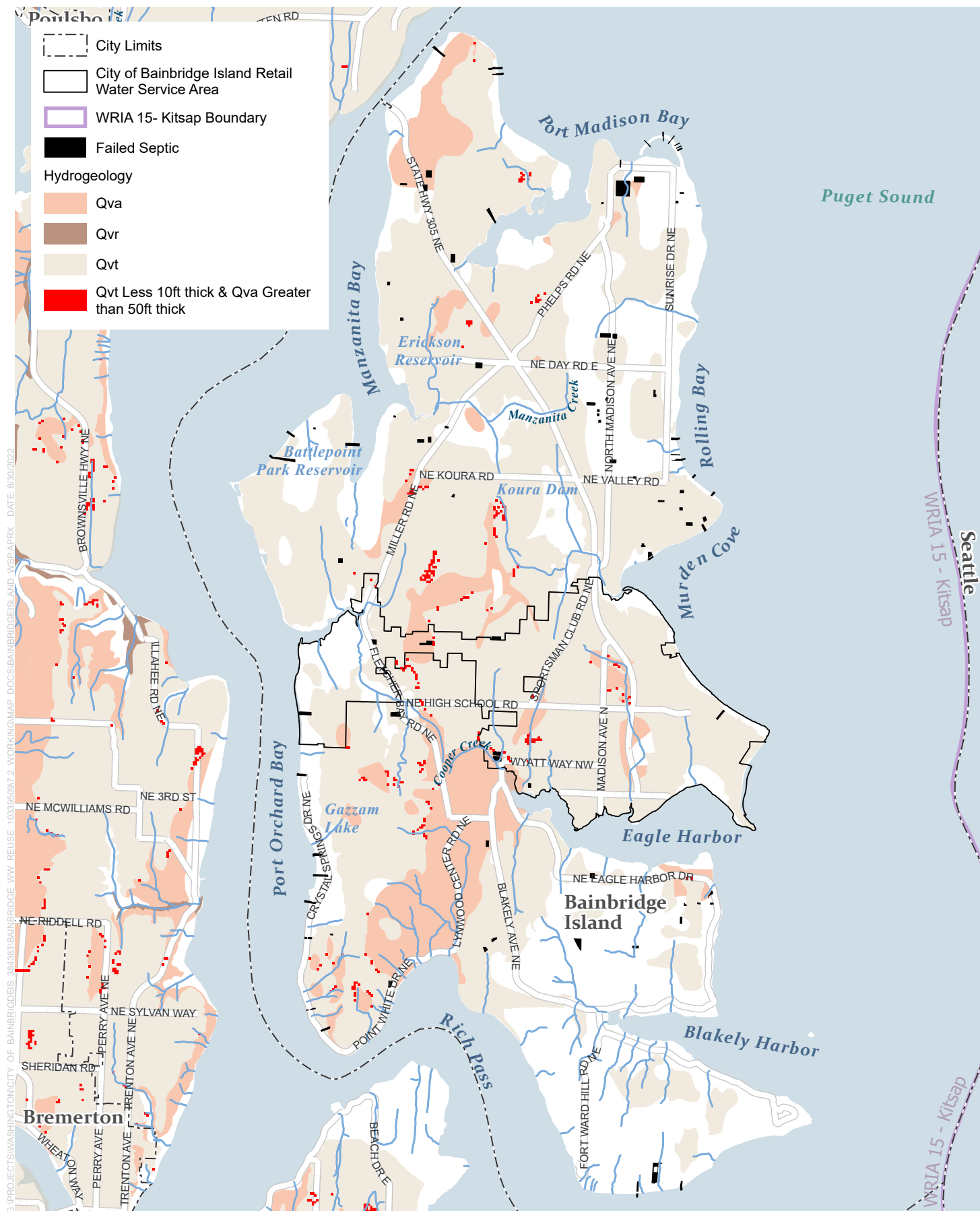
8.0 Next Steps

This TM provides an initial assessment of reuse needs/drivers for the City of Bainbridge Island, and identifies potential reuse opportunities and associated costs. Upon review of this preliminary information and discussion with the Utility Advisory Committee and City Council, the City will proceed with further evaluation of opportunities that have the greatest potential for implementation and which would yield the most benefit to the island.



**POTENTIAL IRRIGATION AND
STORMWATER POND USE LOCATIONS**

Figure 2



0 1 mi



ISLAND SURFACE HYDROGEOLOGY

Figure 4

Memorandum

January 30, 2024

To: Jeffrey Hansen, HDR

From: Luke Maddux, PG, LG, and Cole Bales, PE, Anchor QEA

cc: Chuck Pippin, Anchor QEA

Re: Bainbridge Island Groundwater Recharge Favorability Evaluation

Introduction

Project Overview

This memorandum has been prepared to summarize Anchor QEA's preliminary groundwater recharge favorability evaluation for the City of Bainbridge Island, Washington. A previous study exploring "opportunities related to the beneficial use of wastewater" was conducted by HDR (2022) and led to further investigation into two options for beneficial reuse of Class A reclaimed water: centralized reuse for groundwater recharge proximate to the Winslow Wastewater Treatment Plant and decentralized reuse, which would include a satellite treatment plant to convert sewer service area flows into Class A reclaimed water for groundwater recharge upgradient in the Winslow sewershed. As part of this investigation, Anchor QEA was retained to support the identification of types and locations for potential reuse with a focus on groundwater recharge via infiltration.

Executive Summary

To facilitate the preliminary selection of potential locations for groundwater recharge via infiltration, Anchor QEA completed the following tasks as part of this feasibility study:

- Review publicly available geologic and hydrogeological mapping data
- Develop GIS shapefiles associated with relevant mapping data for use in a GIS web map
- Develop scoring and ranking criteria applied to relevant mapping data for potential groundwater recharge zones
- Develop a Groundwater Recharge Favorability Model (GRFM)
- Conduct a brief site reconnaissance following development of the GRFM to make brief visual observations at identified favorable sites

Following the completion of these tasks, favorable sites for potential groundwater recharge were identified within the island core, including the retail water and sewer service area and bands of the island immediately north and south, in addition to peripheral areas of the island. A tabular summary of these identified locations, as well as the principal factors driving their selection and further study needs or key uncertainties, is provided in Table 1.

Table 1
Summary of Potential Groundwater Recharge Sites per this Study

Site Identification		Site Considerations	
Island Area	Site Name	Selection Basis	Key Uncertainties
Island Core (Water and Sewer Service Area)	Grand Forest East and West	High score; public land	Easements; geohazards
	Sakai Park/Bainbridge High School	Moderate to high score; public land; proximity to existing infrastructure	Till thickness; mapped aquifer characteristics
	Eagle Harbor West	High score; public land; proximity to existing infrastructure	Land use; well field considerations
Island Periphery (North and South)	Manzanita Park	High score; public land	Aquifer thickness/connectivity
	Agate Point		

Document Organization

The contents of this memorandum are organized as follows:

- **Regional Information:** Geography and Topography; Geology; Seismicity and Faulting; Hydrogeology and Groundwater
- **Groundwater Recharge Favorability Analysis:** Approach; Preliminary Results, Site Visit Summary
- **Recommendations for Further Study:** Site-Specific Desktop Review; Site-Specific Geotechnical Investigation; Conclusion
- **References**

Regional Information

Geography and Topography

The City of Bainbridge Island is located on Bainbridge Island in the Puget Sound, west of Seattle, Washington (Figure 1). The glacially scoured island is approximately 3.5 miles wide and 10 miles long, with gently undulating terrain and several hills more than 400 feet above sea level. The coastline is irregular and undulating with several deep inlets and promontories. The island averages more than 37 inches of precipitation per year and is heavily vegetated with coniferous and deciduous trees and underbrush.

The island is moderately developed with an urban center and residential neighborhoods and holds a population of approximately 24,000 people (USCB 2020). Power, water, and sanitary sewer infrastructure is present in parts of the island, and stormwater conveyance systems are in place in the more developed areas of the island.

Geology

Previous geologic and hydrogeologic investigations have compiled detailed geologic maps and cross sections in the Bainbridge Island area. A geologic map is included as Figure 2 (based on Haugerud and Troost 2011, per WDNR 2023). Widespread glaciation in the Puget Sound area is generally responsible for much of the topographic expression and observable geologic features on Bainbridge Island, including glacial scour marks, erratic deposits, and drumlins. Glacial drift materials are present throughout the island. The uppermost layer is Vashon Till (Qvt), a dense, poorly sorted glacial till with varying thicknesses that is the most widely mapped surficial material on the island. In common stratigraphic occurrences, it overlies Esperance Sand (Qve), a well-sorted, porous sand or gravel that is commonly water-bearing. Underlying the Esperance Sand is Lawton Clay (Qvlc), a glaciolacustrine silt and clay unit with extensive lateral distribution and very low hydraulic conductivity. At the south end of the island, Tertiary-aged sedimentary and volcanic rocks are the primary surficial unit and are only locally covered by glacial drift deposits in a few discrete areas.

Seismicity and Faulting

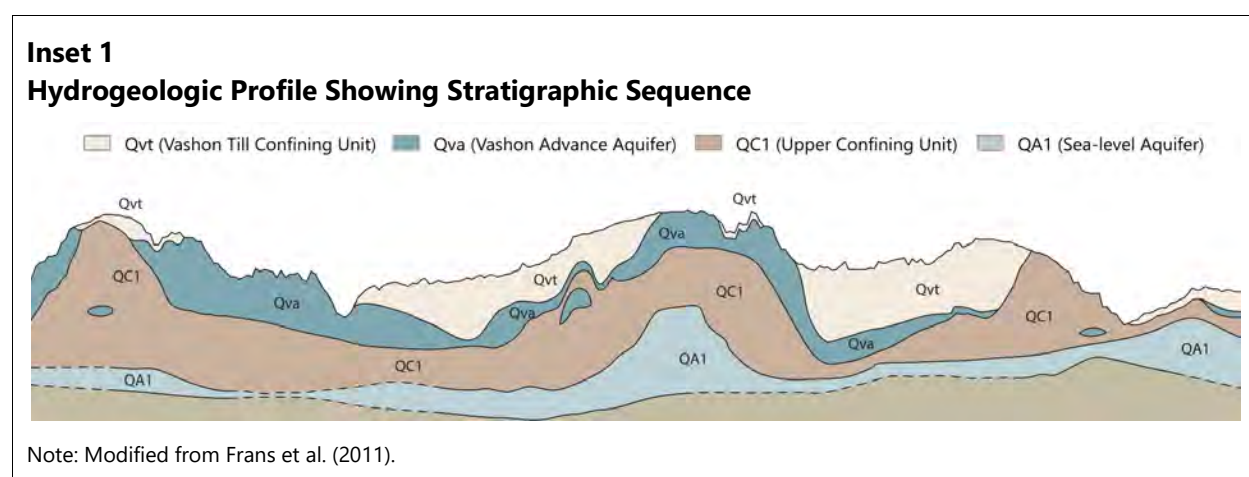
The coastline expression on Bainbridge Island is associated with widespread regional faulting that transects the island. At the south end of the island, the Seattle Fault Zone is an east-to-west trending fault zone comprising several thrust faults, indicative of an overall north-south axis compressional regime in the region. Movement along this fault zone is responsible for the uplift and emplacement of much of the Tertiary-aged geologic features at the south end of the island. The Seattle Fault Zone is considered an active fault and is associated with several seismic events in recorded history.

Inactive faulting in the region includes fault traces between the Seattle Fault Zone and Whidbey Island Fault Zone, which have been identified toward the north end of Bainbridge Island (Mace and Keranen 2012). These fault traces have only been identified using geophysical data and predate glacial deposits, but they connect much of the island's irregular shape and architecture to a seismic origin. Because these data are relatively new, the locations of these inactive faults are not shown on historical geologic maps of the area.

Hydrogeology and Groundwater

Groundwater is present in the subsurface of the island, and the freshwater aquifers are generally separated from saltwater aquifers by confining layers. In cases where fresh and saltwater are both present within an aquifer, the higher density of saltwater drives segregation of fresh and saltwater (with freshwater staying in the upper aquifer) and prevents large-scale mixing of water. Hydrogeologic units consist of both water-bearing and confining units. For the purpose of this study, discussion of groundwater is limited to freshwater aquifers only. The broad surface distribution of the Vashon Till across Bainbridge Island presents limited opportunities to easily recharge groundwater directly through surface infiltration. The Vashon Till ranges from 10 to 100 feet thick and is a poorly sorted and dense

glacial lodgment till with low hydraulic conductivity. Similarly, the Lawton Clay, which is stratigraphically below the Vashon Till and Esperance Sand, is also restrictive of vertical groundwater flow. The presence of the Vason Till across the majority of the island restricts groundwater infiltration to the Esperance Sand, mapped as the Vashon Advance Aquifer (Qva), on the hydrogeologic maps. Stratigraphically, the Esperance Sand commonly occurs beneath the Vashon Till and above the Lawton Clay. In several areas where the Vashon Till is not present at the surface, infiltration of precipitation to the Esperance Sand can occur. The groundwater is in a confined state where it occurs beneath the Vashon Till, but it is unconfined in other areas, such as where Esperance Sand is mapped at the surface. See Figure 3 (attached) for a regional hydrogeologic map of the island. See Inset 1 for an example hydrogeologic profile showing the relative stratigraphic sequence of the identified hydrogeologic units.



The Vashon Advance Aquifer is the primary source of drinking water for the island and is well mapped and understood. It ranges from 20 to 200 feet thick but has limited direct recharge areas due to the presence of the broadly overlying Vashon Till confining unit, which due to its low hydraulic conductivity restricts infiltration into the Vashon Advance Aquifer. A summary of the correlation of the mapped geologic units to the hydrogeologic units is provided in Table 2.

Table 2
Correlation Between Mapped Shallow Hydrogeologic and Geologic Units

Hydrogeologic Units ¹		Geologic Units ¹	
Name	Abbreviation	Name	Abbreviation
Vashon Till Confining Unit	Qvt	Vashon Till	Qvt
Vashon Advance Aquifer	Qva	Ice-Contact Deposits	Qvi
		Esperance Sand	Qve
		Pre-Vashon Deposits	Qpv
Upper Confining Unit	QC1	Lawton Clay	Qvlc

Note: 1. Correlations as identified in Frans et al. (2011).

Groundwater Recharge Favorability Analysis

Approach

The geologic and hydrogeologic attributes of the island were compiled into a geospatial database that included data on measured physical, geologic, and hydrogeologic properties. Incorporated data include items such as geologic formations, structures, slopes, geohazards, topography, hydrogeologic properties, and soil types. Also included in the database were anthropogenic features such as contaminated sites, property use types, and infrastructure considerations. The data were incorporated into GIS as shapefiles, each independently viewable in a GIS web map to convey extents and relative correspondence with each other (e.g., geohazards layer versus liquefaction hazard layer).

Each geologic and anthropogenic characteristic was carefully considered during the modeling process to determine favorable locations for potential groundwater recharge further study. Certain features, such as toxic cleanup sites or sites with unstable slopes, were weighted with a zero value to preclude such sites from being evaluated as feasible for groundwater recharge. In some cases, these sites were given buffer zones to further restrict the potential for inclusion of these areas into the suitability model. The results of this screening are shown in Figure 4.

Other attributes, such as lineaments and areas with nonexistent or relatively thin horizons of Vashon Till mapped above the Vashon Advance Aquifer, were given higher weightings. Over the course of the suitability analysis, multiple models were created (and the range of weighting factors iterated) to analyze whether potentially favorable sites may be present but were ultimately screened out due to incomplete site data or otherwise adjustable traits that would disqualify them (see Sources of Uncertainty in the next section). The final selection of layers and attributes included as part of this preliminary evaluation, with rationale for inclusion and the weighting scheme, is provided in Table 3 (attached).

The analysis was performed in a dedicated GIS tool using numerically weighted raster grid inputs that were multiplied to establish the final score. The approximately 36-square-mile area of the island was first converted to a raster grid using 50-foot by 50-foot grid cells. Each data layer input was weighted according to its specific attributes and then converted to the same 50-foot by 50-foot raster grid encompassing the island.

Preliminary Results

Following the suitability analysis, a detailed review of the results was completed. A cutoff score of 1,000 points was determined as the minimum site suitability score. Scores of less than 1,000 were removed from the final suitability raster file, which was then converted to vector polygon footprints so that the mean suitability score could be calculated for each polygon. The results are displayed in

Figures 5 through 9 as five quantile breaks. Quantile breaks bracket the results equally across each the range of the data, so each bracket has roughly the same number of results for each quantile break.

The resulting weighted rasterized map yields a visual display of the combined hydrogeologic attributes that contribute favorably to groundwater recharge potential. The GRFM allows for easy modification of weighted attributes moving forward as new data are obtained or measured during the course of work. Figure 5 provides the results of the GRFM developed for the island. Figures 6 through 8 show the results of the GRFM for the retail water service area at the island core (middle of the island) and include representation of the geologic units, hydrogeologic units, and screening results.

Generally, the highest scores correspond to areas at and closely surrounding where the Vashon Till is mapped as less than 10 feet thick (or not present) and Vashon Advance Aquifer thicknesses exceed 50 feet thick. The highest scoring areas within or proximal to the water retail service area were then compared with parks, City of Bainbridge Island-owned lots, vacant land, and other areas that are technically more feasible from a siting vantage point to identify potential sites for further study.

Island Core

Within the island core, including the retail water and sewer service area and bands of the island immediately north and south, three general areas have been identified as either broadly scoring favorably or having a combination of favorable scoring and geographic siting potential. These three areas include the southern vicinities of the Grand Forest East and West parks, the Sakai Park/Bainbridge High School area, and the area to the west of the terminus of Eagle Harbor.

These areas correspond to locations where Vashon Till is relatively thin or nonexistent, Vashon Advance Aquifer is present, geohazard risk is low, and properties are owned by the City of Bainbridge Island. These areas scored well; however, unaccounted-for attributes in the vicinity of these areas suggest that a more focused approach to each area may be warranted. The Sakai Park area is located in a higher elevation zone, immediately above and adjacent to a waterbody and wetland, and the Eagle Harbor area is located near a municipal water well pumping site. Areas of interest include or are proximate to publicly owned land and are within or near the water and sewer service areas, which are more suited to potential siting of infrastructure required for groundwater recharge.

Island Periphery

Potential groundwater recharge areas were also identified outside of the retail water and sewer service area in peripheral areas of the island. These higher-scoring areas were selected during the review as potential sites due to their location inside existing vacant, park, or open space. Selected areas within Manzanita Park (northeast of Manzanita Bay), in the vicinity of Miller Road NE at the intersection of NE Koura Road, and a broad area in Agate Point at the far north end of the island were all identified as high-scoring zones (Figure 5). Whereas certain characteristics in these areas are ideal for potential siting, the required infrastructure improvement path forward make these areas more costly to pursue.

Alternatively, other high-scoring areas in several locations around the island were identified; however, due to greater distances from supporting infrastructure and existing property use types, these areas were removed from consideration.

Sources of Uncertainty

Data obtained during the suitability analysis were generally limited to published data, which are often limited to regional studies and mapping efforts. Several datasets used in the model would benefit from a more detailed analysis to confirm scoring values (positively or negatively). For example, geohazards are often mapped based on regional processing and analysis of digital elevation models and Light Detection and Ranging (LiDAR) data and may not accurately represent the distinct geohazards present in the area. Also, items such as surface erosion risk may not adequately record all contributing hazards specific to the hazard area. To define the applied weighting and scoring more accurately, several geohazard zones would benefit from a detailed characterization. A detailed, site-specific review would allow for local refinement of the severity and extent of mapped geohazards and possibly expand the footprint or open new locations of favorable sites.

Additionally, areas of interest for further study within the island core are suggested for more detailed analysis. These areas are considered as follows:

- **Grand Forest Park**
 - Easements and restrictions on publicly owned lands
 - Uncertainty in mapped geohazards
 - Less favorable location (than Sakai Park and the Eagle Harbor area)
- **Sakai Park**
 - Land use restrictions and/or regulatory setback requirements
 - Uncertainty in mapped geohazards
 - Limited regional well and deep boring data lead to coarse interpolations that may under or overpredict hydrogeologic unit thicknesses; this area appears quite sensitive to the interpolation method and available data
 - Of note, after completion of the GRFM development and processing, boring logs from nearby Bainbridge Island High School were provided for review. A preliminary review yielded two important findings, each illustrative of the uncertainty that may be reduced by further study.
 - It appears that the locally mapped glacial till may not be present at the site.
 - The Vashon Advance Aquifer (Frans 2011) was inferred to be present at the site based on the presence of Pre-Vashon Deposits locally identified in geologic maps; however, site investigation data indicate these deposits may locally consist of fine-grained, Pre-Vashon glaciolacustrine deposits “with low permeability characteristics” (Aspect Consulting 2018).
 - Recharge rate and slope proximity definition required

- **Eagle Harbor**
 - Land use restrictions and/or regulatory setback requirements
 - Uncertainty in mapped geohazards
 - Further understanding of well field and implications

Subsurface data pertaining to Vashon Till and Vashon Advance Aquifer thicknesses were also derived from island-wide datasets obtained from well logs and other subsurface exploration data. The well and deep boring logs used to develop the thickness maps are broadly spaced and rely on approximate interpolations to connect data points. While useful for regional modeling and preliminary evaluations as conducted here, their suitability to small sites at the scale being considered for recharge is limited. Accordingly, collecting near-site and site-specific subsurface information specific to potential groundwater recharge locations will be key to reducing uncertainty in subsurface stratigraphy and furthering site suitability evaluations.

Lastly, the process of scoring individual features in the input process is subjective and based on interpretation and experience with similar projects in the region. Minor changes made to weighting of individual features during the input process may have more far-reaching implications as final scores are applied. As site-specific evaluations are completed or new exploration data or other additional information is received, a re-evaluation may be necessary.

Site Visit Summary

A brief site visit was conducted on November 8, 2023, by Luke Maddux, geologist at Anchor QEA, and Cole Bales, geotechnical engineer at Anchor QEA. Mr. Maddux and Mr. Bales were accompanied by Jeffrey Hansen and Sanyukta Gokhale of HDR. Utilizing the initial outcomes of the GFRM, several locations were visited to reach a better understanding of potential site areas.

Locations visited included the Hyla School area (private), Fire Station 22, Grand Forest Park East, Manzanita Park, and Sakai Park. Work was generally limited to a brief observation of local terrain, topography, access, property use type, infrastructure considerations, and other potential siting constraints to the favorable sites identified by the GRFM.

Recommendations for Further Study

The process of scoring and rating physical elements during a desktop investigation is an adaptive process. Refinement of scoring criteria and better understanding of the information that goes into the modeling process is a crucial step toward better understanding of the potential areas of interest in the island core. The following strategies should be considered for further investigation.

Site-Specific Desktop Review

- Detailed examination of site-specific geotechnical data
 - This approach will aid in supporting a more focused evaluation of each area of interest and advance the understanding of the geotechnical constraints at each potential site.
- Review of available geotechnical and hydrological boring data in the vicinity of potential sites
 - This objective is geared toward understanding the subsurface conditions, unit thicknesses, hydrogeologic units, and hydraulic gradients.
- Data gaps evaluation
 - Once select locations have been identified, a data gaps evaluation should be performed to determine how the existing data support use of the location for infiltration and to identify any potential data gaps that will be required to fulfill pilot test and/or design requirements.

Site-Specific Geotechnical Investigation

Following a site-specific desktop review, a site-specific geotechnical and hydrogeologic investigation for selected potential siting locations should be conducted to provide detailed information on local geohazards and subsurface conditions. Potential investigative steps to fulfill identified data gaps may include the following:

- Installation of paired monitoring wells (shallow and deep) and subsequent aquifer testing to provide better understanding of vertical hydraulic gradients and hydraulic conductivities
- Deep exploratory borings
 - Limited deep borings are available for reference. The majority of water well borings only penetrate the uppermost confining layer or are within the unconfined aquifer.
 - Site-specific deep subsurface data may aid in identifying the presence of confining units and potentially identify unsuitable subsurface conditions.
- Geophysical exploration techniques
 - Borehole geophysical surveys
 - Surface geophysical surveys
- Dye tracing of groundwater may help inform groundwater movement to look for artesian conditions or surface water interaction locations

Conclusion

Beneficial reuse of recycled water, especially in areas with limited groundwater resources and high precipitation, is an effective strategy for balancing hydrologic budgets and accounting for increased water use. The development of the groundwater favorability model has aided in identifying which areas on the island may be more suitable for further consideration, exploration, study, and planning. Several locations on Bainbridge Island show strong potential for siting of groundwater recharge facilities; however, more detailed investigations are needed into each potential area to determine site-specific feasibility.

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Table 3

Table 3
Summary of GIS Layers and Screening/Scoring Scheme

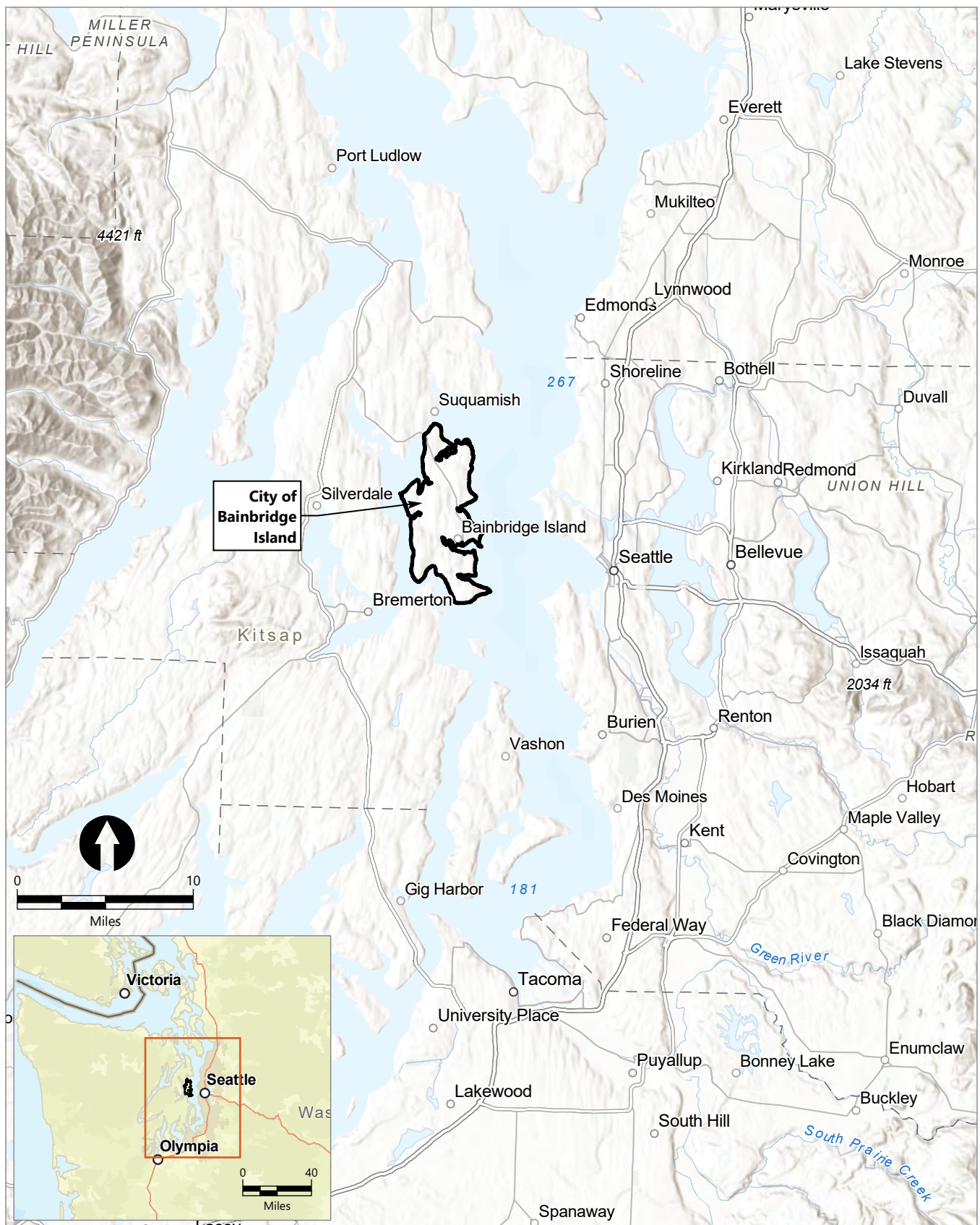
Layer	Unit or Attribute	Buffering	Attribute Weighting (for Multiplication)	Comments	Link to Source
Hydrostratigraphic Units	Vashon Till Confining Unit (Qvt)	No buffering	2	Compared with geologic units; weighting increases with increasing infiltration potential.	https://pubs.usgs.gov/sir/2011/5021/pdf/sir20115021.pdf
	Vashon Advance Aquifer (Qva)		14		
	Upper Confining Unit (QC1)		2		
	Sea Level Aquifer (QA1)		8		
	Bedrock		1.5		
QVT <10 feet and QVA >50 feet	Polygon area	100 feet	7	Thin confining layer with thick aquifer materials below is favorable for infiltration.	https://hdr.maps.arcgis.com/apps/webappviewer/index.html?id=d7d02dedb57241aa81dd7eb376c8625a
	Rest of area	No buffering	1		
USDA Soil Survey Dat – Ksat	<0.0001 foot/day to 0.0001 foot/day	No buffering	1	Higher Ksat values in residual soils suggest better infiltration potential; therefore, weighting increases with higher Ksat values.	https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
	0.0001 to 0.001 foot/day		2		
	0.001 to 0.01 foot/day		3		
	0.01 to 0.1 foot/day		4		
	0.1 to 1 foot/day		5		
	1 to 10 feet per day		6		
	10 to 100 feet per day		7		
Lineaments	–	100 feet	5	Presence of lineament suggest differential weathering of subsurface materials and may increase potential for infiltration.	https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Faults	–	100 feet	5	Presence of fault increase potential for infiltration.	https://geologyportal.dnr.wa.gov/2d-view#wigm?-13686606_-13592971,6028314,6066380?Surface_Geology,500k_Surface_Geology,Map_Units
Earthquake – Liquefaction Susceptibility	High	No buffering	0	Avoid adding water to high geohazard areas.	https://geologyportal.dnr.wa.gov/2d-view#wigm?-13686606_-13592971,6028314,6066380?Surface_Geology,500k_Surface_Geology,Map_Units
	Moderate to high		0		
	Low to moderate		1		
	Low		1		
	Very low to low		1		
	Very low		1		
	Bedrock		1		
Geohazards	Aeras of concern	No buffering	0	Avoid adding water to high geohazard areas.	https://ags.kitsapgov.com/metadata/metadata.asp?xml=enviro/geohazard.shp.xml
	High hazard areas		0		
	All other areas		1		

Table 3
Summary of GIS Layers and Screening/Scoring Scheme

Layer	Unit or Attribute	Buffering	Attribute Weighting (for Multiplication)	Comments	Link to Source
Slope Stability	Stable	No buffering	1	Avoid adding water to high slope hazard areas.	https://ags.kitsapgov.com/metadata/metadata.asp?xml=enviro/stability.shp.xml
	Intermediate		0		
	Unstable – recent or historical		0		
	Unstable – post-glacial/prehistorical		0		
Toxic Cleanup Sites	–	100 feet around feature	0	Site screening within 100-foot buffer zone.	https://geologyportal.dnr.wa.gov/2d-view#wigm?-13686606,-13592971,6028314,6066380?Surface_Geology,500k_Surface_Geology,Map_Units
Surface Mining	–	100 feet around feature	0	Site screening within 100-foot buffer zone.	https://geologyportal.dnr.wa.gov/2d-view#wigm?-13686606,-13592971,6028314,6066380?Surface_Geology,500k_Surface_Geology,Map_Units
Hydrology	Lake or pond	100 feet	0	Site screening within 100-foot buffer zone.	https://hdr.maps.arcgis.com/apps/webappviewer/index.html?id=d7d02dedb57241aa81dd7eb376c8625a
Hydrology Area – Wetlands (National Wetlands Inventory)	250 feet around hydrology layer buffer	250 feet	5	Proximity to hydrology zone is favorable for recharge and may be able to support feature to during periods of maximum use. Greater distance allows for longer flow paths to discharge points and is considered more favorable.	https://cityofbi.maps.arcgis.com/home/group.html?id=d01789e76e054264827538e6eb67a4bf&view=grid&showFilters=false&sortField=title&sortOrder=desc&focus=applications#content
	500 feet around hydrology layer buffer	500 feet	6		
	750 feet around hydrology layer buffer	750 feet	8		
	1,000 feet around hydrology layer buffer	1,000 feet	10		
	> 1,000 feet around hydrology layer buffer	> 1,000 feet	12		
Hydrology Area – Lakes (HDR)	250 feet around hydrology layer buffer	250 feet	5	Proximity to hydrology zone is favorable for recharge and may be able to support feature to during periods of maximum use. Greater distance allows for longer flow paths to discharge points and is considered more favorable. Screening within 100 feet of lake or pond attribute per above hydrology layer.	Provided by client.
	500 feet around hydrology layer buffer	500 feet	6		
	750 feet around hydrology layer buffer	750 feet	8		
	1,000 feet around hydrology layer buffer	1,000 feet	10		
	> 1,000 feet around hydrology layer buffer	> 1,000 feet	12		

Sources:
City of Bainbridge Island, 2023. Public GIS Maps and Apps. Accessed September 2023.
Kitsap County, 2023. Open Data Kitsap County GIS. Accessed September 2023.

Figures

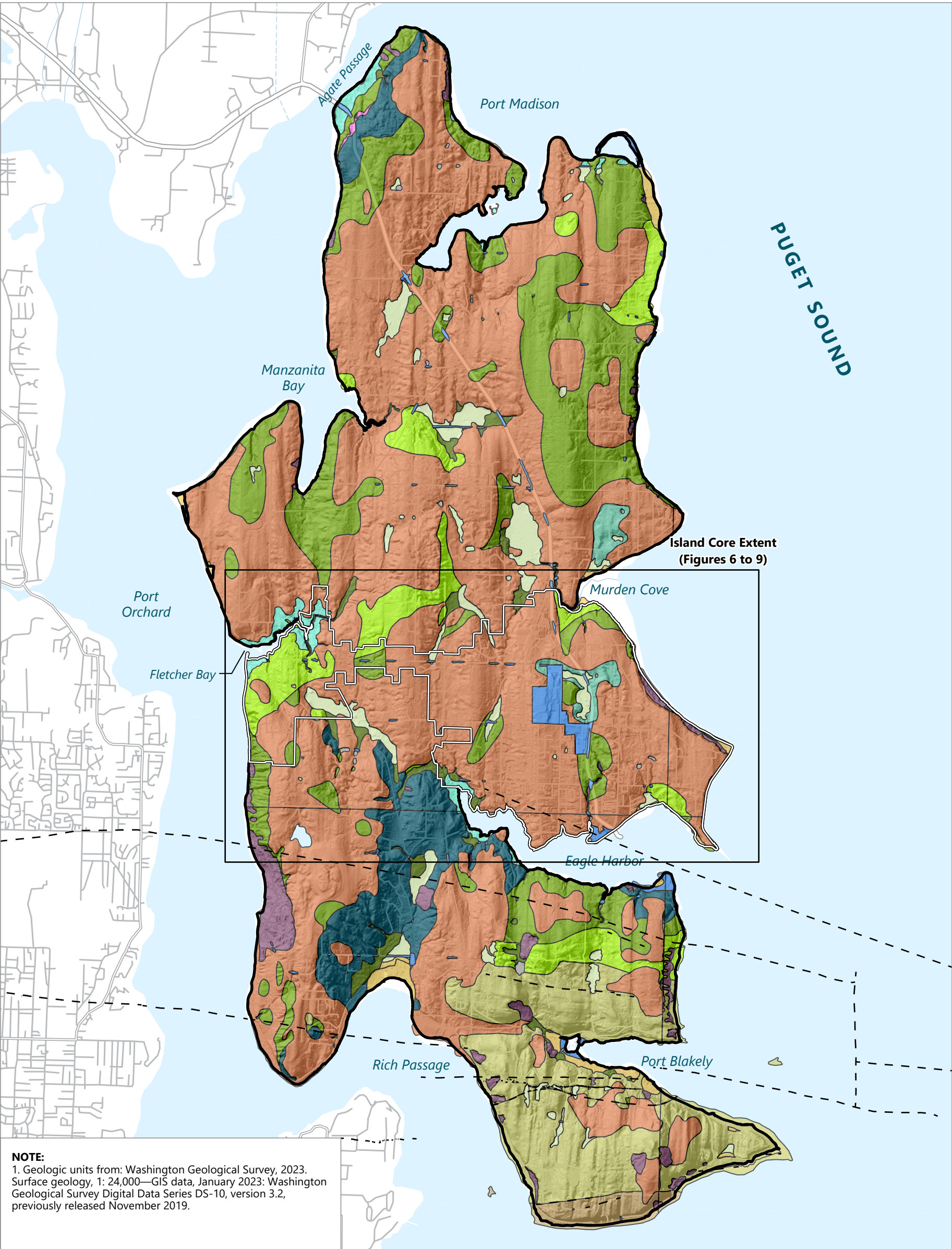


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Figure 1
Site Location Map

Groundwater Recharge Favorability Evaluation
 City of Bainbridge Island



NOTE:
1. Geologic units from: Washington Geological Survey, 2023. Surface geology, 1: 24,000—GIS data, January 2023: Washington Geological Survey Digital Data Series DS-10, version 3.2, previously released November 2019.

LEGEND:

Geologic Units (24k)

Quaternary Rocks and Deposits:

- Holocene artificial fill and modified land (f, m)
- Quaternary bog, marsh, swamp, or lake deposits (Qw)
- Quaternary alluvium and alluvial fan deposits (Qal, Qaf)
- Quaternary beach and tide-flat deposits (Qb, Qtf)
- Quaternary landslide deposits (Qls)
- Pleistocene emergence gravels (Qeg)

Vashon Drift (Pleistocene), Divided into:

- Ice-contact deposits (Qvi)

- Vashon till (Qvt)

- Esperance Sand Member (Qve)

- Lawton Clay Member (Qvlc)

Older Glacial and Non-Glacial Deposits:

- Pre-Olympia deposits (Qpog, Qpor, Qup)
- Pre-Vashon deposits (Qpv, Qpvf, Qpvu)

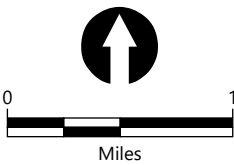
Tertiary Rocks:

- Tertiary sedimentary rocks and deposits (Tb, Tbh)
- Tertiary volcanic and sedimentary rocks (Tbt)

- City of Bainbridge Island

- City of Bainbridge Island Retail Water Service Area

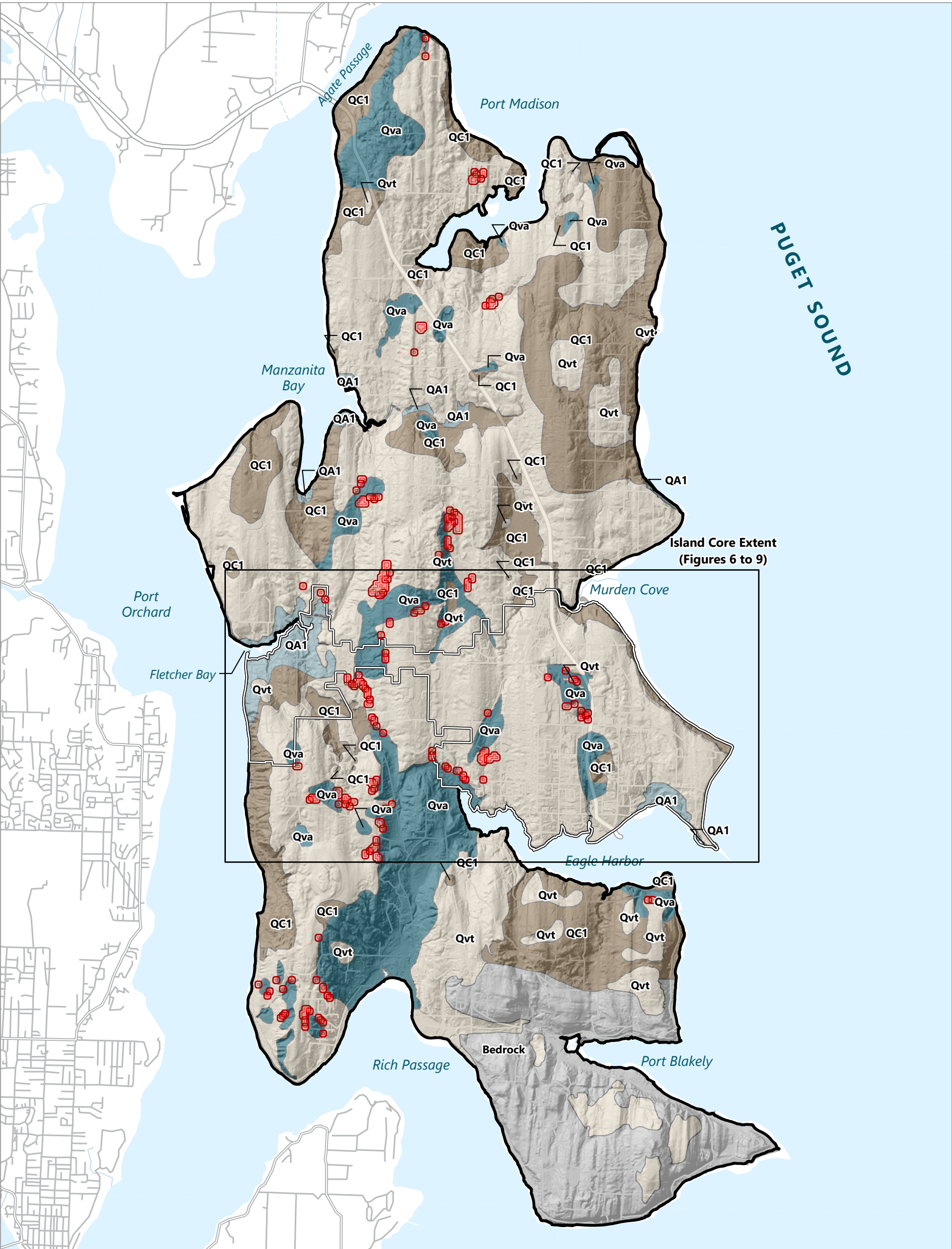
- Seismogenic Faults



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Figure 2
Regional Geologic Map
Groundwater Recharge Favorability Evaluation
City of Bainbridge Island



LEGEND:

- City of Bainbridge Island
- City of Bainbridge Island Retail Water Service Area

Hydrogeologic Units

- Qvt (Vashon Till confining unit)
- Qva (Vashon advance aquifer)
- QC1 (Upper confining unit)
- QA1 (Sea-level aquifer)
- BR (Bedrock)
- Qvt Less than 10 Feet Thick, Qva Greater than 50 Feet Thick
- 100 Foot Buffer for Qvt Less than 10 Feet Thick, Qva Greater than 50 Feet Thick

NOTE:

1. Hydrogeologic units from geologic map and cross sections showing hydrogeologic units—Plate 1. Conceptual Model and Numerical Simulation of the Groundwater-Flow System of Bainbridge Island, Washington (Frans et al. 2011).

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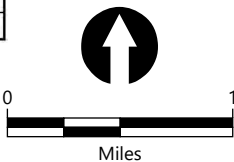
Figure 3
Regional Hydrogeologic Map
Groundwater Recharge Favorability Evaluation
City of Bainbridge Island



LEGEND:

- City of Bainbridge Island
- City of Bainbridge Island Retail Water Service Area
- Indicates Area Was Eligible for Screening
- Indicates Area Zeroed Out During Scoring

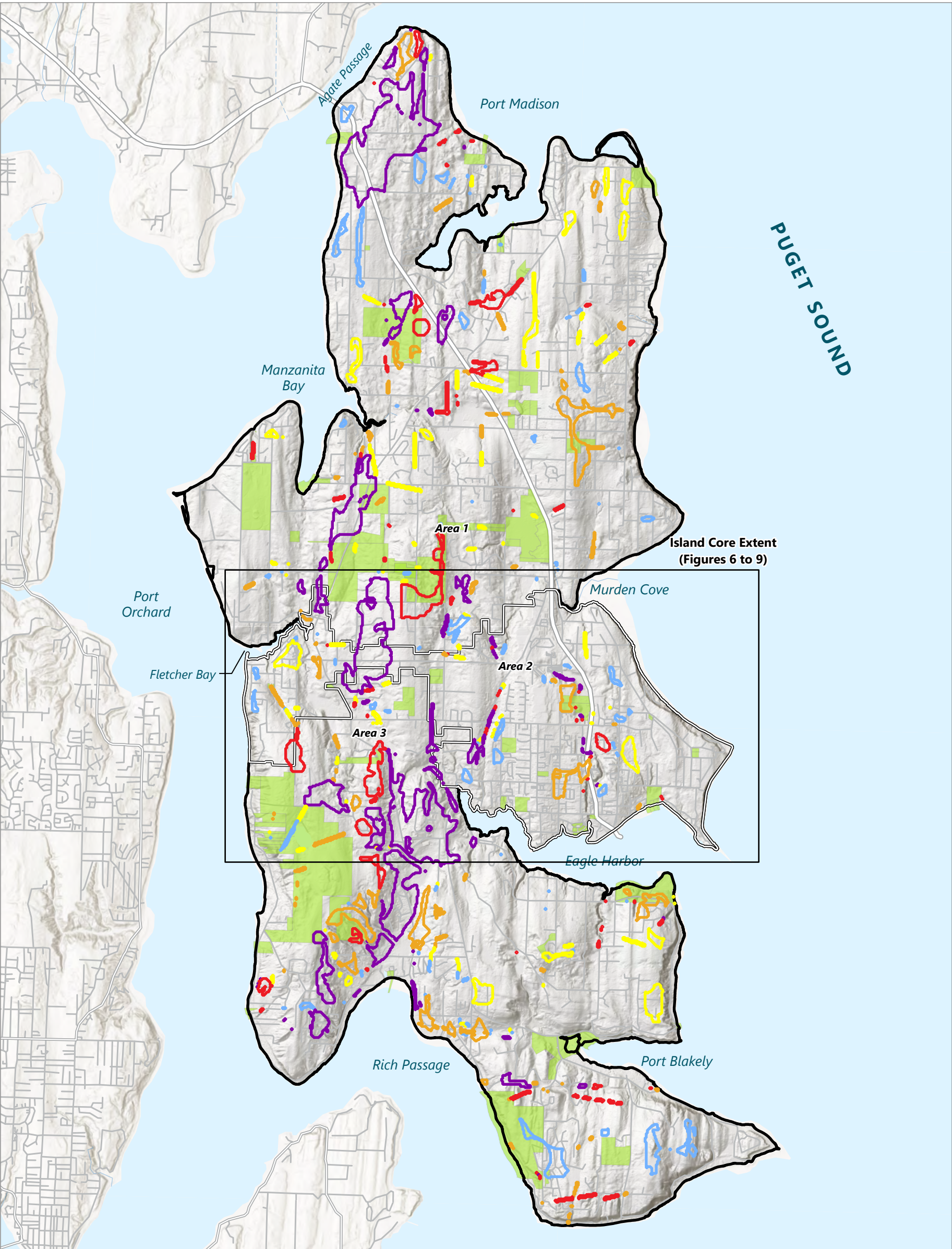
Layer	Attribute	Buffering
Earthquake - Liquefaction Susceptibility	High	No buffering
	Moderate to High	
Geohazards	Areas of Concern	No buffering
	High Hazard Areas	
Slope Stability	Intermediate	No buffering
	Unstable - Recent or Historical	
	Unstable - Post Glacial/Prehistorical	
Toxic Cleanup Sites	-	Buffer 100 feet around feature
Surface Mining	-	Buffer 100 feet around feature
Hydrology	Lake or Wetland	Buffer 100 feet around feature



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Figure 4
Regional Recharge Screening Map
Groundwater Recharge Favorability Evaluation
City of Bainbridge Island



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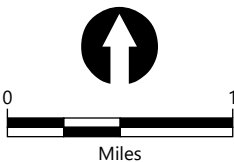
-  City of Bainbridge Island
-  City of Bainbridge Island Retail Water Service Area
-  City-Owned Properties (Parks, Farms, Public Lands)

Favorable Sites – Average Score of Grid Cells Within Footprint

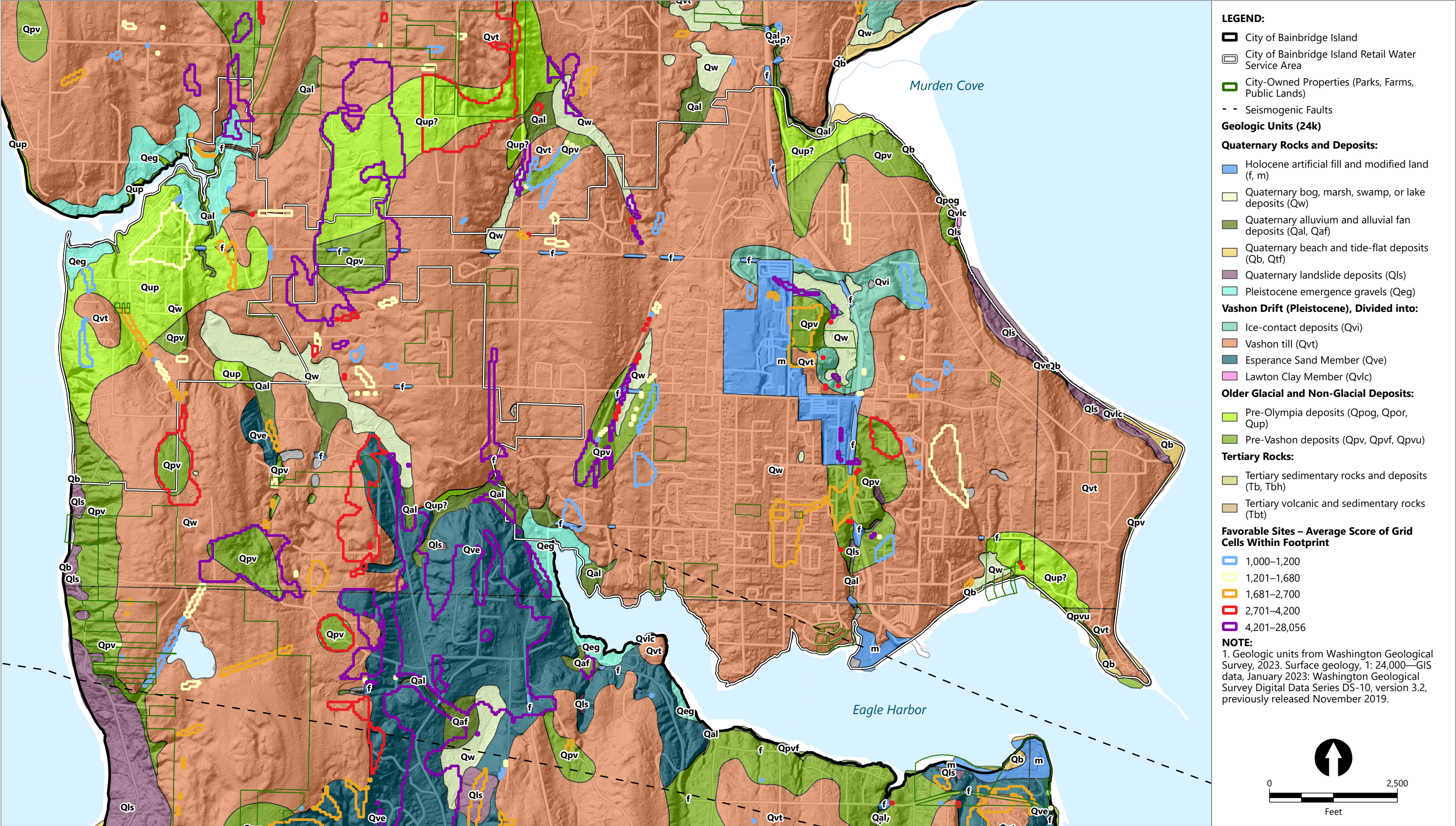
-  1,000–1,200
-  1,201–1,680
-  1,681–2,700
-  2,701–4,200
-  4,201–28,056

NOTE:

1. City-owned properties provided by City of Bainbridge Island.



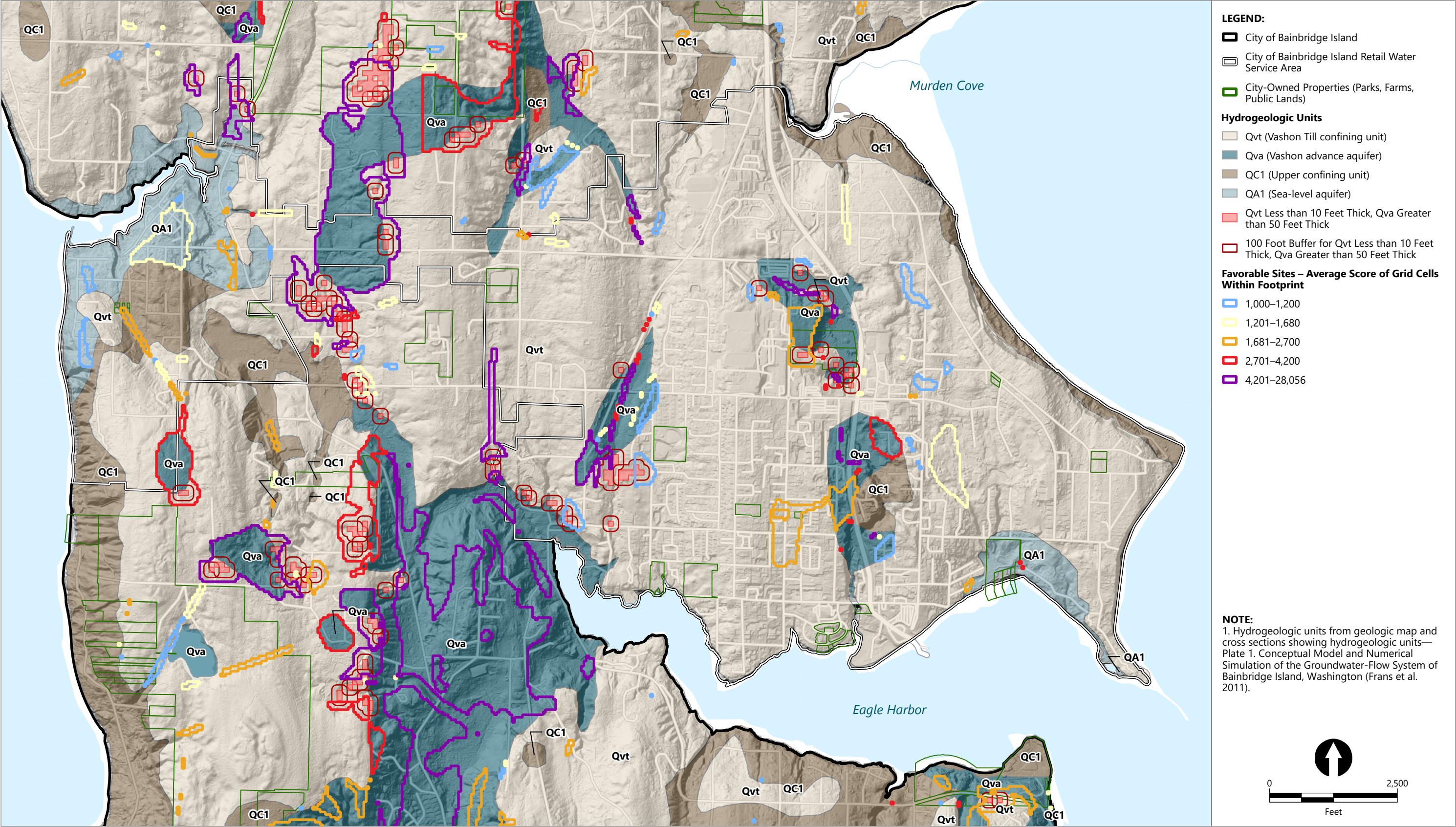
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Figure 6
Island Core Geologic and Recharge Scoring Map
Groundwater Recharge Favorability Evaluation
City of Bainbridge Island

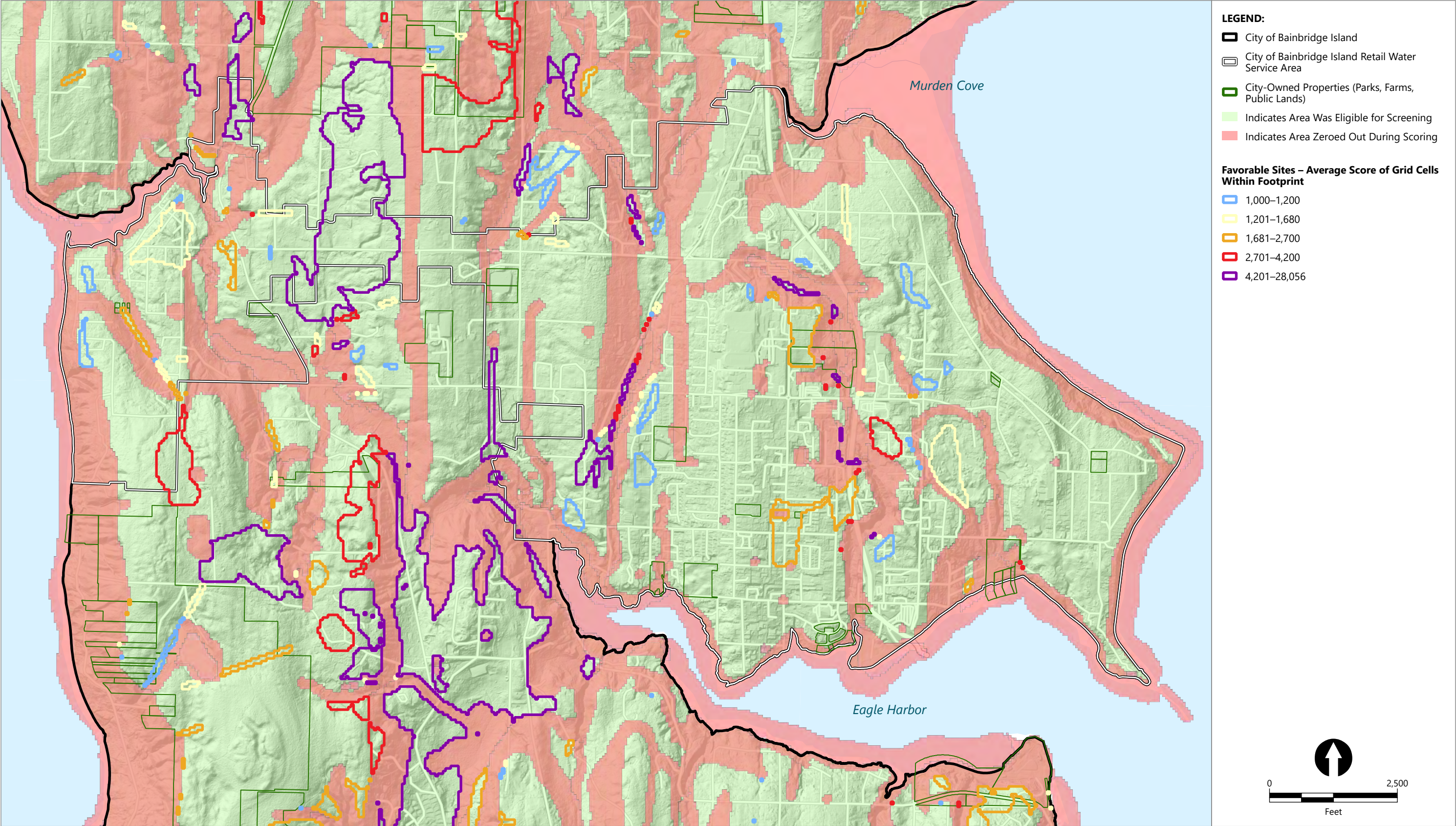


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Figure 7
Island Core Hydrogeologic and Recharge Scoring Map

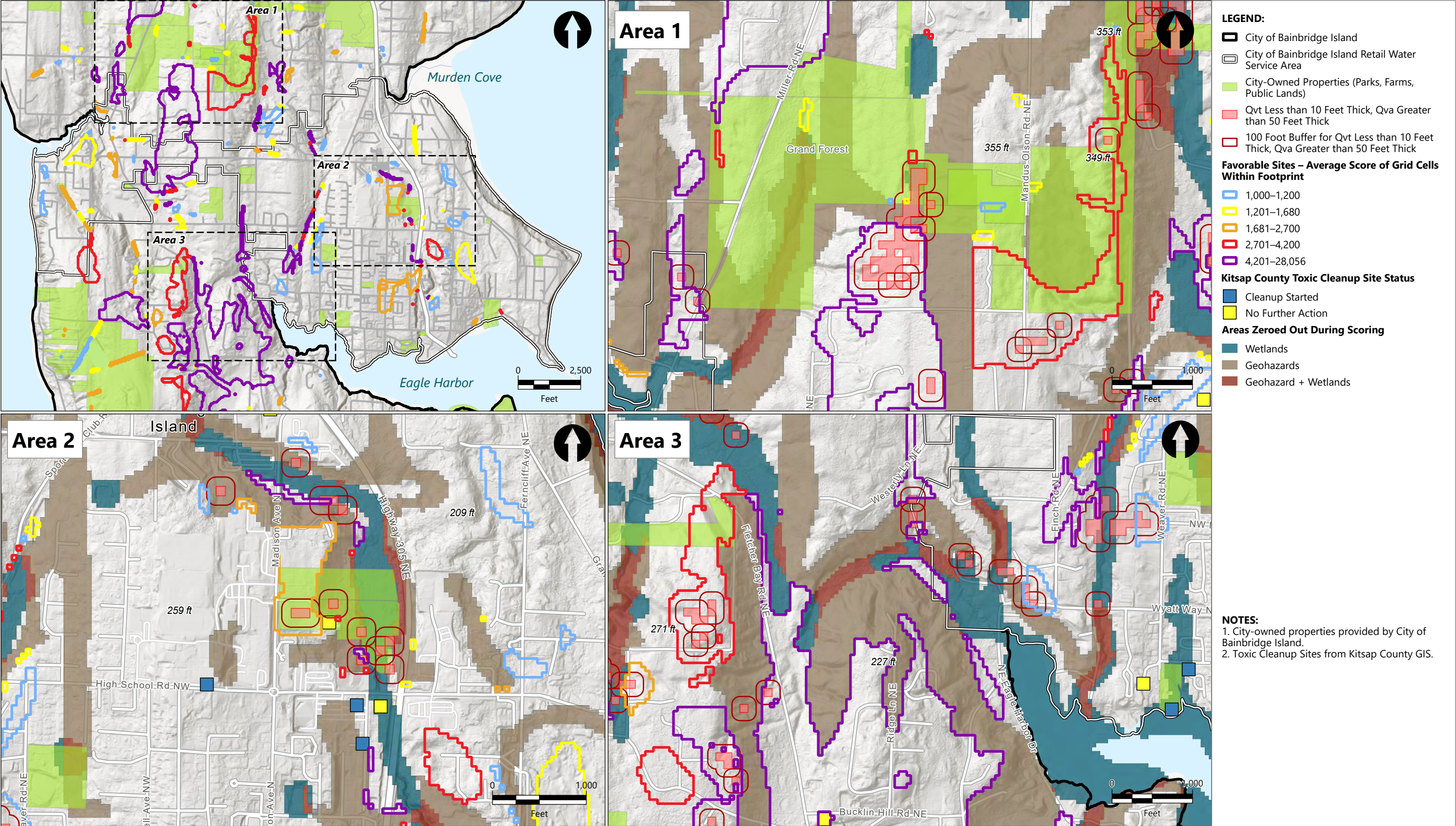
Groundwater Recharge Favorability Evaluation
City of Bainbridge Island



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Figure 8
Island Core Recharge Screening and Recharge Scoring Map
Groundwater Recharge Favorability Evaluation
City of Bainbridge Island



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