

SEPA CHECKLIST AND DETERMINATION OF NON-SIGNIFICANCE

To be inserted at a later date.

**AGENCY COMMENTS AND APPROVAL
ADJACENT PURVEYOR COMMENTS**

To be inserted at a later date.

ADOPTING RESOLUTION

To be inserted at a later date.

INTERLOCAL AGREEMENTS

**CITY OF BAINBRIDGE ISLAND AND KITSAP COUNTY SEWER DISTRICT NO. 7
INTERLOCAL AGREEMENT FOR WASTEWATER TREATMENT**

THIS AGREEMENT is made and entered into this 29th day of march, 2007, by and between the CITY OF BAINBRIDGE ISLAND, Washington ("City") and KITSAP COUNTY SEWER DISTRICT NO. 7, Kitsap County, Washington ("District"), both municipal corporations of the State of Washington.

RECITALS

A. The District operates a wastewater treatment plant that serves a portion of the south end of the City.

B. By interlocal agreement dated October 3, 1997, the District reserved for the City and accepted for treatment 80 equivalent residential units ("ERUs") of capacity in the District's wastewater treatment plant for the purpose of reducing existing water pollution problems in the Lynwood Center area of the City.

C. By amendment dated August 8, 2002, the District and the City amended the 1997 interlocal agreement to clarify the monthly service charge to be paid per equivalent residential unit.

D. By interlocal agreement dated September 24, 2003, the District and the City entered into a new interlocal agreement, which acknowledged the existing reservation of 80 ERUs for the Lynwood Center area and reserved for the City 231 additional residential connections upon creation of the proposed south end sewer local improvement district, plus 19 additional residential connections for use as determined by the City.

E. The City created the south end sewer local improvement district ("LID 20") and constructed the sewer improvements therein, thereby utilizing the sewer connections authorized by the 2003 interlocal agreement.

F. Policy SSP 2.3 of the Water Resources Element of the City's Comprehensive Plan establishes the sewer service area for the south end of the City, and provides that "emergency service or other minor modifications [to that service area], which are within the existing sewer facility capacity, may be allowed with the approval of the City Council."

G. On March 22, 2006, the City Council adopted policies for sewer service in the south end. To implement those policies consistent with the Comprehensive Plan, particularly policy SSP 2.3, the Public Works Department on April 3, 2006 adopted Administrative Procedure 2.14, entitled "South Island Sewer Connections." Among other things, Procedure 2.14 provides that the provision of sewer service to certain land located adjacent to Lynwood Center and LID 20 and characterized as "open space residential" meets the "minor modification" criterion of Policy SSP 2.3. The District is constructing a Phase II addition to its wastewater treatment plant, which will provide sewer service to the areas in the south end not currently served, as identified in the City's South Island Facilities General Plan and Engineering Report (December 2001).

H. The City has requested the District to provide 150 additional ERUs to serve Lynwood Center, LID 20 and Adjacent "Open Space" Residential areas as shown on the attachment to Procedure 2.14 entitled "Figure 1- South Island Sewer Connections."

I. The District desires to provide 150 additional ERUs as requested by the City, which reservation of capacity in the District's wastewater treatment plan is consistent with the District's comprehensive plan and resolutions.

J. In order to provide the additional 150 ERUs, and because many provisions of the 2003 interlocal agreement have been fulfilled or are no longer applicable, the parties desire to enter into a new interlocal agreement regarding the treatment of wastewater and the payment of connection and service charges for the south end of the City.

AGREEMENT

The parties agree as follows:

1. Reservation of Service and Acceptance for Treatment—Lynwood Center. The City has paid connection fees for, and the District shall accept for treatment the wastewater of 80 ERUs in the Lynwood Center area of the City, as described in Section 4 of City Ordinance No. 2001-43 (SSP 2.3 of the Water Resource Element of the City's Comprehensive Plan, Figure 2B) ("Lynwood Center Area"). The 80 ERUs are allocated in accordance with **Exhibit A**. An ERU shall be the equivalent of one "residential connection." The City may authorize the transfer of any or all of the 80 ERUs among the parcels within the Lynwood Center Area. Within 30 days of an ERU transfer, the City shall give notice of the transfer to the District.

2. Reservation of Service and Acceptance for Treatment—LID 20 and South Island Sewer Area. In addition to the wastewater treatment service reserved and wastewater accepted for treatment under Paragraph 1 of this Agreement, the City has paid connection fees for, and the District shall accept for treatment the wastewater from 231 residential connections in the LID 20 area (Blakely School shall be allocated 14 of the 231 residential connections), and 19 additional residential connections in the City sewer service area for the South End, as described in Section 4 of City Ordinance No. 2001-43 (SSP 2.3 of the Water Resource Element of the City's Comprehensive Plan, Figure 2B), which includes the Lynwood Center area, and as shown on **Exhibit B**. A "residential connection" shall mean a single-family residential unit including its related accessory dwelling unit.

3. Reservation of Service and Acceptance for Treatment—Additional Parcels in Lynwood Center and Adjacent "Open Space" Residential. In addition to the wastewater treatment service reserved and wastewater accepted for treatment under Paragraphs 1 and 2 of this Agreement, the District shall reserve service for the City and will accept for treatment the wastewater of an additional 150 ERUs after October 1, 2007. An ERU shall be the equivalent of a "residential connection." The allocation and use of the additional 150 ERUs shall be determined by the City pursuant to the City's comprehensive plan, and the policies and procedure in City Public Works

Department Administrative Procedure – 2.14 South Island Sewer Connections attached as **Exhibit C**. The City shall pay \$5,991.00 per ERU, which shall be due within 30 days of the date of the connection. Effective January 1 of a year and following 90 days advance notice to the City, the District may increase the connection fee by the same amount of any increase in District connection fees pursuant to RCW 57.08.005(10).

4. Notification of Binding Commitment and Connection. Within 30 days of a binding commitment to an owner for sewer service, the City shall give notice of the binding commitment to the District. Within 30 days of a connection, the City shall give notice of the connection to the District.

5. Service Charges. At execution of this Agreement, the District has a service charge per ERU of \$35.00 per month. The District may amend the monthly service charge to cover changes in operation and maintenance costs, so long as the charge is uniform for class of customer, whether located within or without the District. The District shall not impose a surcharge or similar additional charge due solely to the fact that the customer is located outside of the District. Effective January 1 of a year and following 90 days advance notice to the City, the District may increase the monthly service charge. The City shall pay the monthly service charges for properties served by the District. The District shall send to the City a monthly bill for all service charges, which shall be due 30 days from the date of mailing of the bill. All charges remaining unpaid after 30 days shall bear interest at the rate of one percent per month until paid in full. The City and the District shall maintain appropriate books and accounts regarding the number of connections made and the number of connections available.

6. Sewer Availability. For the 19 connections authorized by paragraph 2 of this Agreement, and the 150 connections authorized by paragraph 3 of this Agreement, a City official may execute a binding commitment letter to such owner with such conditions and terms as the City official shall deem appropriate.

7. Additional Connections. If the District has sufficient capacity in the District's wastewater treatment plant after October 1, 2007 to treat the wastewater from more than the number of ERUs provided for in Paragraphs 1, 2, and 3 of this Agreement, the City and the District may by an amendment to this Agreement reserve capacity for additional ERUs .

8. Meetings. Each year in September, at least one representative of the City and of the District shall meet to discuss issues and matters relating to this Agreement and the District's provision of sewer service under this Agreement including but not limited to the status of authorized connections, increases in and the payment of connection and service charges, and infiltration and inflow in the District's sewer system.

9. Construction and Operation Standards. All City sewer facilities shall be constructed, installed, operated and maintained in accordance with federal, state and local laws and regulations, and City and District policies and procedures. Each party shall cooperate in the development, implementation and administration of pre-treatment procedures and limitations on quality and quantity of wastewater, to the extent necessary to allow the facilities of the City and District to satisfy federal, state and local laws and regulations and City and District policies and procedures.

The City shall operate its facilities in a manner that will prevent the entry of excessive water, turbidity, and grit into the facilities. If the District believes that City wastewater contains substances that will or have damaged the facilities or will or have caused the District's treatment plant to violate federal, state or local laws and regulations, it shall immediately notify the City. If the City agrees that City wastewater has so damaged the facilities or treatment plant, or if an arbitrator or court (issuing a final decision) determines that the City's wastewater has caused such damage, in whole or in part, the City shall pay for the damages it has caused.

10. Operation and Maintenance of Sewer Facilities. The City shall own, operate and maintain the sewer facilities located north of, and including, the manhole in the south 160 feet of the parcel described in AF #9502060195 ("Terminus Manhole"), except the existing meter manhole. The Terminus Manhole is also known as "Manhole No. F-1" in the 1995 plans by A.D.A. Engineering for Lynwood Center Wastewater Pump and Force main attached as **Exhibit D**. The District shall own, operate and maintain the treatment plant, the gravity lines from the Terminus Manhole to the wastewater treatment plant and the meter manhole approximately nine feet north of the Terminus Manhole.

11. Insurance. The District and the City shall maintain in full force and effect comprehensive general liability, public official liability and property insurance policies, with coverage and limits at least equal to the coverage and limits in effect under their respective insurance policies at the execution of this Agreement. Current certificates of insurance for the District and the City are attached as **Exhibits E and F**, respectively.

12. Indemnification. The District shall protect, defend, indemnify and save the City, its officers, employees and agents, harmless from any and all costs, claims, judgments or awards of damages, arising out of or in connection with the negligent acts or omissions of the District, its officers, employees or agents. The City shall protect, defend, indemnify and save the District, its officers, employees and agents, harmless from any and all costs, claims, judgments or awards of damages, arising out of or in connection with the negligent acts or omissions of the City, its officers, employees or agents.

13. Mediation. If a party disagrees with an interpretation or application of this Agreement by the other party, the party may file a notice requesting a meeting to discuss the dispute. The meeting shall be held within seven days between two representatives of each party designated by the Mayor and the Secretary of the Board of Commissioners. If the parties are unable to resolve the dispute at the meeting or any continued meetings, they may, by mutual consent, initiate mediation. If the dispute involves the calculation or timing of payment of connection fees or service charges, the City shall pay the amount claimed by the District to the District pending resolution of the dispute. The mediator(s) shall be selected based on expertise in the nature of the matter in dispute and ability to facilitate settlement. The parties agree to provide all documentation and information requested by the mediator(s) and in all other regards to cooperate fully with the mediator(s). If mediation is unsuccessful in providing a mutually acceptable solution to the dispute within 30 days after commencement of the mediation, unless extended by mutual agreement of the parties, the parties may pursue any other form of relief. The costs for mediation shall be equally shared between the parties. Unless arbitration is requested pursuant to Paragraph 14, the City or the District shall pay or

refund, as applicable, the difference between the amount paid by the City and the amount agreed at mediation.

14. Arbitration. Within 14 days after completion of the meeting under Paragraph 13, or after the mediation under Paragraph 13, either party may file a notice requesting arbitration under this Paragraph. If the dispute involves the calculation or timing of payment of charges, the City shall continue to pay the amount claimed by the District to the District pending resolution of the dispute. The parties shall attempt to agree upon a person with appropriate expertise in the subject matter to be arbitrated. If the parties are unable to select an arbitrator, they shall obtain from Municipal Research Services Center the names of five persons who have some expertise in the subject matter to be arbitrated. From the list of five names, the parties will attempt to agree on one person to serve as arbitrator. If the parties are unable to agree on which of the five shall be the arbitrator, the parties shall alternately eliminate the name of one person on the list until only one name remains. The person remaining shall be the arbitrator. The arbitrator shall commence the arbitration hearing as soon as possible. The decision of the arbitrator shall be binding upon the parties and is subject to confirmation and review only as provided in Chapter 7.04 RCW. The arbitrator shall not be empowered to impose any remedy that has the effect of altering the terms of this Agreement. All costs of the arbitration proceeding shall be shared equally by the parties. The City or the District shall pay or refund, as applicable, the difference between the amount paid by the City and the amount awarded by the arbitrator.

15. Litigation Costs. If either party commences litigation against the other party relating to this Agreement, the prevailing party shall be entitled to all costs, including attorneys' fees incurred, relating to such litigation.

16. Notices and Payments. All notices shall be in writing and may be delivered or mailed to the following respective addresses or to such other respective addresses as either party may designate in writing:

To the City: City of Bainbridge Island
 280 Madison Avenue North
 Bainbridge Island, Washington 98110

To the District: Kitsap County Sewer District No. 7
 P.O. Box 400088
 Bellevue, Washington 98015

Notices sent by certified or registered mail shall be deemed to have been given when and if properly mailed, and the postmark affixed by the United States Post Office shall be conclusive evidence of the date of mailing. All notices shall be sent to the attention of City Public Works Director and Sewer District 7 District Manager. All payments and bills shall be sent to the attention of City Accounts Payable Division and Sewer District 7 District Manager.

17. Severability. Invalidation of any of the provisions of this Agreement or of any section, sentence, clause, phrase, or word in this Agreement, or the unenforceability of the

Agreement in any circumstance, shall not affect the validity of the remainder of this Agreement or the application of this Agreement in any other circumstance.

18. Amendment. This Agreement shall remain in force until mutually amended or terminated.

CITY OF BAINBRIDGE ISLAND

By 
Mayor

KITSAP COUNTY SEWER DISTRICT NO. 7

By 
President of Board of Commissioners

EXHIBIT A

1. Lynwood Center Building – tax parcel no. 042402-1-014-2004: 14 ERUs.
2. Serenity House – tax parcel nos. 042402-1-002-2008; 042402-1-003-2007; and 042402-1-006-2004: 23 ERUs.
3. Pleasant Beach Village – Auditor’s File No. 3035993: 10 ERUs.
4. Rich Pass LLC – tax parcel no. 042402-1-004-2006 (formerly Pleasant Beach Grill): 10 ERUs.
5. Lynwood Commons – tax parcel nos. 042402-1-078-2007; 042402-1-079-2006; 042402-1-080-2003; 042402-1-081-2002; 042402-1-082-2001 (formerly Blossom tax parcels 042402-1-12-2006; 042402-1-047-2005; 042402-1-048-2004; 042402-1-049-2003 and 042402-1-050-2002): 23 ERUs.

Exhibit B

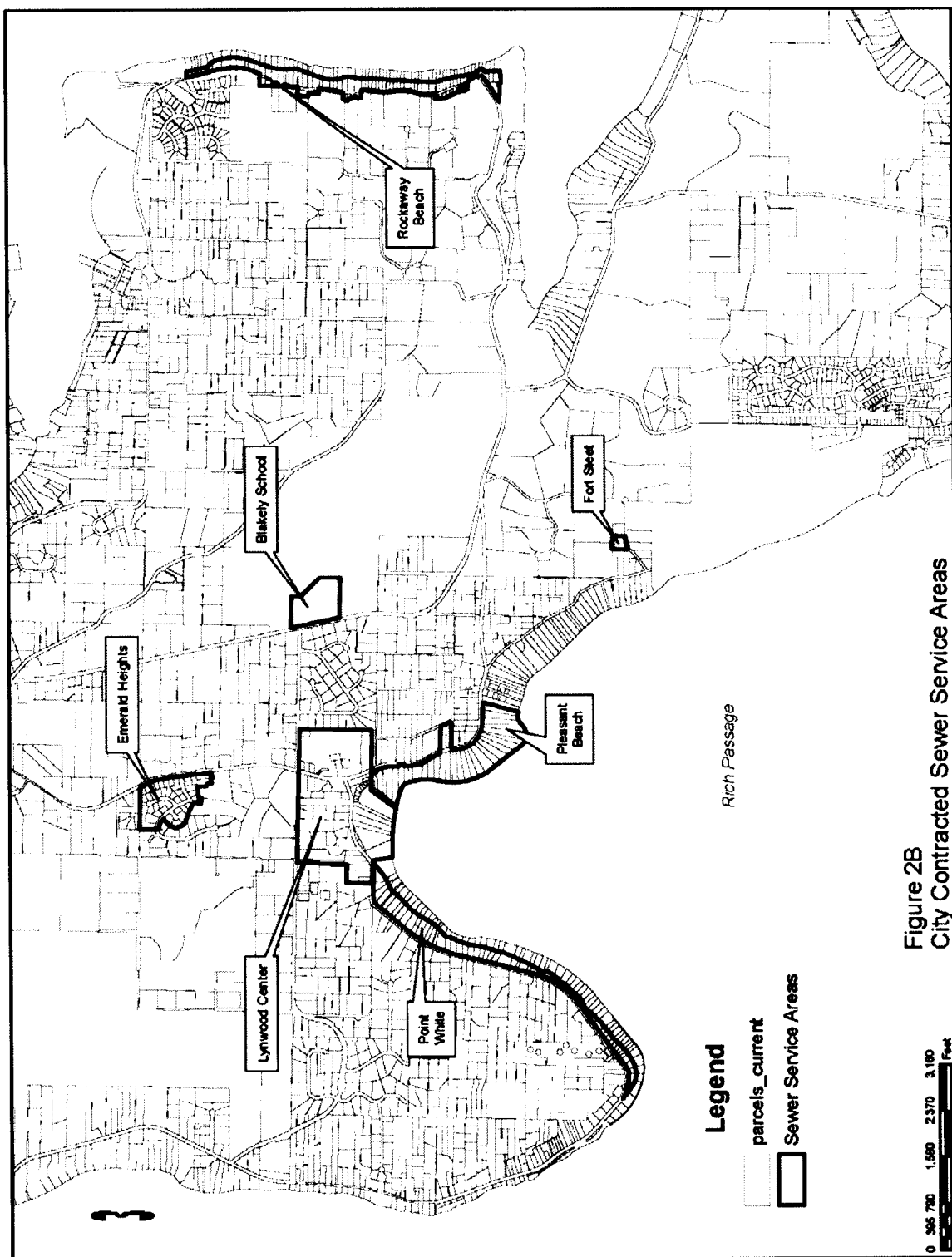


Figure 2B
City Contracted Sewer Service Areas

Exhibit C

	PUBLIC WORKS DEPARTMENT ADMINISTRATIVE PROCEDURE	2.14 SOUTH ISLAND SEWER CONNECTIONS
INDEX: 2.0 Direct Services	EFFECTIVE DATE: April 3, 2006	APPROVED: Signature on File

REFERENCES: City of Bainbridge Island Comprehensive Plan, as amended, on file in the Department of Planning and Community Development
Interlocal Agreement between the City and Sewer District No. 7 (SD7) dated October 3, 1997
Interlocal Agreement between the City and Sewer District No. 7 (SD7) dated September 24, 2003
All Interlocal Agreements between the City and Sewer District No. 7 (SD7) that provide for sewer connections in an amount greater than the number of connections defined in the Interlocal Agreement dated September 24, 2003.
Sewer Connection Analysis form, as amended, on file in the Department of Public Works.

POLICY: The policy and priority of the City is to manage the use of available ERUs in a manner that follows the guidance provided in the City's Comprehensive Plan, SD7 policies and resolutions, and this connection procedure. 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. are used (or planned for) to serve a public need,
 - c. are planned for residential use at densities greater than four units per acre or greater,
 - d. are planned for commercial and mixed use, or
 - 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 in the Comprehensive Plan, and
4. Avoid the creation of a secondary market for unused ERUs.

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

It is required that

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 (City would not take possession until a new recipient is identified), 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, 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 current zoning requirements, and plans approved by Planning and Community Development.

DEFINITIONS:

City of Bainbridge Island (City) South Island sewer capacity is defined as the number of Equivalent Residential Units (ERUs) reserved for wastewater treatment as established by interlocal agreement between the City and Kitsap County Sewer District No. 7 (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 (attached.) 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.

GUIDANCE:

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 connection of properties is largely governed by the following Comprehensive Plan policies:

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.

BACKGROUND: 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.

PROCEDURE:

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 consist of connected and unconnected parcels.

A. Connect all parcels at a time of the owner's choosing with the exception of a parcel located at 7936 NE Beck Road Rd. (see below)

B. The parcel (Parcel Tax Account # 4164-003-013-0003) located at 7936 NE Beck Road Rd. shall be permitted to connect in the future provided that the following conditions as stipulated in an agreement with the City are met:

1. The parcel is within the City's sewer service area
2. Sufficient City sewer capacity is available as determined by the City
3. 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,

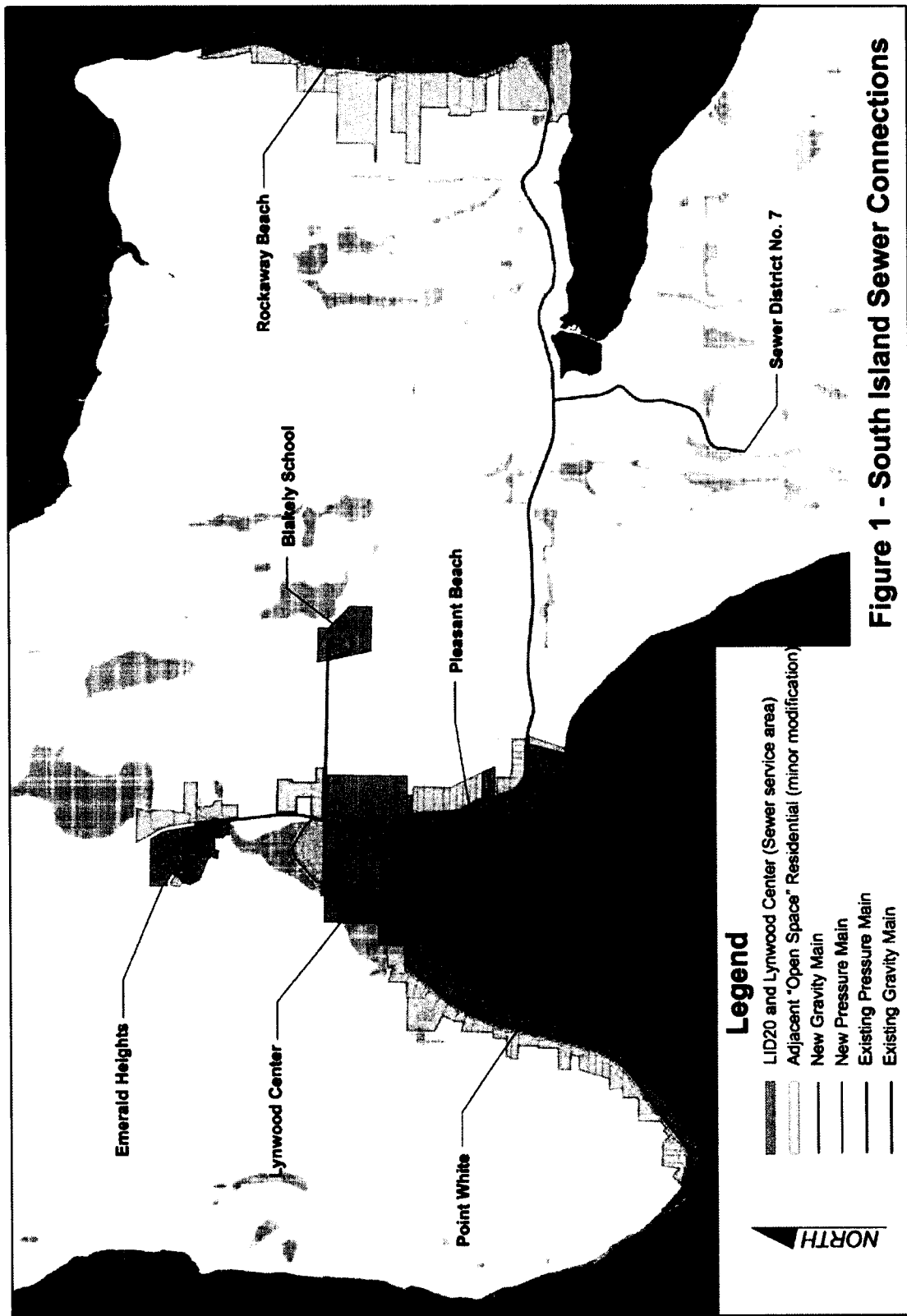
the City's current Comprehensive Plan, the City's current zoning requirements, and plans approved by Planning and Community Development:

- A. Assign requests for sewer connections to one of the following eight priority categories:
 - 1. Parcels in Lynwood Center with building(s) that have failing septic systems
 - 2. Parcels in Lynwood Center with building(s) served by a septic system that are located with a proximity to sensitive bodies of water and that have a high probability of negatively affecting the quality of those bodies of water
 - 3. Projects in Lynwood Center used (or planned for) that serve a public need
 - 4. Projects in Lynwood Center planned for residential use at densities of four units to the acre or greater
 - 5. Projects in Lynwood Center planned for commercial and mixed use
 - 6. Projects in Lynwood Center planned for residential use at densities of less than four units to the acre.
 - 7. Parcels in Adjacent "Open Space" Residential areas with building(s) that have failing septic systems
 - 8. Parcels in Adjacent "Open Space" Residential with building(s) served by a septic system that are located with a 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 date rank each request according to the date the City received the request with the oldest request ranked 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 established above.
- D. After requests in categories A.1 through A.4 are fulfilled use available connections to fulfill requests in priority categories A.5 through A.8 in numerical order with the lowest number fulfilled first following the date ranking established 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 may be pursued.

ATTACHMENTS: Figure 2B – City Contracted Sewer Service Area
Figure 1 – Adjacent “Open Space” Residential Area
Sewer Connection Analysis form, Page 1
Sewer Connection Analysis form, Page 2



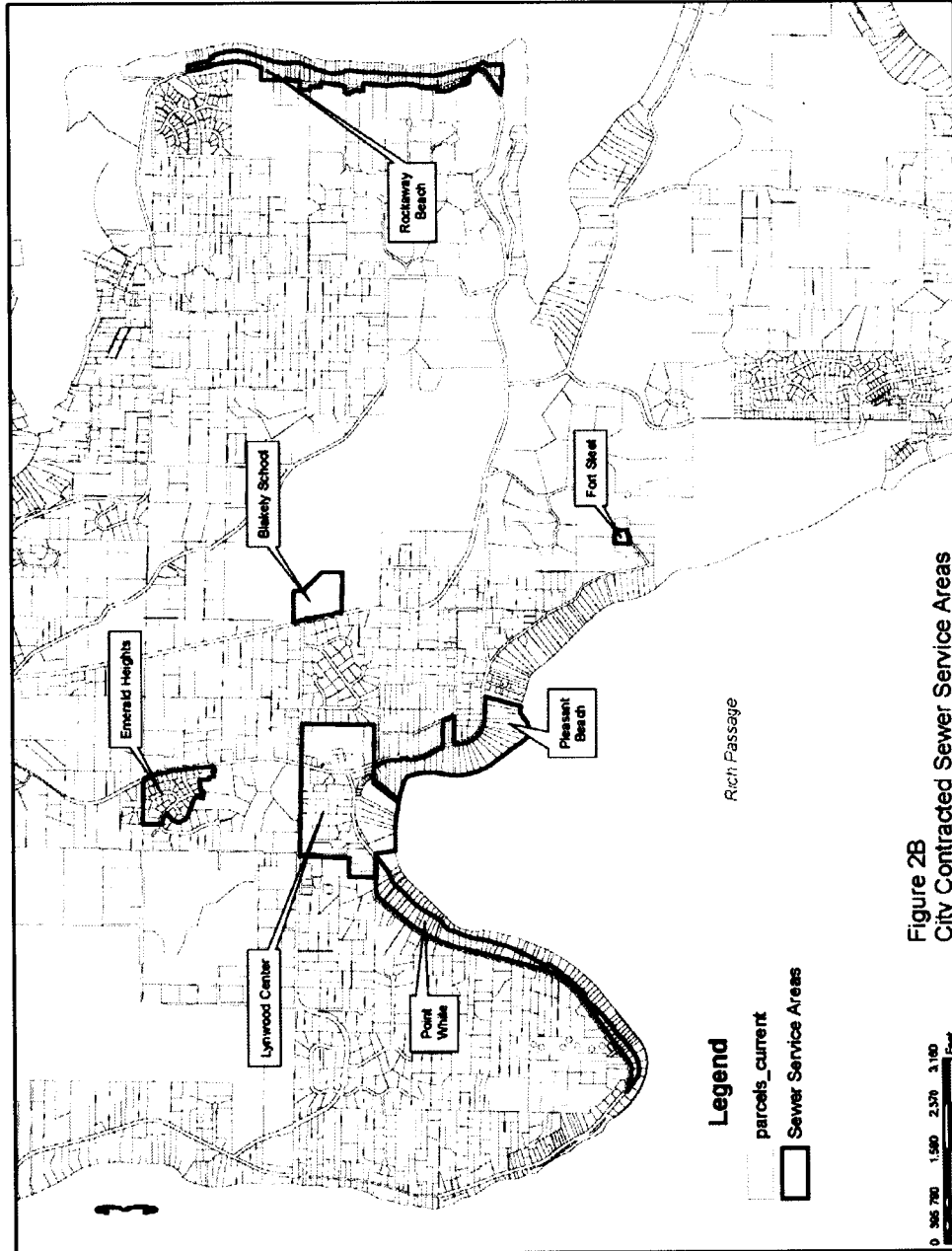


Figure 2B
City Contracted Sewer Service Areas



CITY OF BAINBRIDGE ISLAND
PUBLIC WORKS DEPARTMENT
280 MADISON AVENUE N.
BAINBRIDGE ISLAND, WA 98110
206-780-3708

Sewer Connection Analysis

This information is for ☐ Current Sewer Connections
☐ Proposed Sewer Connections

Change to previously submitted information? ☐ Yes ☐ No

Parcel Information Please print

Parcel Tax Account #'s _____
Legal Street Address _____ Bainbridge Island, WA

Applicant Information Please print

Owner	Name _____	COBI Utility Account Number _____	
	Mailing Address1 _____	Current or previous sewer connections only. Use one form for each account.	
	Mailing Address2 _____		
	City _____ State _____ Zip _____		Phone _____
	Project Name _____		Email _____

Agent	Name _____	Applications submitted by an Agent are required to have a notarized Owner/Agent Agreement with Construction Permit authorization on file or submitted with this form.	
	Company _____		
	Mailing Address1 _____	Business License # _____	Year _____
	Mailing Address2 _____	Phone _____	
	City _____ State _____ Zip _____	Email _____	

Industrial/Commercial ERUs

Fixture Type	Fixture Unit Value	Bldg #		Bldg #		Bldg #		Bldg #		Bldg #		Total Qty	Total Fixture Units
		Qty	Units	Qty	Units	Qty	Units	Qty	Units	Qty	Units		
Bath tub and/or shower	4												
Dental units or lavatory	1												
Dishwasher, commercial	4												
Drinking fountain (each head)	1												
Hose bib or Sill cock	5												
Laundry tub or Clothers washer	4												
Sink, bar or lavatory	2												
Sink, clinic, flushing	10												
Sink, kitchen	4												
Sink, other	4												
Sink, wash, circle spray	4												
Urinal, flush tank	3												
Urinal, pedestal	10												
Urinal, wall or stall	5												
Water closet, tank	5												
Water closet, flush valve	10												
Total Fixture Units													
Total ERUs													

Fixture Unit Value X Qty = Fixture Units
20 Fixture Units equal 1.0 Equivalent Residential Units (ERU) rounded to the nearest 1/100 ERU

Over

Industrial/Commercial Pre-treatment

The discharge of industrial wastewater (other than domestic wastewater) into municipal sewerage systems which would interfere with, pass through, or otherwise be incompatible with such systems or which would contaminate the sludge will not be permitted.

WAC 173-216

Will industrial or commercial wastewater (other than domestic wastewater) including wastewater from restaurants, food processing facilities, and chemical processing facilities be discharged into the City of Bainbridge Islands (City) wastewater treatment plant?

☐ Yes ☐ No

Will industrial or commercial wastewater (other than domestic wastewater) including wastewater from restaurants, food processing facilities, and chemical processing facilities be discharged into the Kitsap County Sewer District 7 (SD7) wastewater treatment plant?

☐ Yes ☐ No

Applicants submitting a request for sewer connections where industrial or commercial wastewater (other than domestic wastewater) will be discharged into the City or SD7 wastewater treatment plant shall provide engineering data in a form determined by the City Engineer or designated representative to establish pre-treatment requirements.

Residential Multi-Family Living Units

Bldg #	Bldg #	Bldg #	Bldg #	Bldg #	Bldg #	Bldg #	Bldg #	Bldg #	Total Residential Living Units
Units/Building									

Assisted Living Multi-Family Living Units - ERUs

Fixture Units X Total Fixtures = Total Fixture Units 20 Fixture Units equal 1.0 Equivalent Residential Units (ERU)

Fixture Type	Fixture Unit Value	Bldg #	Bldg #	Bldg #	Bldg #	Bldg #	Bldg #	Total
		Qty	Units	Qty	Units	Qty	Units	
Bath tub and/or shower	4							
Dishwasher	4							
Hose bib or Sill cock	5							
Laundry tub or Clothers washer	4							
Sink, bar or lavatory	2							
Sink, kitchen	4							
Sink, other	4							
Urinal, flush tank	3							
Urinal, pedestal	10							
Urinal, wall or stall	5							
Water closet, tank	5							
Water closet, flush valve	10							
Total Fixture Units								
Total ERUs								

Fixture Unit Value X Qty = Fixture Units
20 Fixture Units equal 1.0 Equivalent Residential Units (ERU) rounded to the nearest 1/100 ERU

Applicant agrees that all information submitted on this form is truthful and based upon best available information known at the time of submittal. Applicant further agrees to immediately inform the City of any and all changes in the information submitted, and to any change in use including any unoccupied, unsold, or otherwise undefined industrial or commercial space with a resubmittal of this form.

Owner/Agent Signature*

Date

*Applications submitted by an Agent are required to have a notarized Owner/Agent Agreement on file or submitted with this form.

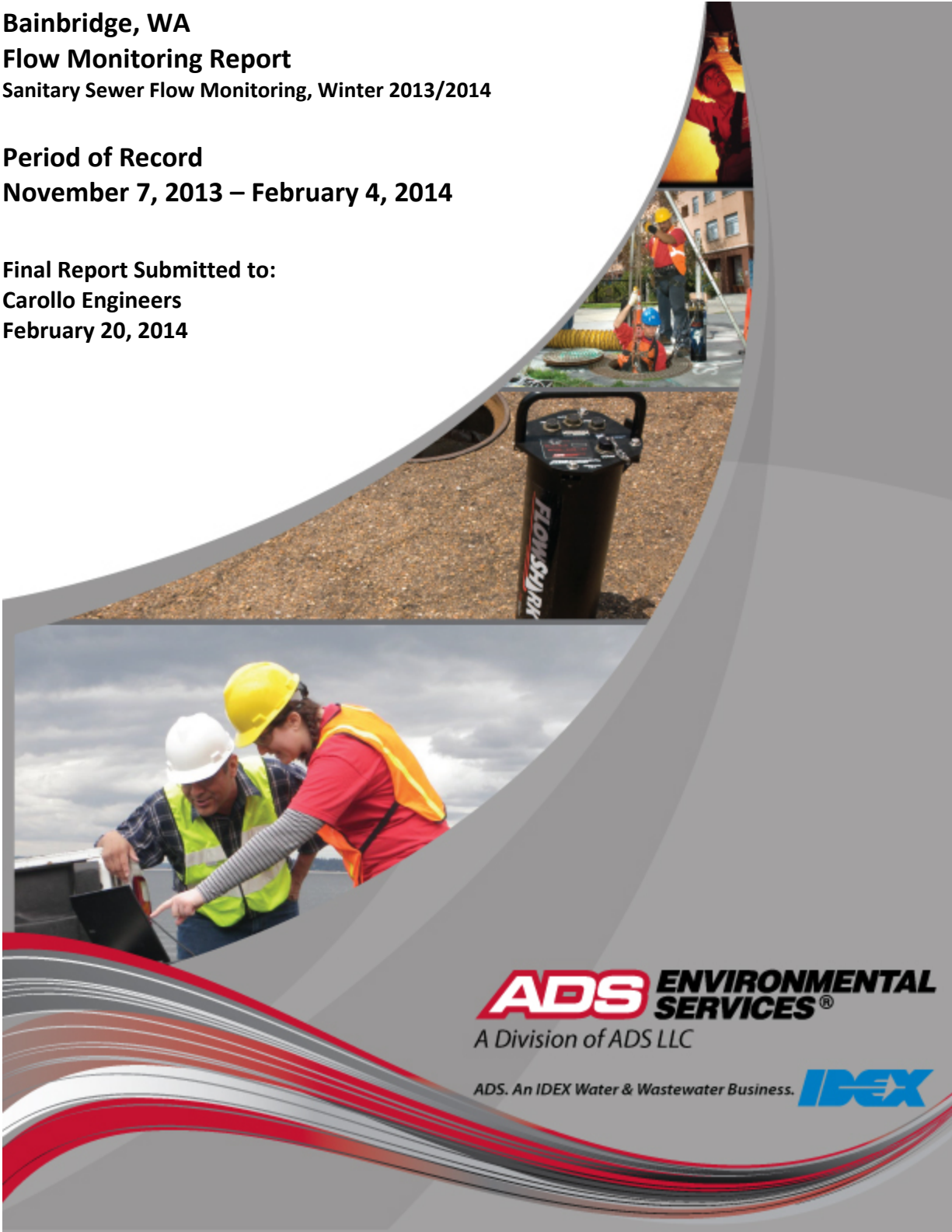
01/31/06

ADS FLOW MONITORING REPORT

Bainbridge, WA
Flow Monitoring Report
Sanitary Sewer Flow Monitoring, Winter 2013/2014

Period of Record
November 7, 2013 – February 4, 2014

Final Report Submitted to:
Carollo Engineers
February 20, 2014



ADS ENVIRONMENTAL SERVICES®

A Division of ADS LLC

ADS. An IDEX Water & Wastewater Business. **IDEX**

February 20, 2014

Alena Bennett
Carollo Engineers
1218 Third Avenue, Suite 1600
Seattle, WA 98101
P: 206-684-6532
abennett@carollo.com

Re: City of Bainbridge, WA Sanitary Sewer Flow Monitoring Final Report

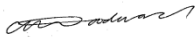
Dear Ms. Bennett,

Thank you for the opportunity to complete this flow monitoring work effort for the City of Bainbridge, WA.

Please find attached the electronic report containing the analysis and results for the data set collected in the City's sanitary sewer system from November 7, 2013 – February 4, 2014.

Alena, we certainly look forward to other opportunities to work with the City and Carollo on wastewater projects as they arise. If you have any questions regarding the content of this report, please do not hesitate to call me at (206) 255 6904 or Mike Pina at (206) 762 5070.

Sincerely,



Gillian Woodward P.E.
Senior Project Engineer
(206) 255-6904

ADS Environmental Services
gwoodward@idexcorp.com

Bainbridge_11-5
Site Access

**ADS ENVIRONMENTAL
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NE Wing Point Way

Site Location

Site access looking southeast

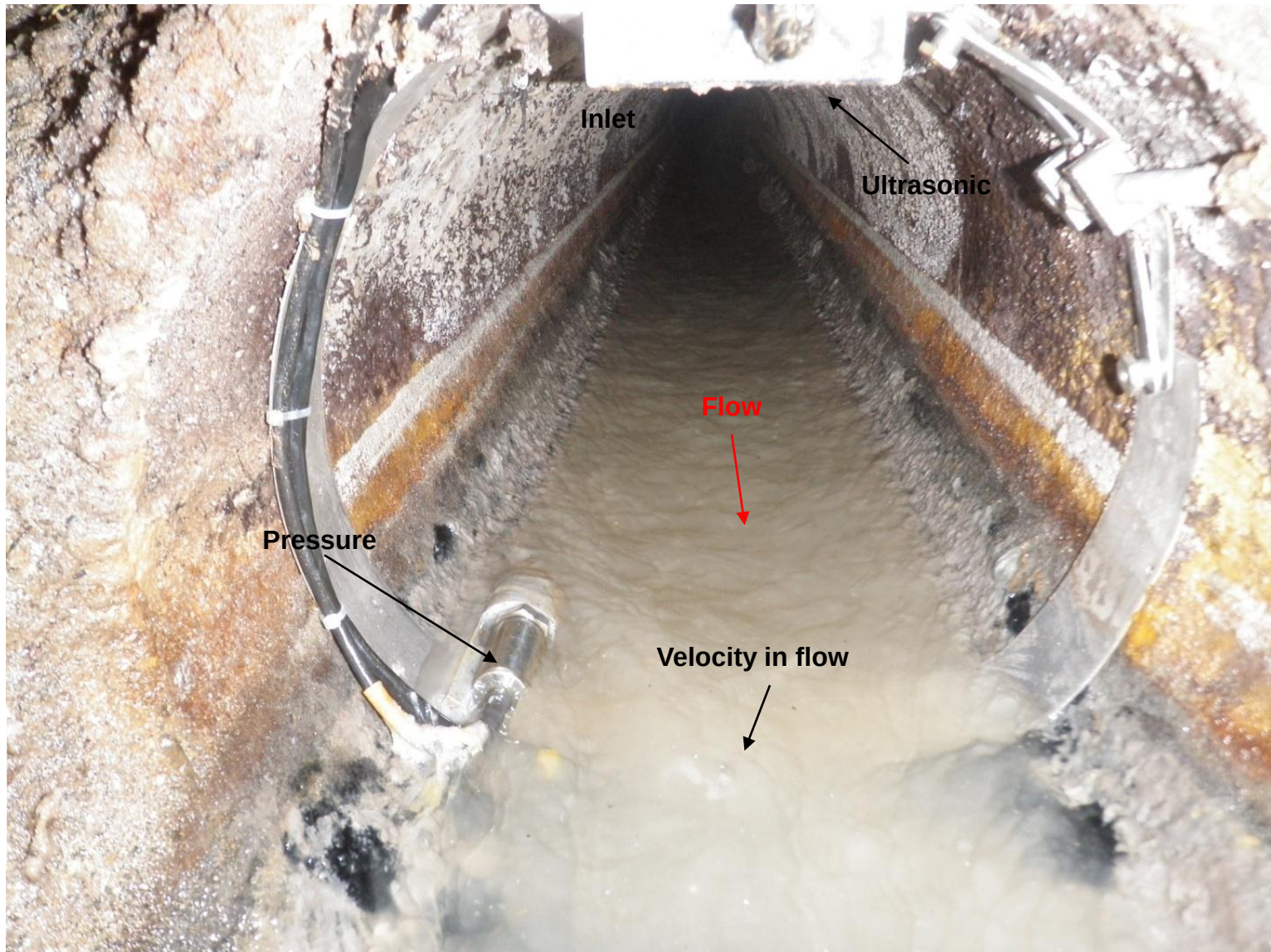
Bainbridge_11-5
Site setup



View of site looking north

Bainbridge_11-5
Site setup

**ADS ENVIRONMENTAL
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View of inlet and sensor placement

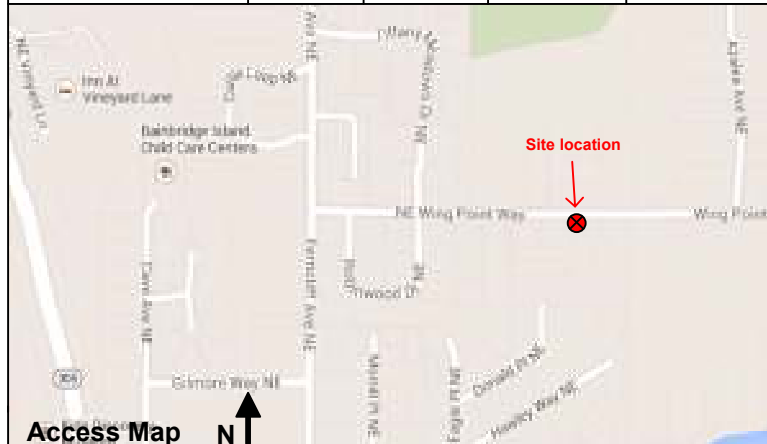
Bainbridge_11-5
Site setup

ADS ENVIRONMENTAL
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View of outlet and hydraulics

Project Name: Bainbridge		City / State: Bainbridge, WA		FM Initials: SW	
Site Name: Bainbridge 11-5		Monitor Series: 5000 AG		Monitor S/N: 20032	
Address/Location: 1221 NE Wing Point Way (in drive way close to house)		Manhole #		11-5	
		GPS		47°37'40.64"N, 122°30'19.69"W	
		Pipe Height:		12.25"	
Access: Drive	Type of System:	Sanitary ☒	Storm ☐	Combined ☐	Pipe Width: 12.25"
					IP Address: 166.219.172.10



Investigation Information:		Manhole Information:	
Date/Time of Investigation:	11/06/13 @ 15:00	Manhole Depth:	20'
Site Hydraulics:	Low steady flow	Manhole Material / Condition	Concrete / Good
Upstream Input: (L/S, P/S)	Not influenced	Pipe Material / Condition:	Clay / Good
Upstream Manhole:	1 inlet / 1 outlet	Mini System Character:	☒ Residential ☐ Commercial ☐ Industrial ☐ Trunk
Downstream Manhole:	1 inlet / 1 outlet	Telephone Information:	Does not apply
Depth of Flow:	2.00" +/- 0.25"	Access Pole #:	Does not apply
Range (Air DOF):	10.25" +/- 0.25"	Distance From Manhole:	Does not apply Feet
Peak Velocity:	3.18 fps	Road Cut Length:	Does not apply Feet
Silt:	0.00" Inches	Trench Length:	Does not apply Feet

Other Information:	
Cross Section	Planar

Installation Information		Backup		Yes	No	?	Distance
Installation Type: Standard		Trunk		☐	☐	☒	
Sensors Devices: U, V, P		Lift / Pump Station		☐	☒	☐	
Surcharge Height: 0 Feet		WWTP		☐	☒	☐	
Rain Guage Zone: Bainbridge_RG		Other		☐	☐	☒	

Additional Site Information / Comments:	
---	--

Pressure (5 PSI, accuracy +/- 0.25% for range of 0.25 – 11.5 ft.)
Site installed on 11/06/13

Drawn 11/18/13

Flow Monitoring Site Safety Plan

Project Name: Bainbridge **Site ID:** Bainbridge_11-5 **Site Classification:** (see below)

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	☐
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located in a high speed (>45MPH) or high density roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☐
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☐
	10	Work may be performed during darkness; requiring additional site lighting	☐
Confined Space	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☒
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

No hazards found at this site

*** Site Classification**

	Class	Description
☒	1	2-person crew. Standard procedures and equipment. No special requirements
☐	2	Worksite (non-traffic) with access obstacles and or worksite hazards
☐	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. <i>Must be approved by Corporate Safety Manager</i>

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

No Site Specific Safety Requirements

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

- ☐ This worksite does NOT require a traffic control Plan
- ☒ Standard Traffic Control Plan TA-18 is to be used at this work site
- ☐ This site requires a special Traffic Control Plan which is attached

Approved

Field Mgr Name: Sean Winder

Signature: Signed copy can be obtained from ADS

Date: 11/6/13

Reviewed

Project Mgr Name: Mike Pina

Signature: Signed copy can be obtained from ADS

Date: 11/6/13

Bainbridge 11-5

Monitoring Period: November 7, 2013 – February 4, 2014
Located At: See attached site report for details
Pipe Dimensions: 12.25" x 12.25"
Finalized Silt Level: 0"

Site Data Characteristics: This site is located in a sanitary sewer pipe, and the equipment type was an ADS FlowShark. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate the flow rate for the monitoring period.

Analysis of Hydrograph: The hydrograph indicates a flow pattern with a significant pump station influence.

Analysis of Scattergraph: The majority of the data are grouped above $Fr=1$ indicating supercritical flow however the low flow data do cross $Fr=1$ resulting in a slight hydraulic jump. No other unusual characteristics are noted.

Site Data Bias & Editing: The depth and velocity measurements recorded by the flow monitor were consistent with field confirmations conducted to date and supported the relative accuracy of the flow monitor at this location. The finalized depth data utilized the down looking ultrasonic sensor during normal flow conditions. Data points "drops and pops" (outside the normal data set) were flagged. For the finalized velocity data "drops" (outside the normal data set) were flagged.

Site Data Uptime: The raw and finalized data uptime achieved during the monitoring period is provided in the table below and this information is based on the 5-minute sample interval.

Entity	Percentage Uptime Raw	Percentage Uptime Final
Depth (in)	100%	100%
Velocity (ft/s)	100%	98%
Quantity (MGD)	100%	98%

Site Data Summary: The average flow depth, velocity, and quantity data observed during the monitoring period along with observed minimum and maximum data, are provided in the following table. The minimum and maximum rates recorded in the tables are based on 5-minute data intervals.

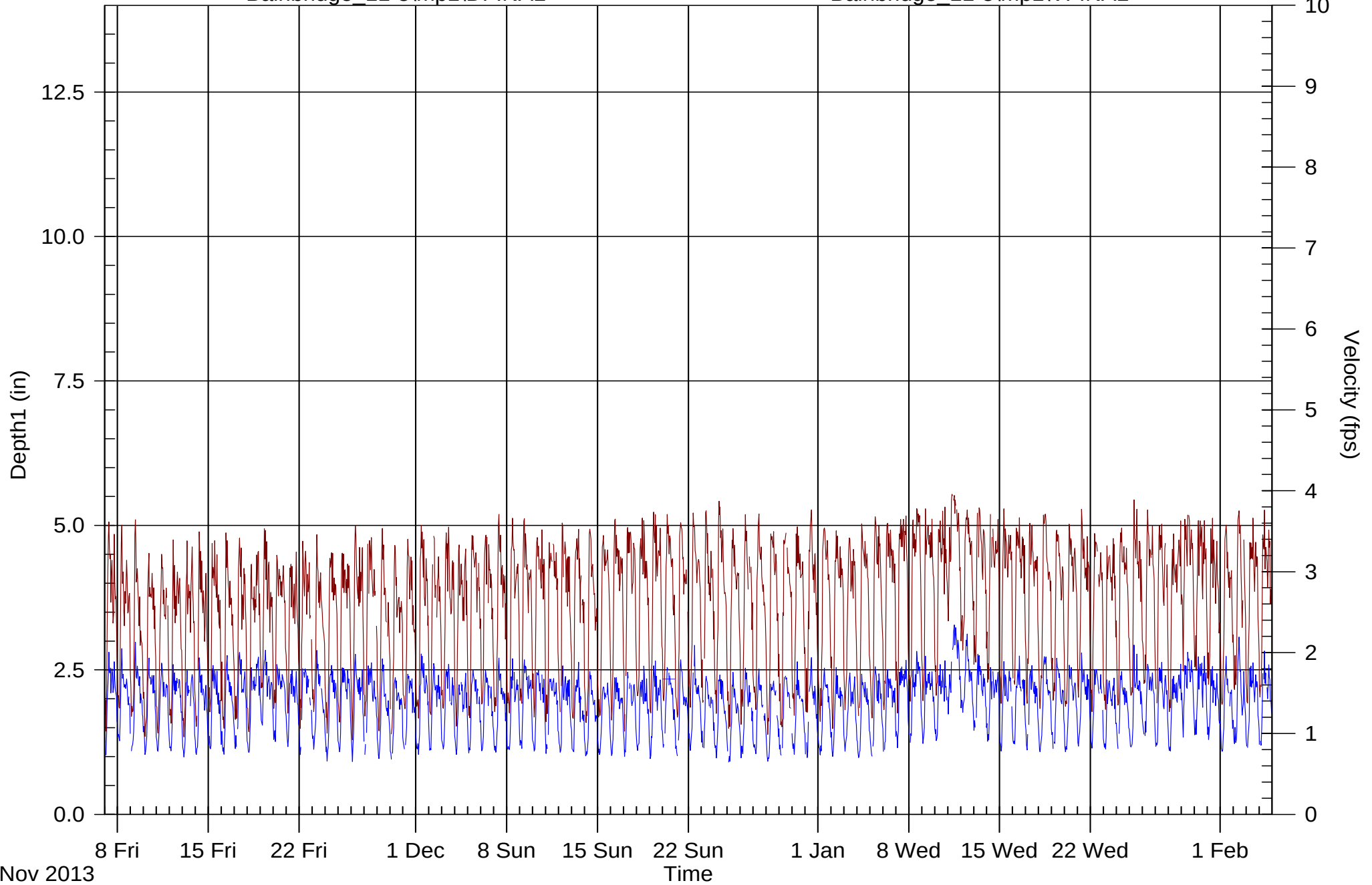
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Minimum	0.70	0.57	0.01
Maximum	4.72	4.36	0.67
Average	1.93	2.61	0.17

ADS Environmental Services

Pipe Height: 12.25

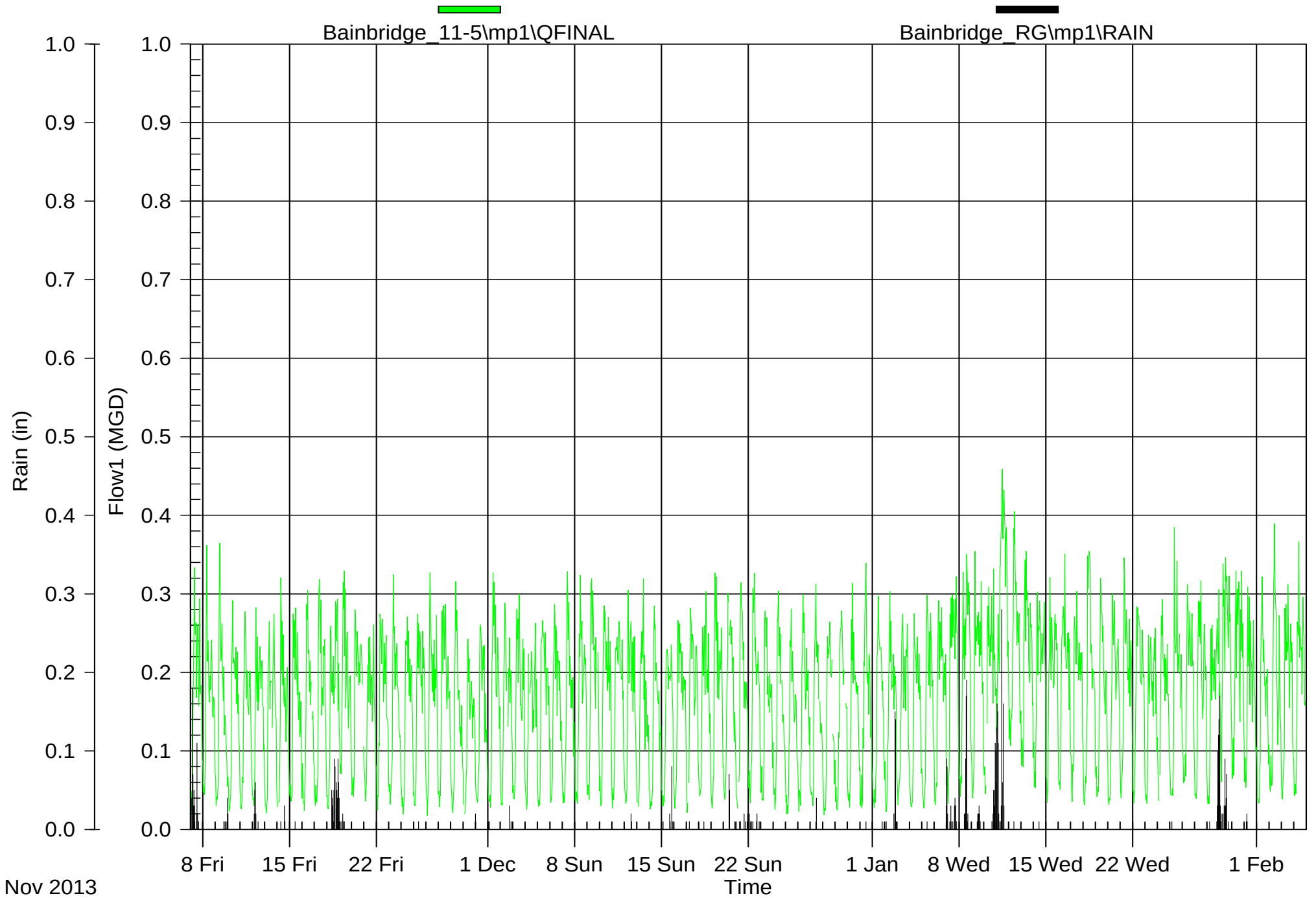
Bainbridge_11-5\mp1\DFINAL

Bainbridge_11-5\mp1\VFINAL



ADS Environmental Services

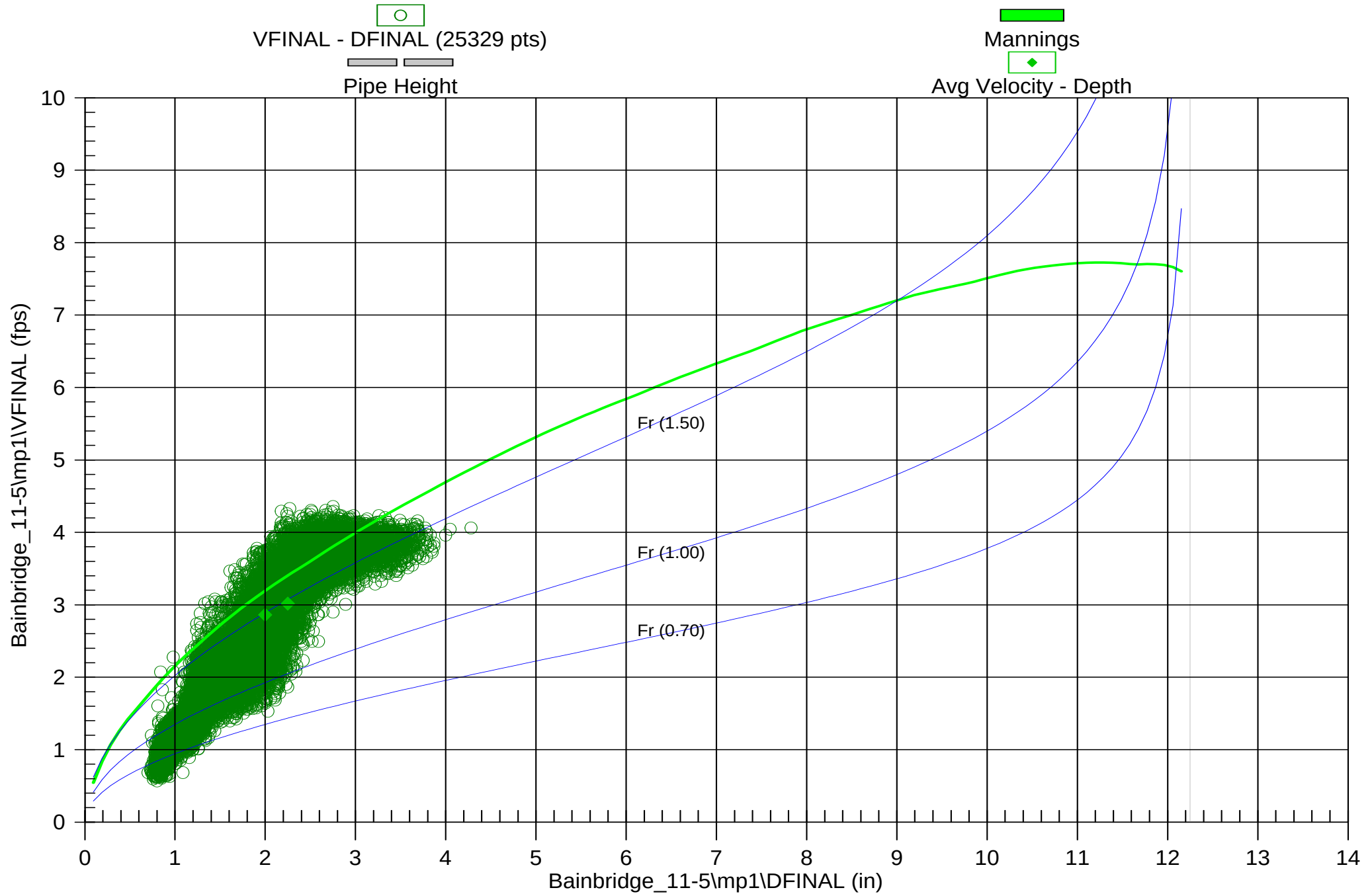
Pipe Height: 12.25



ADS Environmental Services

11/7/2013 12:00:00 AM - 2/5/2014 12:00:00 AM

Pipe Height: 12.25



Bainbridge_2-1
Site Access

**ADS ENVIRONMENTAL
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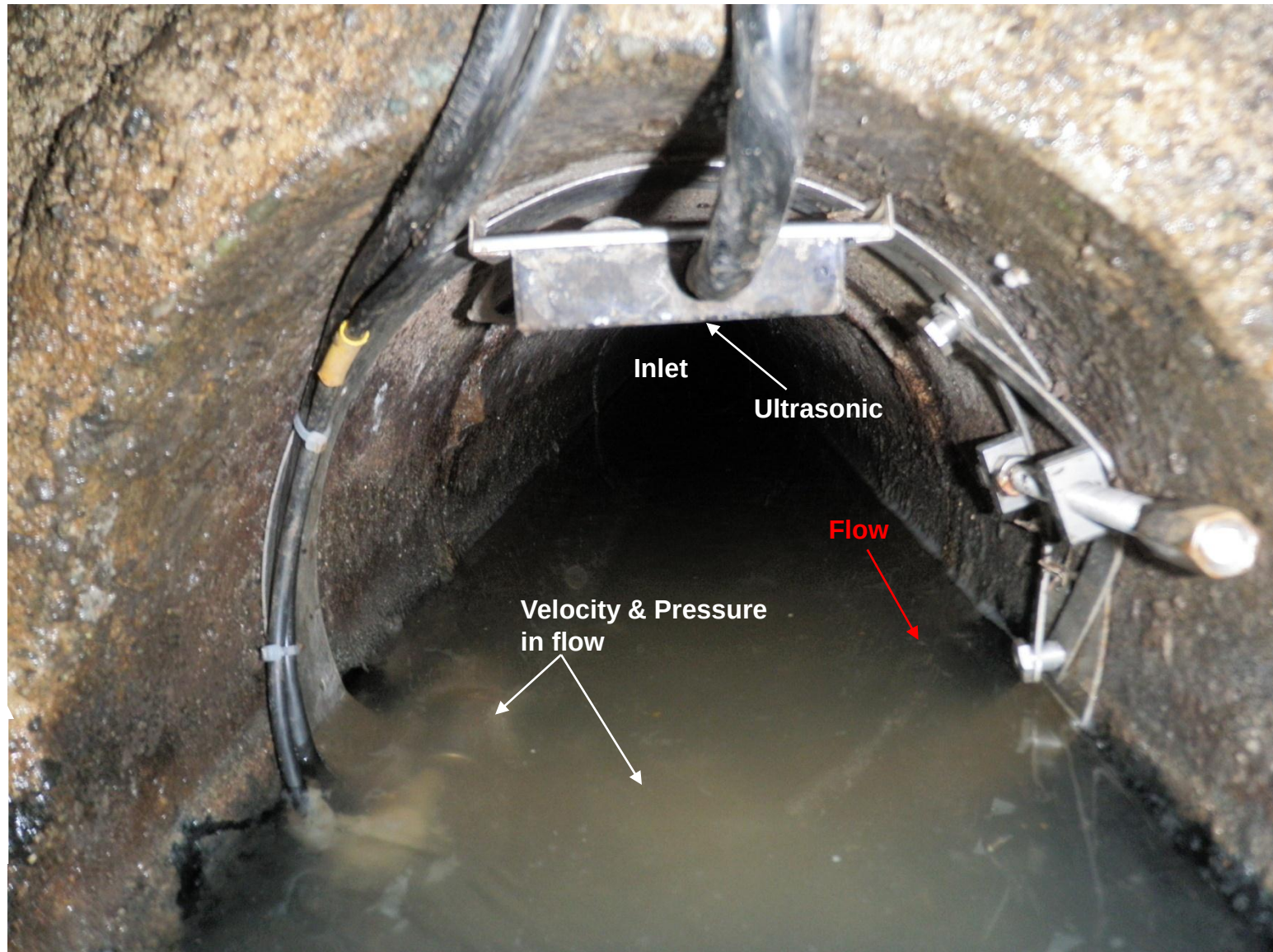
Site access looking north

Bainbridge_2-1
Site setup



View of site looking northeast

Bainbridge_2-1
Site setup



View of inlet and sensor placement

Bainbridge_2-1
Site setup



View of outlet and hydraulics

Project Name: Bainbridge		City / State: Bainbridge, WA		FM Initials: SW	
Site Name: Bainbridge 2-1		Monitor Series: 5000 AG		Monitor S/N: 20037	
Address/Location: Hildebrand Ln (near Kitsap CU)		Manhole #		2-1	
		GPS		47°38'2.23"N, 122°31'1.09"W	
		Pipe Height:		9.88"	
Access: Drive	Type of System:	Sanitary ☒	Storm ☐	Combined ☐	Pipe Width:
					9.88"
					IP Address: 166.219.168.92



Investigation Information:		Manhole Information:	
Date/Time of Investigation:	11/06/13 @ 11:00	Manhole Depth:	20'
Site Hydraulics:	Smooth and slow moving	Manhole Material / Condition	Concrete / Good
Upstream Input: (L/S, P/S)	Not influenced	Pipe Material / Condition:	Clay / Good
Upstream Manhole:	1 inlet / 1 outlet	Mini System Character:	Residential ☒ Commercial ☐ Industrial ☐ Trunk ☐
Downstream Manhole:	1 inlet / 1 outlet	Telephone Information:	Does not apply
Depth of Flow:	3.25" +/- 0.25"	Access Pole #:	Does not apply
Range (Air DOF):	6.63" +/- 0.25"	Distance From Manhole:	Does not apply Feet
Peak Velocity:	0.80 fps	Road Cut Length:	Does not apply Feet
Silt:	0.00" Inches	Trench Length:	Does not apply Feet

Other Information:	
Cross Section	Planar

Installation Information	Backup	Yes	No	?	Distance
Installation Type: Standard	Trunk	☐	☐	☒	
Sensors Devices: U, V, P	Lift / Pump Station	☐	☒	☐	
Surcharge Height: 0 Feet	WWTP	☐	☒	☐	
Rain Gauge Zone: Bainbridge_RG	Other	☐	☐	☒	

Additional Site Information / Comments:

Pressure (5 PSI, accuracy +/- 0.25% for range of 0.25 – 11.5 ft.)
 Site installed on 11/06/13

Drawn 11/18/13

Flow Monitoring Site Safety Plan

Project Name: Bainbridge **Site ID:** Bainbridge_2-1 **Site Classification:** (see below)

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	☐
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located in a high speed (>45MPH) or high density roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☐
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☐
	10	Work may be performed during darkness; requiring additional site lighting	☐
Confined Space	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☒
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

No hazards found at this site

*** Site Classification**

	Class	Description
☒	1	2-person crew. Standard procedures and equipment. No special requirements
☐	2	Worksite (non-traffic) with access obstacles and or worksite hazards
☐	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. <i>Must be approved by Corporate Safety Manager</i>

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

No Site Specific Safety Requirements

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

☐	This worksite does NOT require a traffic control Plan
☒	Standard Traffic Control Plan TA-18 is to be used at this work site
☐	This site requires a special Traffic Control Plan which is attached

Approved

Field Mgr Name: Sean Winder
 Signature: Signed copy can be obtained from ADS
 Date: 11/6/13

Reviewed

Project Mgr Name: Mike Pina
 Signature: Signed copy can be obtained from ADS
 Date: 11/6/13

Bainbridge 2-1

Monitoring Period: November 7, 2013 – February 4, 2014
Located At: See attached site report for details
Pipe Dimensions: 9.88" x 9.88"
Finalized Silt Level: 0"

Site Data Characteristics: This site is located in a sanitary sewer pipe, and the equipment type was an ADS FlowShark. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate the flow rate for the monitoring period.

Analysis of Hydrograph: The hydrograph indicates a flow pattern with a significant pump station influence.

Analysis of Scattergraph: The data are grouped below FR=1 indicating subcritical flow. No other unusual characteristics are noted.

Site Data Bias & Editing: The depth and velocity measurements recorded by the flow monitor were consistent with field confirmations conducted to date and supported the relative accuracy of the flow monitor at this location. The finalized depth data utilized the down looking ultrasonic sensor during normal flow conditions. Data points "drops and pops" (outside the normal data set) were flagged. For the finalized velocity data "drops" (outside the normal data set) were flagged.

Site Data Uptime: The raw and finalized data uptime achieved during the monitoring period is provided in the table below and this information is based on the 5-minute sample interval.

Entity	Percentage Uptime Raw	Percentage Uptime Final
Depth (in)	100%	100%
Velocity (ft/s)	100%	99%
Quantity (MGD)	100%	99%

Site Data Summary: The average flow depth, velocity, and quantity data observed during the monitoring period along with observed minimum and maximum data, are provided in the following table. The minimum and maximum rates recorded in the tables are based on 5-minute data intervals.

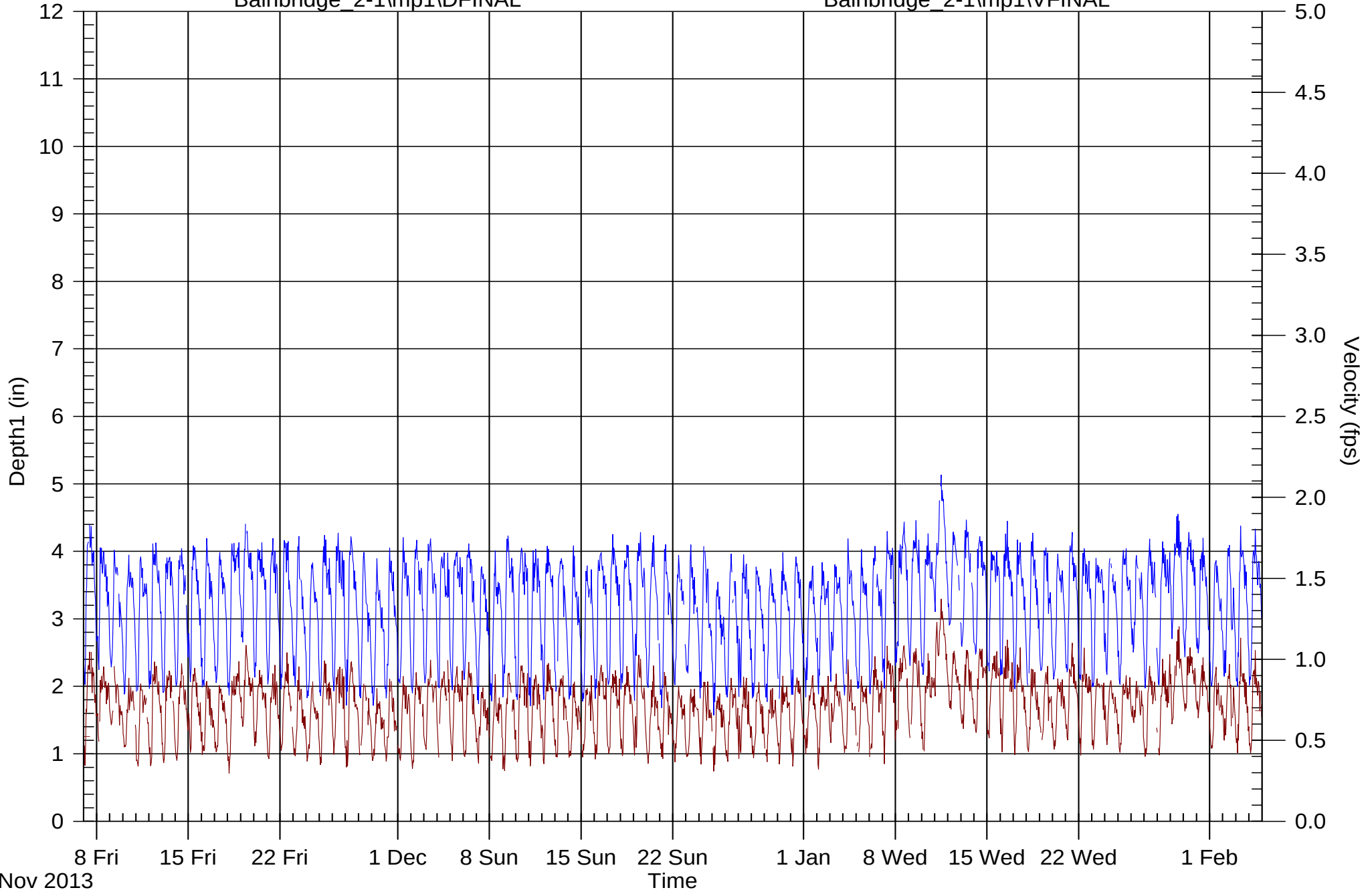
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Minimum	1.5	0.15	0.01
Maximum	6.21	1.81	0.41
Average	3.22	0.71	0.08

ADS Environmental Services

Pipe Height: 9.88

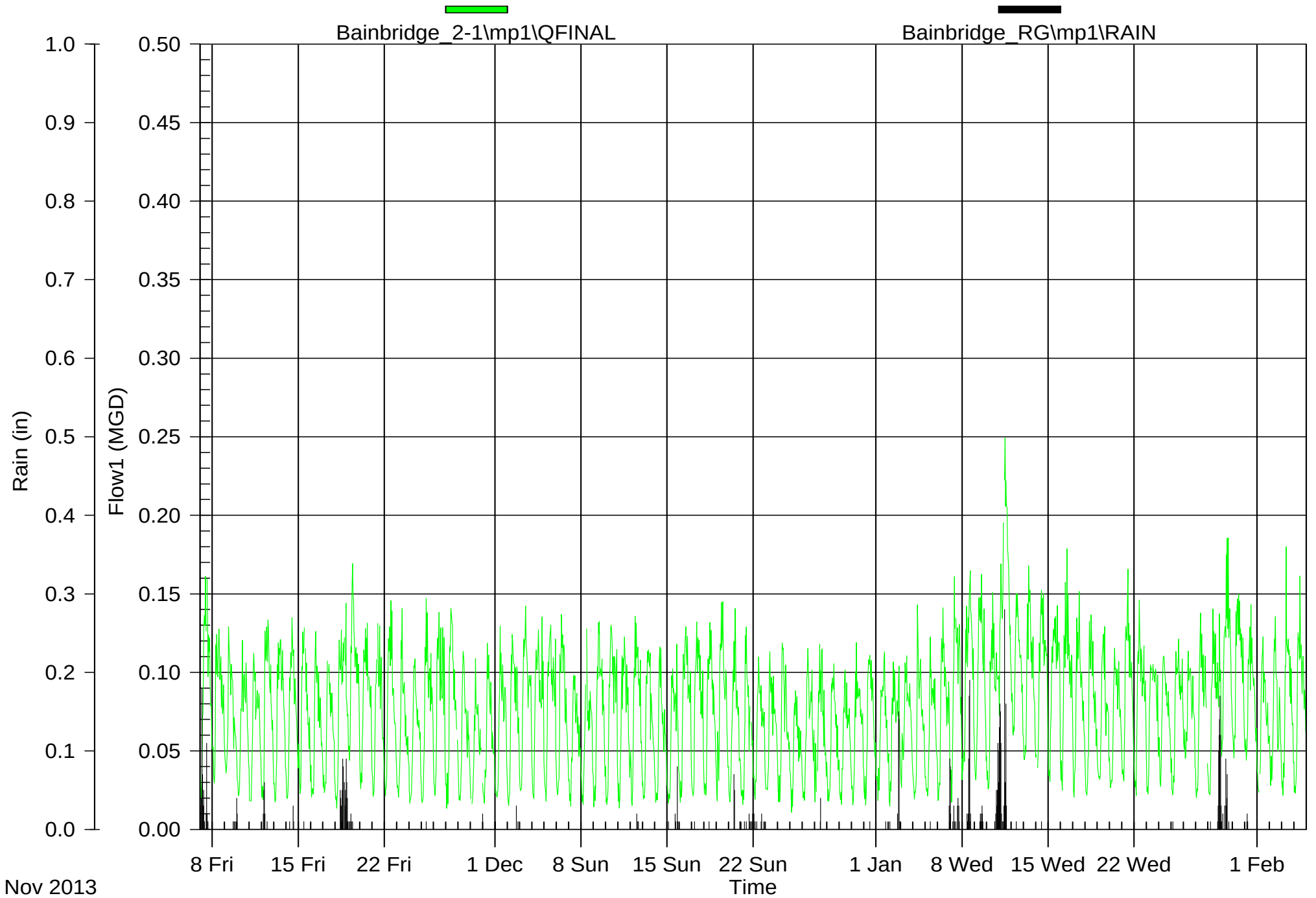
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Bainbridge_2-1\mp1\VFINAL



ADS Environmental Services

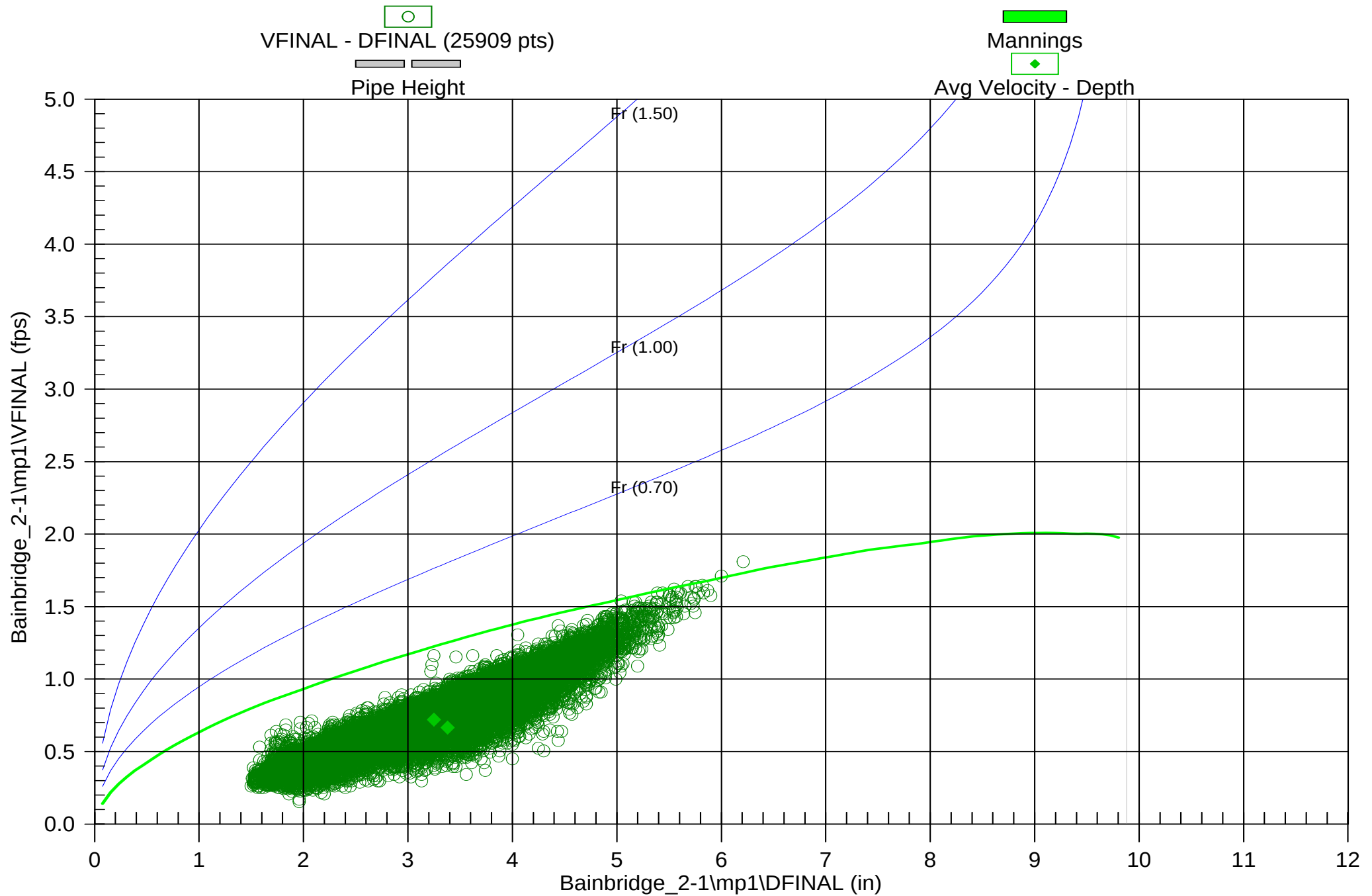
Pipe Height: 9.88



ADS Environmental Services

11/7/2013 12:00:00 AM - 2/5/2014 12:00:00 AM

Pipe Height: 9.88



Bainbridge_5-1
Site Access

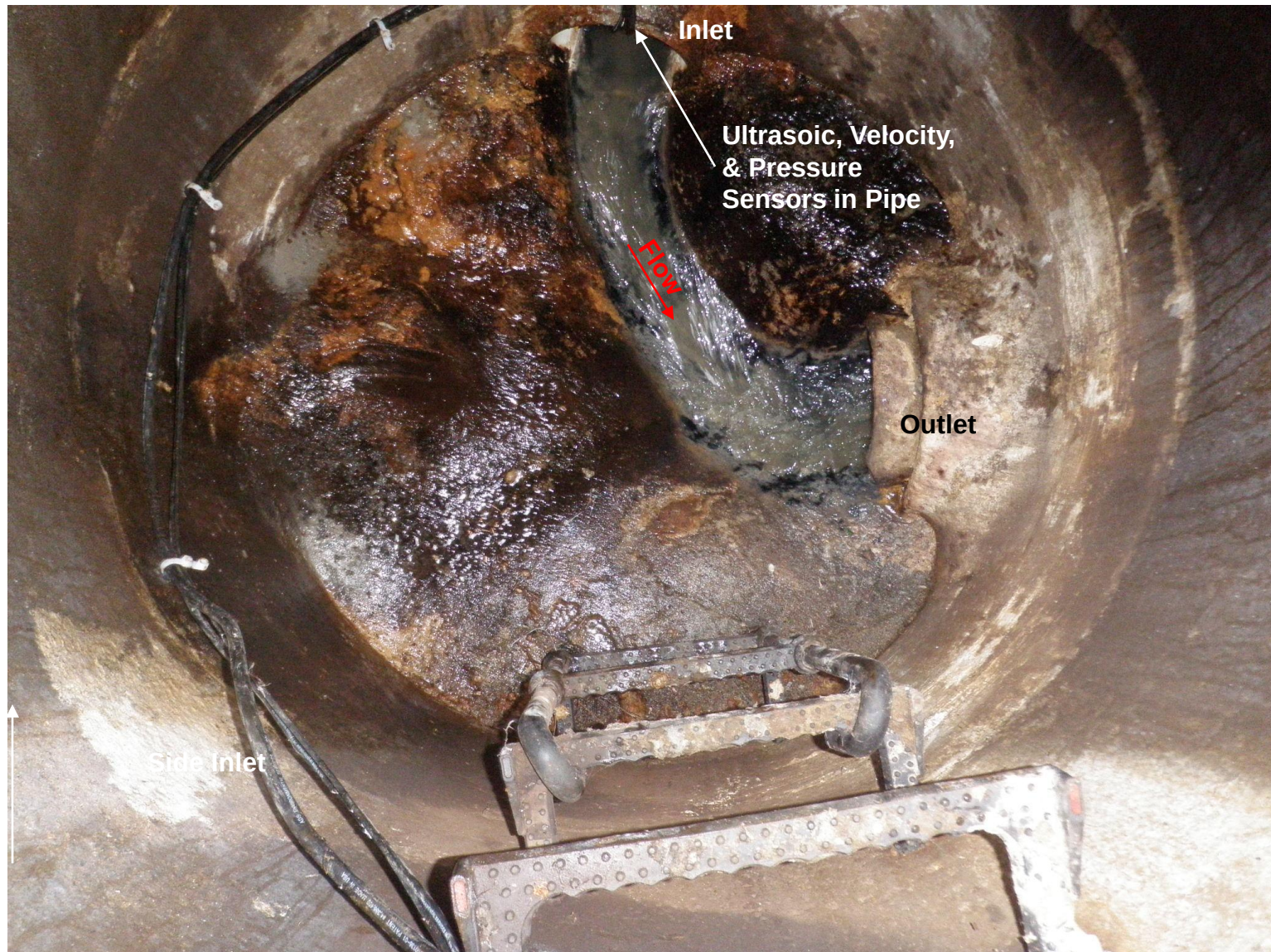
**ADS ENVIRONMENTAL
SERVICES®**



Site access looking north

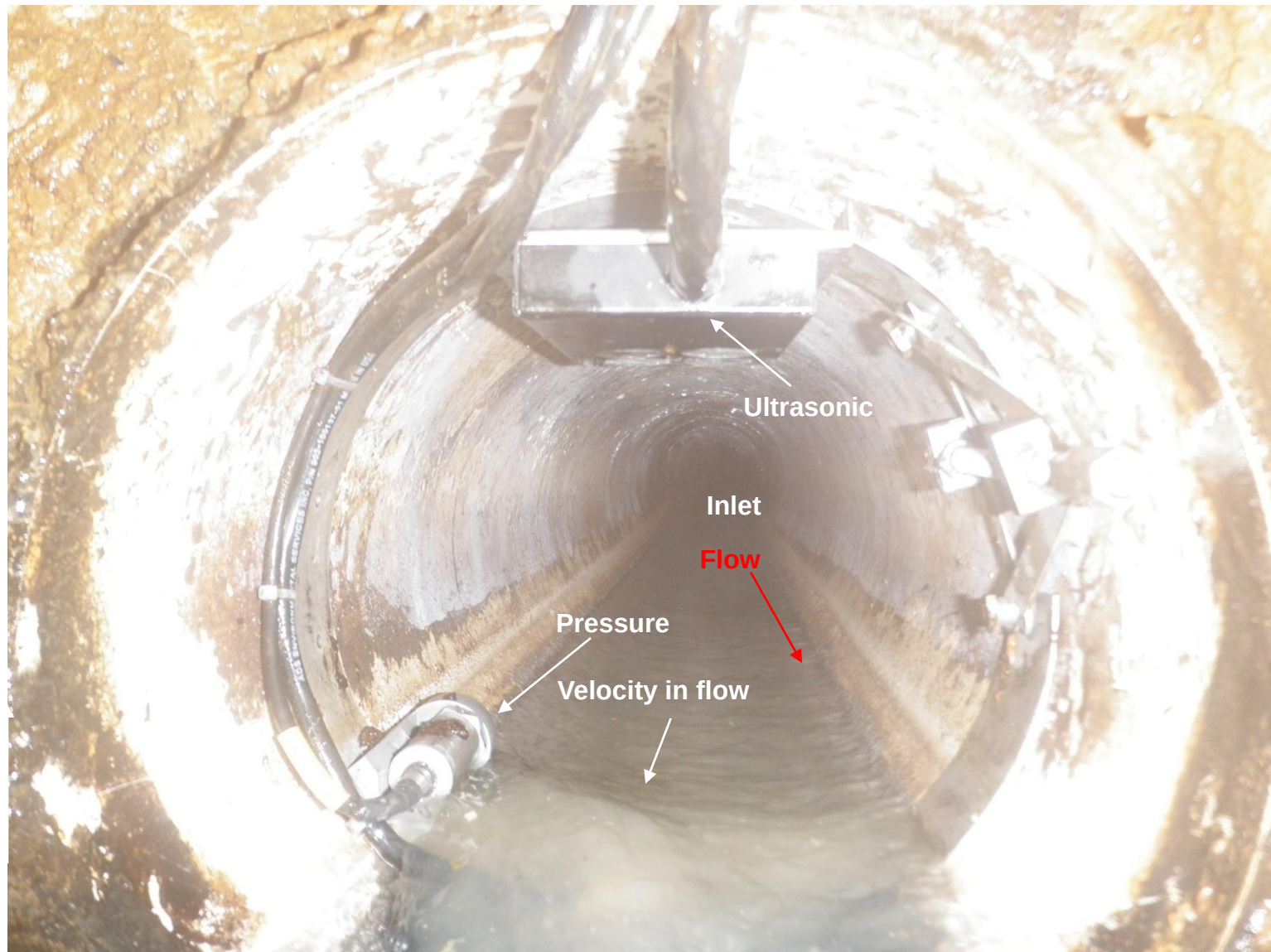
Bainbridge_5-1
Site setup

**ADS ENVIRONMENTAL
SERVICES®**



View of site looking north

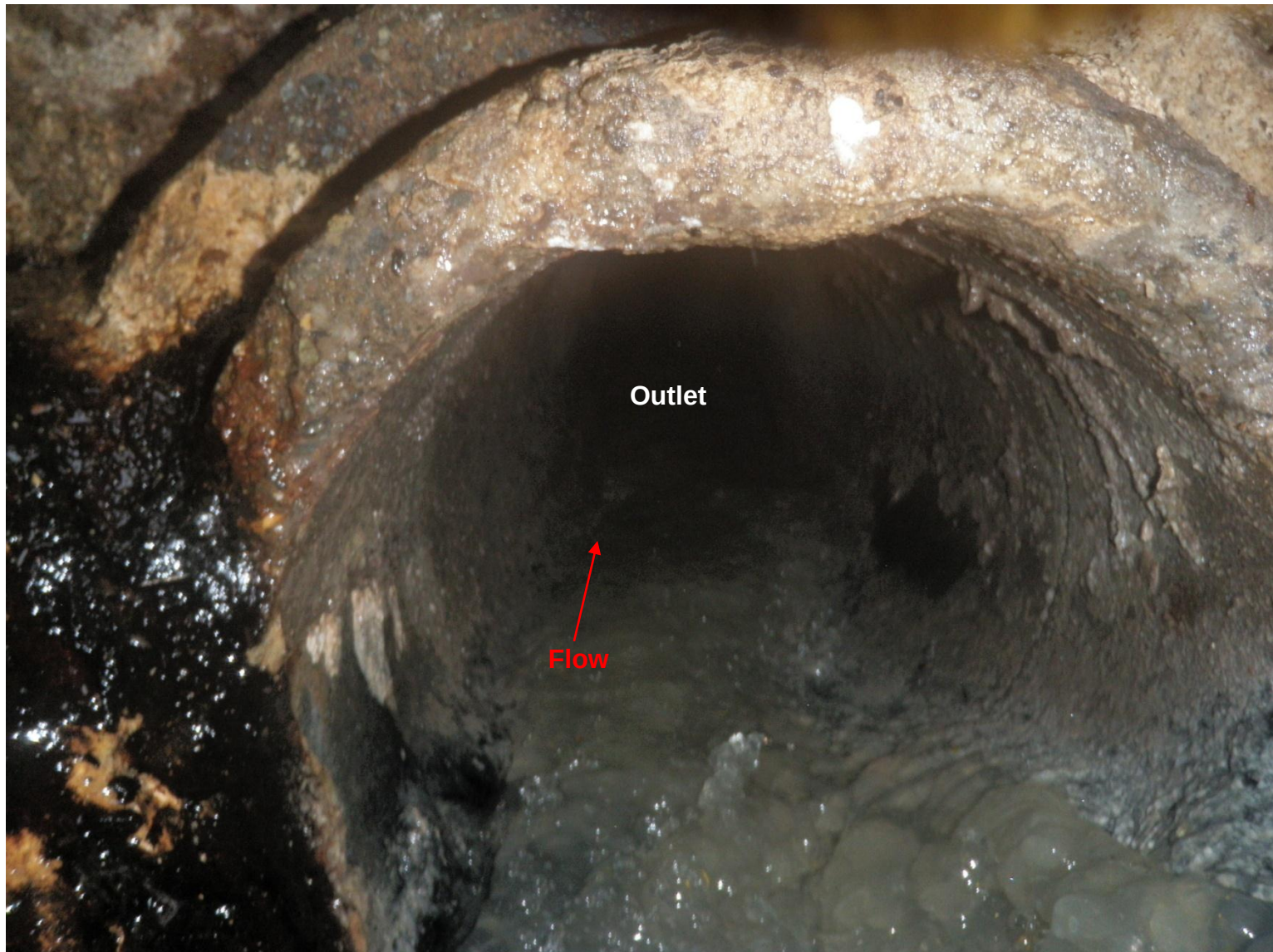
Bainbridge_5-1
Site setup



View of inlet and sensor placement

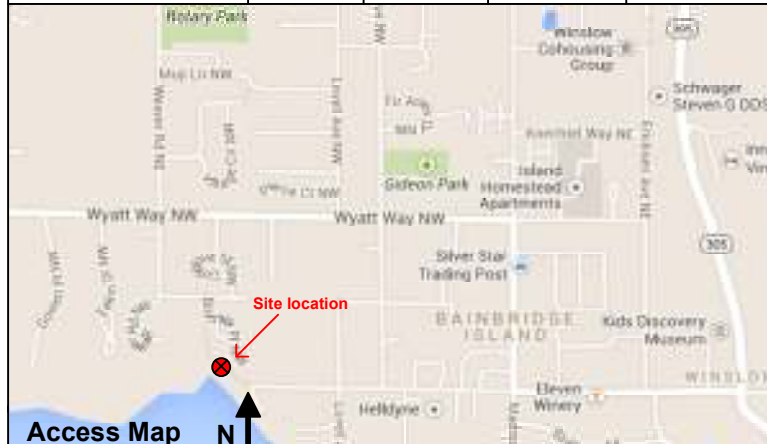
Bainbridge_5-1
Site setup

ADS ENVIRONMENTAL
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View of outlet and hydraulics

Project Name: Bainbridge		City / State: Bainbridge, WA		FM Initials: SW	
Site Name: Bainbridge 5-1		Monitor Series: 5000 AG		Monitor S/N: 21477	
Address/Location: End of Bromley PI NW (down trail four houses down)				Manhole # 5-1	
				GPS 47°37'31.73"N, 122°31'47.53"W	
				Pipe Height: 9.75"	
Access: Walk	Type of System:	Sanitary ☒	Storm ☐	Combined ☐	Pipe Width: 9.75"
					IP Address: 166.213.158.65



Investigation Information:		Manhole Information:	
Date/Time of Investigation:	11/06/13 @ 09:00	Manhole Depth:	8'
Site Hydraulics:	Smooth and slow moving	Manhole Material / Condition	Concrete / Good
Upstream Input: (L/S, P/S)	Not influenced	Pipe Material / Condition:	Clay / Good
Upstream Manhole:	1 inlet / 1 outlet	Mini System Character:	Residential ☒ Commercial ☐ Industrial ☐ Trunk ☐
Downstream Manhole:	1 inlet / 1 outlet	Telephone Information:	Does not apply
Depth of Flow:	1.75" +/- 0.25"	Access Pole #:	Does not apply
Range (Air DOF):	8.00" +/- 0.25"	Distance From Manhole:	Does not apply Feet
Peak Velocity:	2.20 fps	Road Cut Length:	Does not apply Feet
Silt:	0.00" Inches	Trench Length:	Does not apply Feet

Other Information:	
Cross Section	Planar

Installation Information	Backup	Yes	No	?	Distance
Installation Type: Standard	Trunk	☐	☐	☒	
Sensors Devices: U, V, P	Lift / Pump Station	☐	☒	☐	
Surcharge Height: 0 Feet	WWTP	☐	☒	☐	
Rain Guage Zone: Bainbridge_RG	Other	☐	☐	☒	

Additional Site Information / Comments:

Pressure (5 PSI, accuracy +/- 0.25% for range of 0.25 – 11.5 ft.)
Site installed on 11/06/13

Drawn 11/18/13

Flow Monitoring Site Safety Plan

Project Name: Bainbridge **Site ID:** Bainbridge_5-1 **Site Classification:** (see below)

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	☐
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located in a high speed (>45MPH) or high density roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☐
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☐
	10	Work may be performed during darkness; requiring additional site lighting	☐
Confined Space	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☒
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

No hazards found at this site

*** Site Classification**

	Class	Description
☒	1	2-person crew. Standard procedures and equipment. No special requirements
☐	2	Worksite (non-traffic) with access obstacles and or worksite hazards
☐	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. <i>Must be approved by Corporate Safety Manager</i>

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

No Site Specific Safety Requirements

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

☒	This worksite does NOT require a traffic control Plan
☐	Standard Traffic Control Plan is to be used at this work site
☐	This site requires a special Traffic Control Plan which is attached

Approved

Field Mgr Name: Sean Winder
 Signature: Signed copy can be obtained from ADS
 Date: 11/6/13

Reviewed

Project Mgr Name: Mike Pina
 Signature: Signed copy can be obtained from ADS
 Date: 11/6/13

Bainbridge 5-1

Monitoring Period: November 7, 2013 – February 4, 2014
Located At: See attached site report for details
Pipe Dimensions: 9.75" x 9.75"
Finalized Silt Level: 0"

Site Data Characteristics: This site is located in a sanitary sewer pipe, and the equipment type was an ADS FlowShark. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate the flow rate for the monitoring period.

Site Data Characteristics: This site is located in a sanitary sewer pipe.

Analysis of Hydrograph: The hydrograph indicates a predominantly residential diurnal flow pattern.

Analysis of Scattergraph: The majority of the data are grouped above $Fr=1$ indicating supercritical flow however the low flow data do cross $Fr=1$ resulting in a slight hydraulic jump. No other unusual characteristics are noted.

Site Data Bias & Editing: The depth and velocity measurements recorded by the flow monitor were consistent with field confirmations conducted to date and supported the relative accuracy of the flow monitor at this location. The finalized depth data utilized the down looking ultrasonic sensor during normal flow conditions. Data points "drops and pops" (outside the normal data set) were flagged. For the finalized velocity data "drops" (outside the normal data set) were flagged.

Site Data Uptime: The raw and finalized data uptime achieved during the monitoring period is provided in the table below and this information is based on the 5-minute sample interval.

Entity	Percentage Uptime Raw	Percentage Uptime Final
Depth (in)	100%	99%
Velocity (ft/s)	100%	99%
Quantity (MGD)	100%	99%

Site Data Summary: The average flow depth, velocity, and quantity data observed during the monitoring period along with observed minimum and maximum data, are provided in the following table. The minimum and maximum rates recorded in the tables are based on 5-minute data intervals.

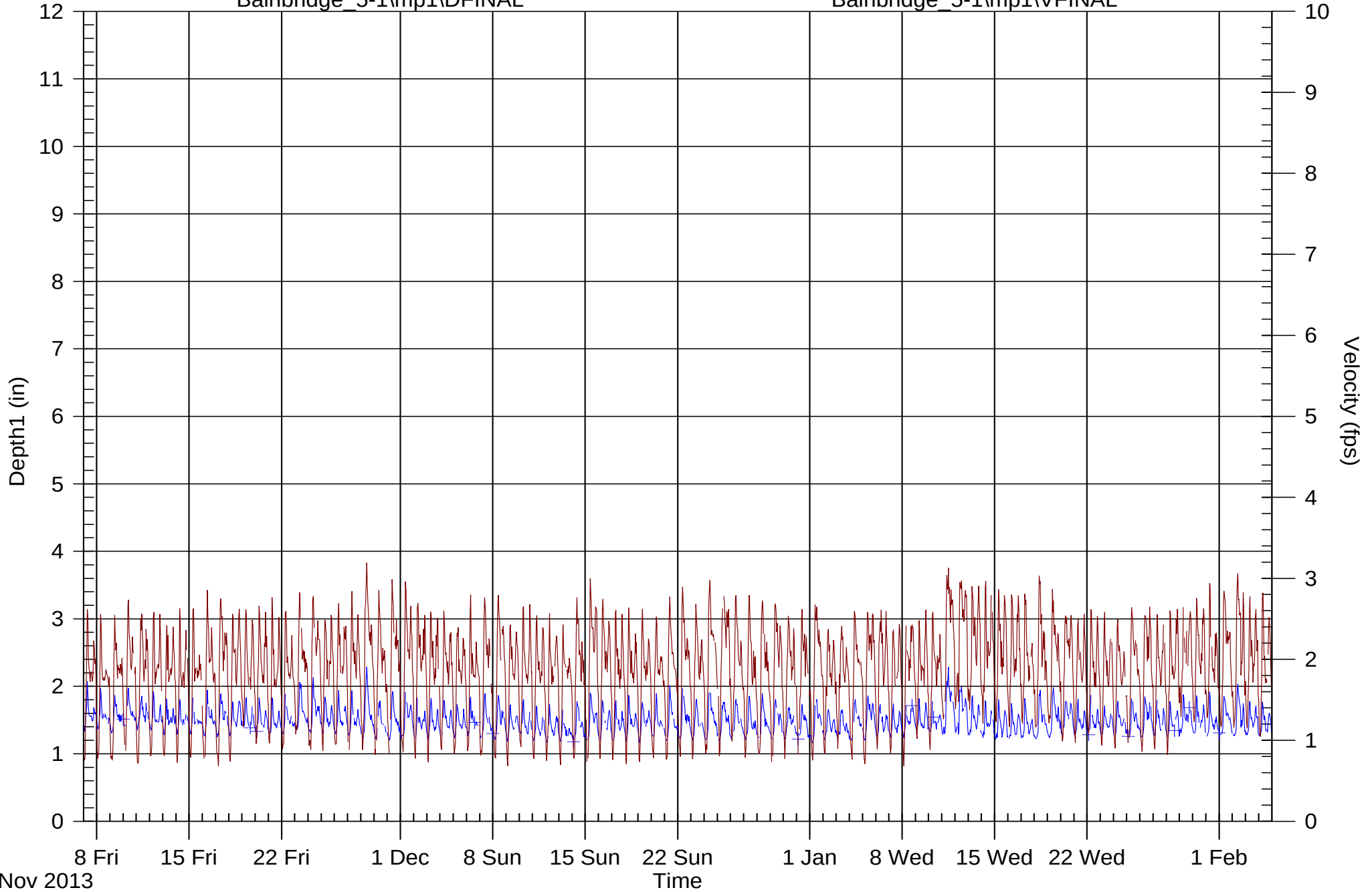
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Minimum	1.01	0.50	0.01
Maximum	2.74	3.83	0.30
Average	1.48	1.87	0.06

ADS Environmental Services

Pipe Height: 9.75

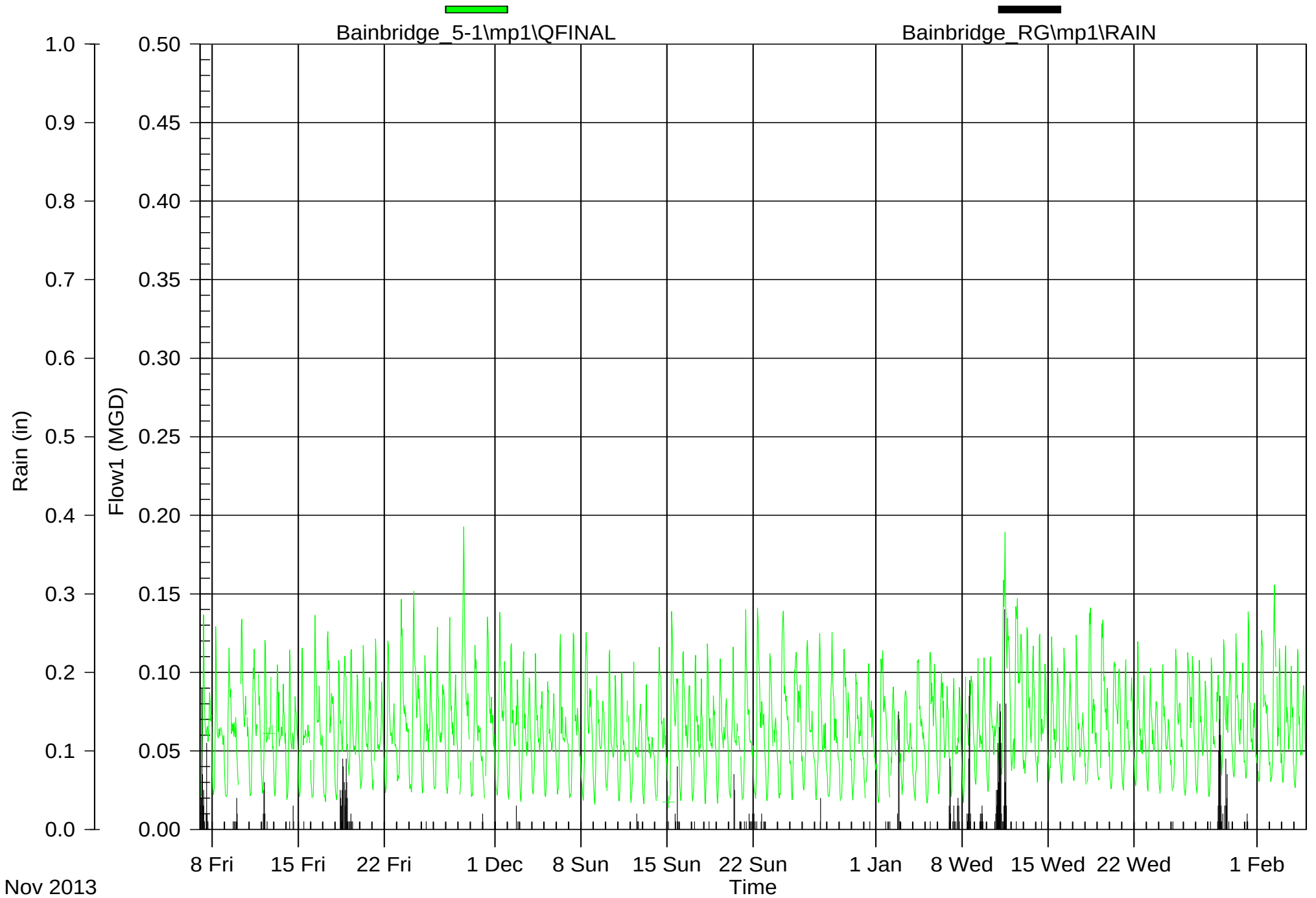
Bainbridge_5-1\mp1\DFINAL

Bainbridge_5-1\mp1\VFINAL



ADS Environmental Services

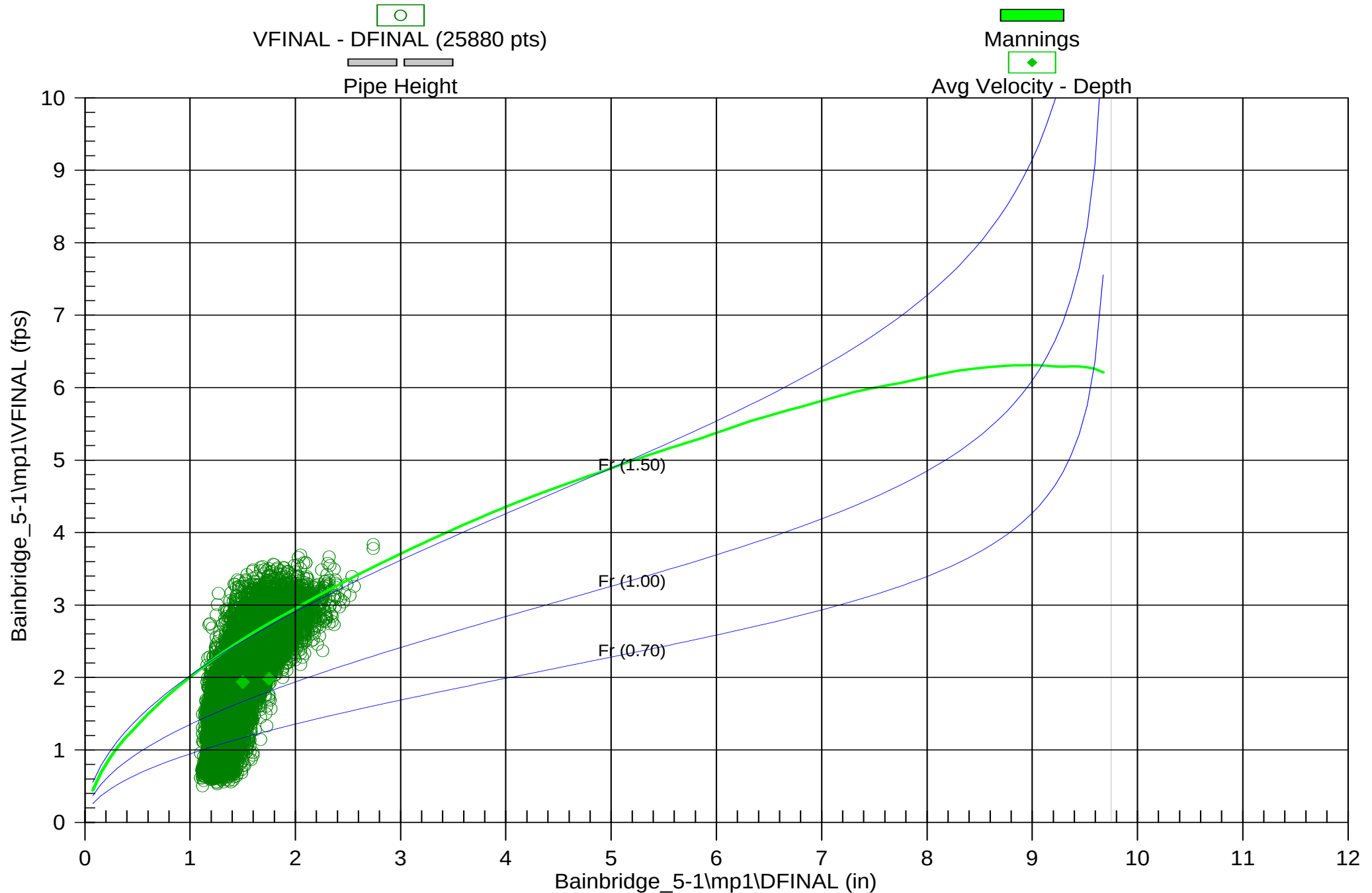
Pipe Height: 9.75



ADS Environmental Services

11/7/2013 12:00:00 AM - 2/5/2014 12:00:00 AM

Pipe Height: 9.75



Bainbridge_8-4
Site Access

**ADS ENVIRONMENTAL
SERVICES®**



Site access looking north

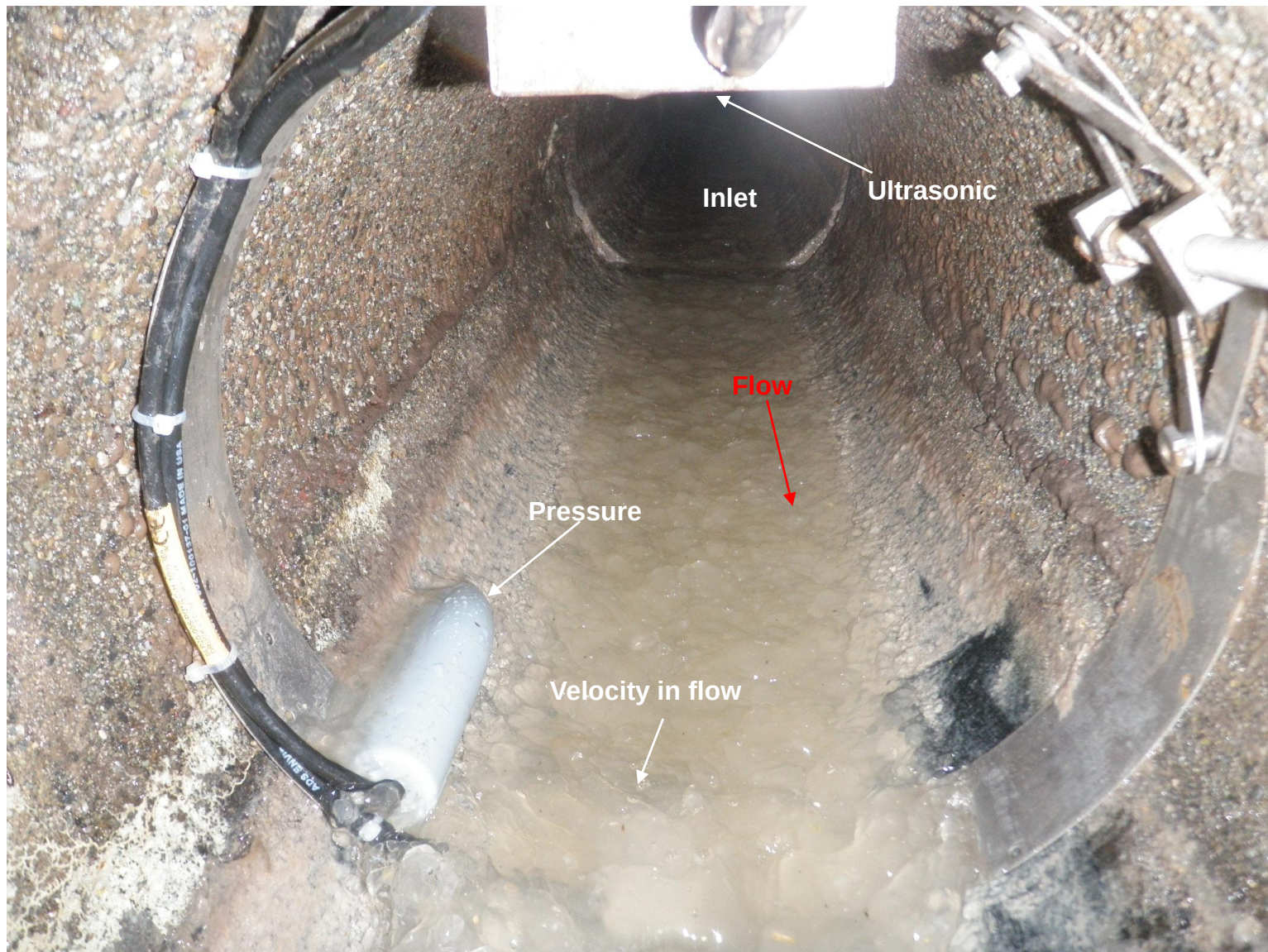
Bainbridge_8-4
Site setup



View of site looking north

Bainbridge_8-4
Site setup

**ADS ENVIRONMENTAL
SERVICES®**



View of inlet and sensor placement

Bainbridge_8-4
Site setup

ADS ENVIRONMENTAL
SERVICES®



View of outlet and hydraulics

Project Name: Bainbridge		City / State: Bainbridge, WA		FM Initials: SW	
Site Name: Bainbridge 8-4		Monitor Series: 5000 AG		Monitor S/N: 21520	
Address/Location: Shannon Dr SE & Waterfront Trail				Manhole # 8-4	
				GPS 47°37'23.73"N, 122°30'57.43"W	
				Pipe Height: 12.00"	
Access: Drive	Type of System:	Sanitary ☒	Storm ☐	Combined ☐	Pipe Width: 11.88"
					IP Address: 166.219.170.20



Investigation Information:		Manhole Information:	
Date/Time of Investigation:	11/06/13 @ 13:00	Manhole Depth:	8'
Site Hydraulics:	Smooth and Fast moving	Manhole Material / Condition	Clay / Good
Upstream Input: (L/S, P/S)	Not influenced	Pipe Material / Condition:	Clay / Good
Upstream Manhole:	1 inlet / 1 outlet	Mini System Character:	Residential ☒ Commercial ☐ Industrial ☐ Trunk ☐
Downstream Manhole:	1 inlet / 1 outlet	Telephone Information:	Does not apply
Depth of Flow:	1.13" +/- 0.25"	Access Pole #:	Does not apply
Range (Air DOF):	10.88" +/- 0.25"	Distance From Manhole:	Does not apply Feet
Peak Velocity:	6.90 fps	Road Cut Length:	Does not apply Feet
Silt:	0.00" Inches	Trench Length:	Does not apply Feet

Other Information:	
Cross Section	Planar

Installation Information	Backup	Yes	No	?	Distance
Installation Type: Standard	Trunk	☐	☐	☒	
Sensors Devices: U, V, P	Lift / Pump Station	☐	☒	☐	
Surcharge Height: 0 Feet	WWTP	☐	☒	☐	
Rain Guage Zone: Bainbridge_RG	Other	☐	☐	☒	

Additional Site Information / Comments:

Pressure (5 PSI, accuracy +/- 0.25% for range of 0.25 – 11.5 ft.)
Site installed on 11/06/13

Drawn 11/18/13

Flow Monitoring Site Safety Plan

Project Name: Bainbridge **Site ID:** Bainbridge_8-4 **Site Classification:** (see below)

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	☐
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located in a high speed (>45MPH) or high density roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☐
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☒
	10	Work may be performed during darkness; requiring additional site lighting	☐
Confined Space	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☒
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

No hazards found at this site

*** Site Classification**

	Class	Description
☒	1	2-person crew. Standard procedures and equipment. No special requirements
☐	2	Worksite (non-traffic) with access obstacles and or worksite hazards
☐	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. <i>Must be approved by Corporate Safety Manager</i>

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

No Site Specific Safety Requirements

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

☒	This worksite does NOT require a traffic control Plan
☐	Standard Traffic Control Plan TA-18 is to be used at this work site
☐	This site requires a special Traffic Control Plan which is attached

Approved

Field Mgr Name: Sean Winder
 Signature: Signed copy can be obtained from ADS
 Date: 11/6/13

Reviewed

Project Mgr Name: Mike Pina
 Signature: Signed copy can be obtained from ADS
 Date: 11/6/13

Bainbridge 8-4

Monitoring Period: November 7, 2013 – February 4, 2014
Located At: See attached site report for details
Pipe Dimensions: 12.00" x 11.88"
Finalized Silt Level: 0"

Site Data Characteristics: This site is located in a sanitary sewer pipe, and the equipment type was an ADS FlowShark. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate the flow rate for the monitoring period.

Analysis of Hydrograph: The hydrograph indicates a flow pattern with a significant pump station influence.

Analysis of Scattergraph: The data are grouped above $Fr=1$ indicating supercritical flow. No other unusual characteristics are noted.

Site Data Bias & Editing: The depth and velocity measurements recorded by the flow monitor were consistent with field confirmations conducted to date and supported the relative accuracy of the flow monitor at this location. The finalized depth data utilized the down looking ultrasonic sensor during normal flow conditions and the pressure sensor during surcharge conditions. Data points "drops and pops" (outside the normal data set) were flagged. For the finalized velocity data "drops" (outside the normal data set) were reconstituted using a best fit curve for the monitoring period (this applied to velocity data being recorded below 1.5" depth. From November 7 – 28, 2013 approximately 10% of the velocity data were reconstituted and from November 29, 2013 – February 4, 2014 approximately 2% of the velocity data were reconstituted).

Site Data Uptime: The raw and finalized data uptime achieved during the monitoring period is provided in the table below and this information is based on the 5-minute sample interval.

Entity	Percentage Uptime Raw	Percentage Uptime Final
Depth (in)	100%	99%
Velocity (ft/s)	100%	99%
Quantity (MGD)	100%	99%

Site Data Summary: The average flow depth, velocity, and quantity data observed during the monitoring period along with observed minimum and maximum data, are provided in the following table. The minimum and maximum rates recorded in the tables are based on 5-minute data intervals.

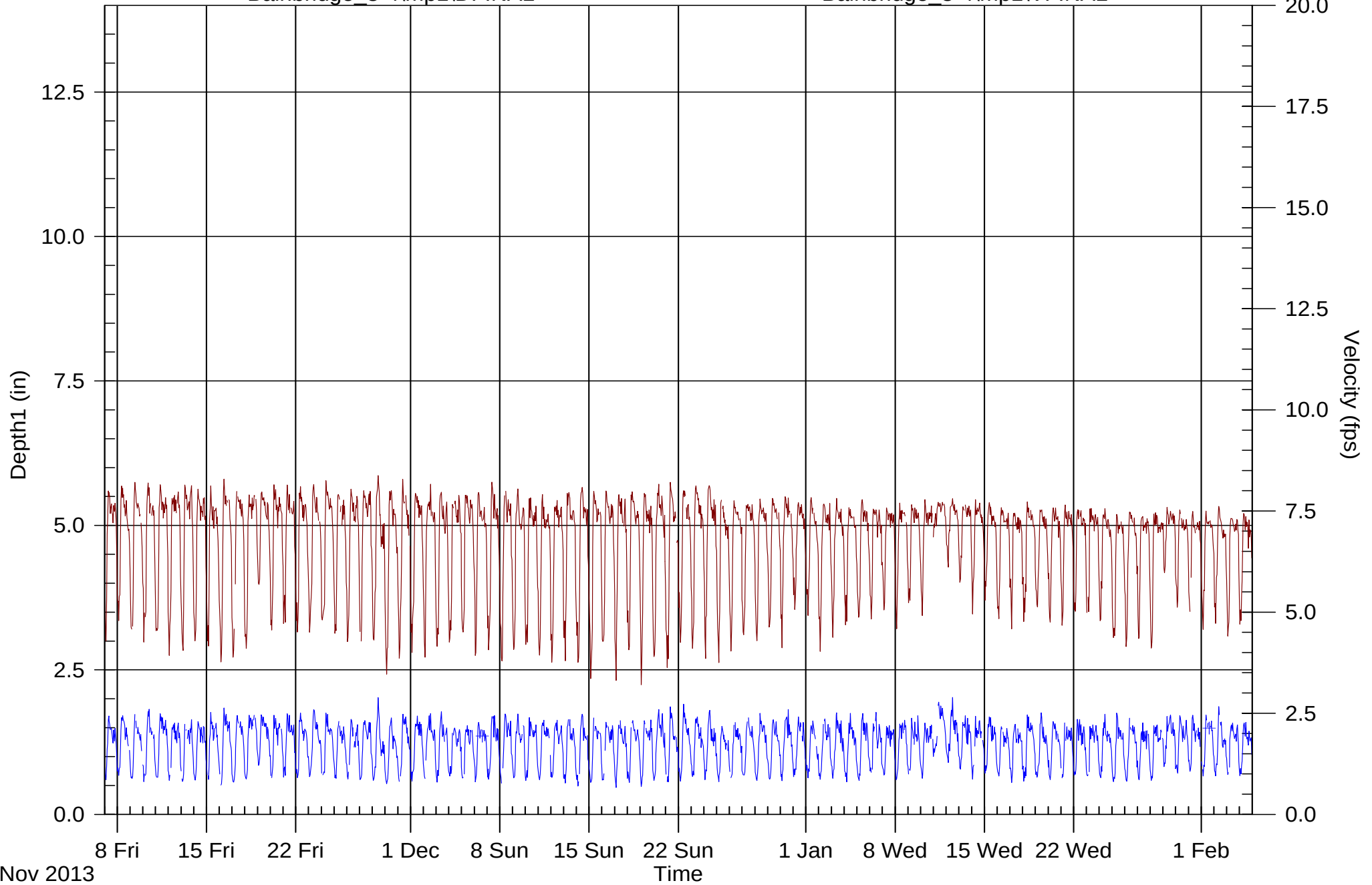
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Minimum	0.25	1.34	0.01
Maximum	3.42	9.33	0.80
Average	1.23	6.76	0.21

ADS Environmental Services

Pipe Height: 12.00

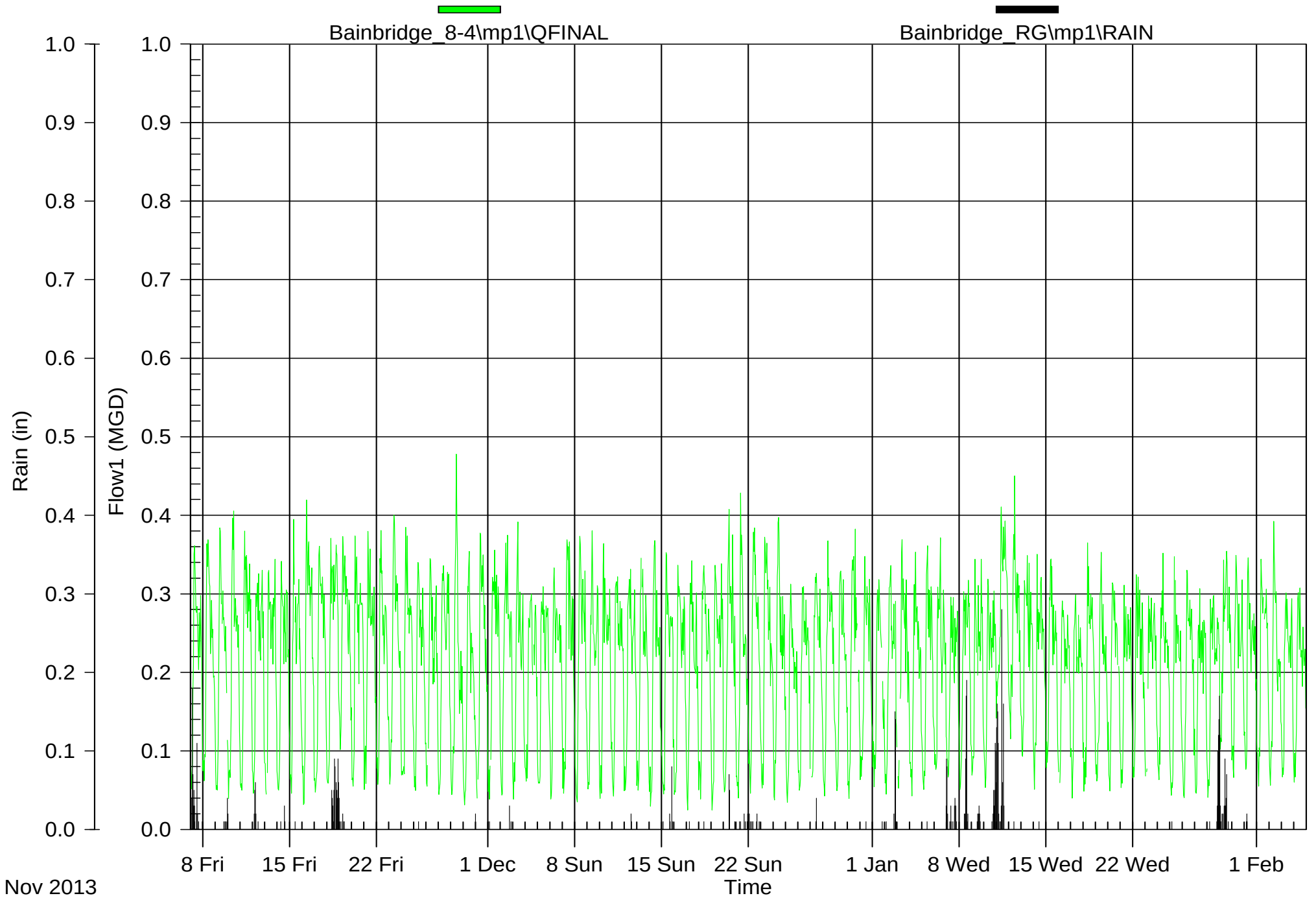
Bainbridge_8-4\mp1\DFINAL

Bainbridge_8-4\mp1\VFINAL



ADS Environmental Services

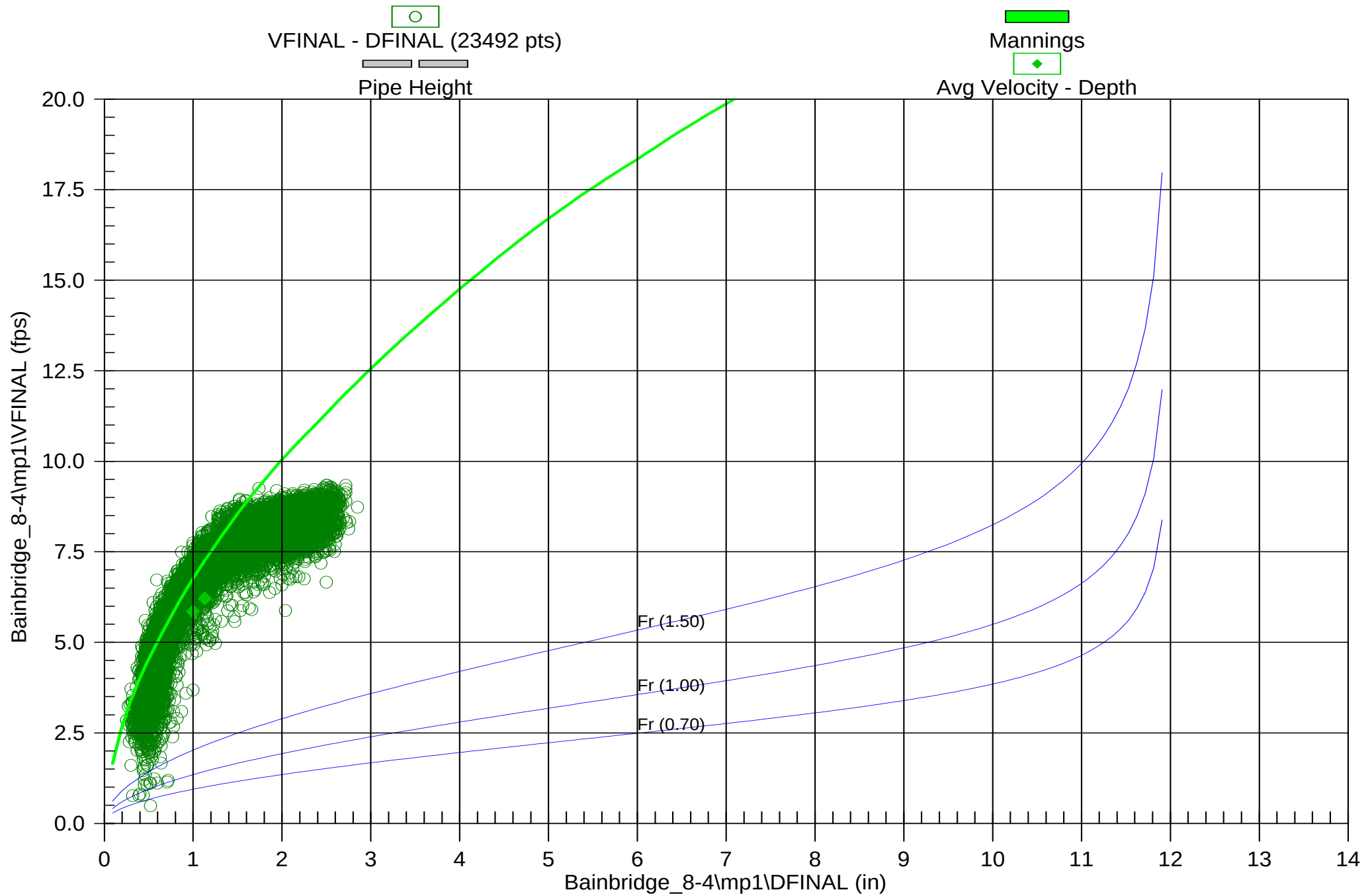
Pipe Height: 12.00



ADS Environmental Services

11/7/2013 12:00:00 AM - 2/5/2014 12:00:00 AM

Pipe Height: 12.00

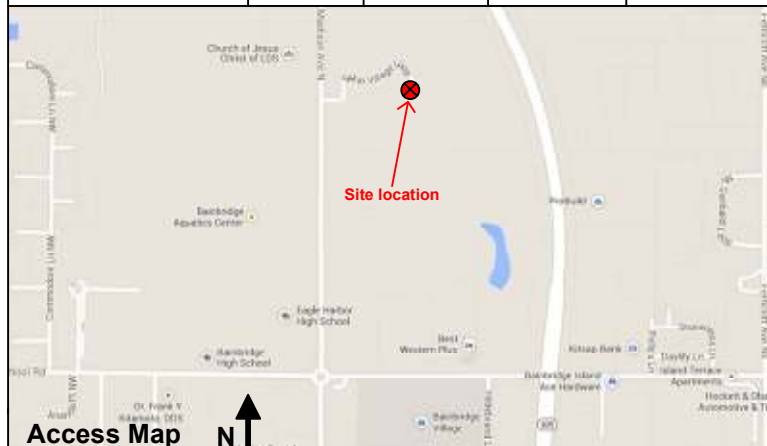


Bainbridge_RG
Site set up

ADS ENVIRONMENTAL
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Project Name: Bainbridge		City / State: Bainbridge, WA		FM Initials: SW	
Site Name: Bainbridge RG		Monitor Series: 5000 AG		Monitor S/N: 21805	
Address/Location: End of Sakai Village Loop				Manhole # : n/a	
				GPS : 47°38'25.27"N, 122°31'07.99"W	
				Pipe Height : n/a	
Access: Drive	Type of System:	Sanitary ☒	Storm ☐	Combined ☐	Pipe Width : n/a
					IP Address : 166.219.174.160



Investigation Information:		Manhole Information:			
Date/Time of Investigation:	11/06/13 @ 16:30	Manhole Depth:		n/a	
Site Hydraulics:	n/a	Manhole Material / Condition		n/a	
Upstream Input: (L/S, P/S)	n/a	Pipe Material / Condition:		n/a	
Upstream Manhole:	n/a	Mini System Character:	Residential ☒	Commercial ☐	Industrial ☐
Downstream Manhole:	n/a	Telephone Information: Does not apply			
Depth of Flow:	n/a	Access Pole #: Does not apply			
Range (Air DOF):	n/a	Distance From Manhole:		Does not apply Feet	
Peak Velocity:	n/a	Road Cut Length:		Does not apply Feet	
Silt:	n/a	Trench Length:		Does not apply Feet	

Other Information:	
Cross Section	Planar

Installation Information		Backup	Yes	No	?	Distance
Installation Type: Standard		Trunk	☐	☒	☐	
Sensors Devices: Tipping Bucket		Lift / Pump Station	☐	☒	☐	
Surcharge Height: n/a		WWTP	☐	☒	☐	
Rain Guage Zone: n/a		Other	☐	☒	☐	

Additional Site Information / Comments:

Site installed on 11/06/13

Drawn 11/18/13

Flow Monitoring Site Safety Plan

Project Name: Bainbridge	Site ID: Bainbridge_RG	Site Classification: (see below)
---------------------------------	-------------------------------	---

Note: Class 5 Site Safety Plans must be approved by the Corporate Safety Manager

*** Hazards found at this site (Discuss checked items below)**

Type	#	Special Hazard	
Communications	1	The site is in a communications "Dead-Zone"	☐
Traffic	2	The site is located in or adjacent to an intersection	☐
	3	The site is located on hill, curve, or where motorists visibility of the site or other vehicles is reduced	☐
	4	The site is located in a high speed (>45MPH) or high density roadway	☐
	5	Site traffic is congested at peak hours	☐
Access	6	Site has access obstacles (rough terrain, fences, deep easement, etc.)	☐
Worksite	7	Worksite contains hazards (terrain, slope, obstructions, etc.)	☐
	8	Elevated work requiring a ladder / work near an unguarded edge. Raised manhole (indicate height below)	☐
	9	Pedestrian control necessary as the site is located in or near a walkway, school, playground, etc.	☐
	10	Work may be performed during darkness; requiring additional site lighting	☐
Confined Space	11	Site is located in a high crime area (check with client & local authorities if unsure)	☐
	12	Confined Space does not have useable rungs	☐
	13	Confined Space depth is greater than 50 feet	☐
	14	Confined Space has internal platforms, weirs or other obstructions that interfere with or prevent unobstructed vertical retrieval	☐
	15	Work requires lateral movement that would interfere with or prevent unobstructed vertical retrieval	☐
	16	Flow is hazardous due to depth, velocity, pipe diameter, or is industrial process flow	☐
	17	Confined Space subject to surcharge during / after a rain event	☐
	18	CO, H2S, low O2 or other toxic / flammable gases present or anticipated	☐
	19	Confined Space has active drop connections	☐

*** Hazards found at this site (Discuss checked items below)**

No hazards found at this site

*** Site Classification**

	Class	Description
☒	1	2-person crew. Standard procedures and equipment. No special requirements
☐	2	Worksite (non-traffic) with access obstacles and or worksite hazards
☐	3	Traffic site requiring special scheduling, additional personnel and / or traffic control equipment, or outsourcing
☐	4	Confined Space Entry requiring special scheduling, additional personnel and / or safety equipment
☐	5	Special Operation requiring a separate safety plan. <i>Must be approved by Corporate Safety Manager</i>

*** Site Specific Safety Requirements. Must Complete for any site Class 2 & Above**

No Site Specific Safety Requirements

Traffic Control Plan

Note: All worksites located in a roadway or immediately adjacent to a roadway, where the operation may impede the normal flow of traffic, are required to have a Traffic Control Plan. Standard Traffic Control Plans are to be carried in the vehicle and referred to when setting up the worksite. Special Traffic Control Plans are to be developed when required by clients or regulating agencies or when a standard Traffic Control Plan is not sufficient to control traffic at the worksite.

- ☒ This worksite does NOT require a traffic control Plan
- ☐ Standard Traffic Control Plan is to be used at this work site
- ☐ This site requires a special Traffic Control Plan which is attached

Approved

Field Mgr Name: Sean Winder

Signature: Signed copy can be obtained from ADS

Date: 11/6/13

Reviewed

Project Mgr Name: Mike Pina

Signature: Signed copy can be obtained from ADS

Date: 11/6/13

Bainbridge RG

Monitoring Period: November 7, 2013 – February 4, 2014

Located At: See attached site report for details

Site Data Characteristics: This site is a rain gauge.

Site Data Uptime: The raw and finalized data uptime achieved during the monitoring period is provided in the table below and this information is based on the 5-minute sample interval.

Entity	Percentage Uptime Raw Data	Percentage Uptime Final Data
Rain (in)	100%	100%

Site Data Summary: The rainfall each month of the monitoring period is provided in the following table.

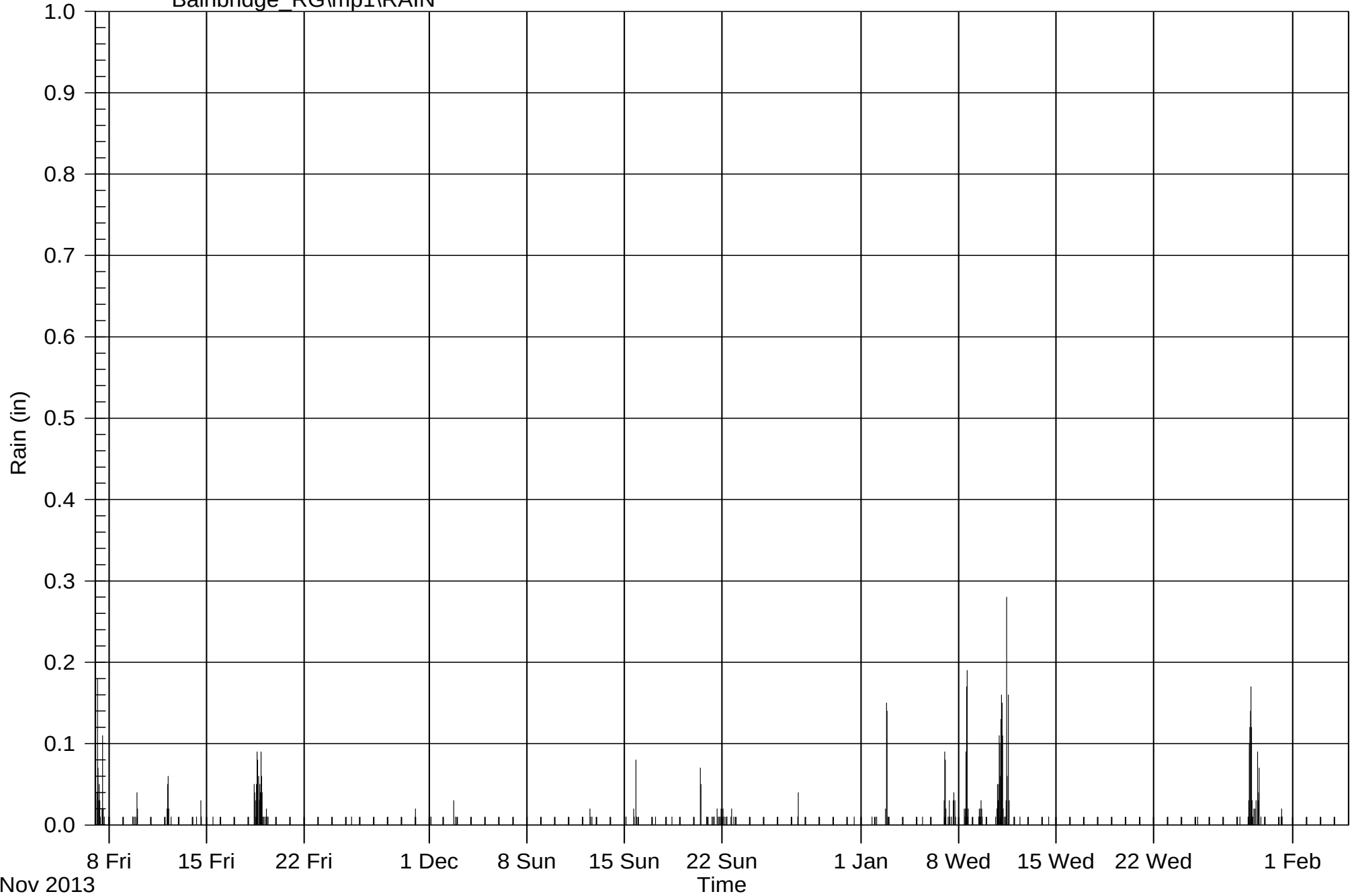
Item	Rain (in)
November 2013*	1.93
December 2013	0.73
January 2014	4.28
February 2014*	0

*Denotes partial month

ADS Environmental Services

Pipe Height: 0.00

Bainbridge_RG\mp1\RAIN



FLOW FACTOR DEVELOPMENT TABLES

Table F.1 Existing Developed Land Use Acreage per Flow Monitoring Basin General Sewer Plan City of Bainbridge Island						
Land Use Classification	Flow Meter Tributary Areas (acres)					Non Metered
	Total	Meter 01	Meter 02	Meter 03	Meter 04	
Agriculture	11.82	11.82	0.00	0.00	0.00	0.00
Commercial	90.72	1.87	37.25	32.47	9.89	9.24
Low-density Residential	122.78	12.19	18.21	17.60	42.38	32.41
Medium-density Residential	257.67	78.59	19.21	31.57	88.41	39.89
High-density Residential	141.66	31.50	27.77	50.92	15.30	16.17
Parks/Open Space	16.44	5.90	10.10	0.44	0.00	0.00
Public	187.03	0.56	159.03	14.47	3.75	9.22
Utilities	0.93	0.00	0.00	0.93	0.00	0.00
Vacant	0.00	0.00	0.01	0.00	0.00	0.00
Roads, etc.	4.34	0.01	0.01	1.91	1.93	0.47
Total	835.20	142.7	271.6	151.8	161.7	107.4

Table F.2 Wastewater Flow Factors per Land Use by Basin General Sewer Plan City of Bainbridge Island					
Land Use Classification	Wastewater Flow Factor				
	Meter 01 (gpd/ac)	Meter 02 (gpd/ac)	Meter 03 (gpd/ac)	Meter 04 (gpd/ac)	Non Metered (gpd/ac)
Agriculture	50	50	50	50	50
Commercial	300	300	300	300	300
Low-density Residential	100	220	200	200	200
Medium-density Residential	350	900	900	700	1200
High-density Residential	985	1,100	1,550	950	3000
Parks/Open Space	0	0	0	0	0

Table F.2 Wastewater Flow Factors per Land Use by Basin General Sewer Plan City of Bainbridge Island					
Land Use Classification	Wastewater Flow Factor				
	Meter 01 (gpd/ac)	Meter 02 (gpd/ac)	Meter 03 (gpd/ac)	Meter 04 (gpd/ac)	Non Metered (gpd/ac)
Public	70	70	70	70	70
Utilities	50	50	50	50	50
Vacant	0	0	0	0	0
Roads, etc.	0	0	0	0	0

Table F.3 Existing ADWF by Flow Monitoring Basin Tributaries and Land Use General Sewer Plan City of Bainbridge Island						
Land Use Classification	Flows by Land Use					
	Total (mgd)	Meter 01 (mgd)	Meter 02 (mgd)	Meter 03 (mgd)	Meter 04 (mgd)	Non Metered (mgd)
Agriculture	0.001	0.001	0.000	0.000	0.000	0.000
Commercial	0.027	0.001	0.011	0.014	0.003	0.000
Low-density Residential	0.023	0.001	0.004	0.004	0.008	0.006
Medium-density Residential	0.178	0.028	0.017	0.033	0.062	0.033
High-density Residential	0.190	0.031	0.031	0.092	0.015	0.023
Parks/Open Space	0.000	0.000	0.000	0.000	0.000	0.000
Public	0.013	0.000	0.011	0.002	0.000	0.000
Utilities	0.000	0.000	0.000	0.000	0.000	0.000
Vacant	0.000	0.000	0.000	0.000	0.000	0.000
Roads, etc.	0.000	0.000	0.000	0.000	0.000	0.000
Total	0.430	0.061	0.074	0.146	0.088	0.061
Measured ADWF	0.430	0.061	0.074	0.146	0.087	0.062
% Difference	0.2%	0.3%	0.0%	0.1%	0.9%	-0.4%
Flow Isolation		Meter 01	Meter 02	Meter 03 - Meter 01	Meter 04 - Meter 02	WWTP - Meter 03 - Meter 04

Table F.4 Wastewater Flow Balance Summary General Sewer Plan City of Bainbridge Island			
Land Use Classification	Service Area Land Use ⁽¹⁾	Wastewater Flow Factor (gpd/acre)	Existing ADWF (mgd)
	Total Developed Area (acres)		
Agriculture	11.8	50	0.00
Commercial	90.7	300	0.03
Low-density Residential	122.8	200	0.02
Medium-density Residential	257.7	700	0.18
High-density Residential	141.7	1,350	0.19
Parks/Open Space	16.4	0	0.00
Public	187.0	70	0.01
Utilities	0.93	50	0.00
Vacant	0.0	0	0.00
Roads, etc.	4.3	0	0.00
	835.2	Total Estimated ADWF =	0.44
		Measured ADWF⁽²⁾ =	0.43
		% Difference⁽³⁾ =	1.8%
Notes: (1) Total area for the City's existing sewer service area. Source: City provided GIS database. (2) Total does not include not metered area in the system. (3) % Difference = (Estimated ADWF - Measured ADWF) / (Measured ADWF) x 100.			

Table F.5 Future Wastewater Flow Factors General Sewer Plan City of Bainbridge Island	
Land Use Classification	Wastewater Flow Factor (gpd/acre)
Commercial	300
Low-density Residential	200
Medium-density Residential	700
High-density Residential	1,350
Public	70
Utilities	50
Mixed-Use	1,650
<i>Parks/Open Space</i>	<i>0</i>
<i>Vacant</i>	<i>0</i>
<i>Roads, etc.</i>	<i>0</i>

**PROJECT MEMORANDUM 1 – MID-ISLAND
TREATMENT OPTIONS**

1218 Third Avenue, Suite 1600
Seattle, Washington 98101
P. 206.684.6532
F. 206.903.0419

PROJECT MEMORANDUM

Project Name:	General Sewer Plan	Date:	8/25/2014
Client:	City of Bainbridge Island	Project Number:	9162A.00
Prepared By:	Alena Bennett		
Reviewed By:	Karl Hadler, Lara Kammereck		
Subject:	Mid-Island Study Area Sewer Service Options – Draft		
Distribution:	Chris Munter		

1.0 PURPOSE AND BACKGROUND

The City of Bainbridge Island (City) has identified two neighborhood service centers outside of Winslow for potential future City sewer service. These two areas were delineated as the Mid-Island Study Area. The boundaries of the Mid-Island Study Area are shown in Figure 1. The western pocket is located near the intersection of Miller Road and New Brooklyn Road. The eastern pocket is centered at the intersections of Valley Road and Sunrise Drive.

The purpose of this project memorandum is to provide an overview of the sewer treatment and disposal options available for the Mid-Island Study Area as permitted by local and state regulations.

2.0 MID-ISLAND FLOW PROJECTIONS

Build-out average dry weather flow (ADWF) projections for the eastern and western pockets were estimated using land use data and the wastewater flow factors developed for the Winslow Collection System based on data from the flow monitoring program that was carried out from November 2013 through February 2014. A peaking factor between ADWF and peak hour flow (PHF) of three (3) was assumed to estimate peak hour flows, which is based on the Washington State Department of Ecology (Ecology) design guideline for sewers and pump stations. As shown in Table 2.1, ADWFs of 2,570 gpd and 13,020 gpd are projected for the eastern and western pockets, respectively. This corresponds to peak flows of 7,710 gpd and 39,060 gpd for the eastern and western pockets, respectively.



Source: Kitsap County

PROJECT MEMORANDUM

Table 2.1 Mid-Island Study Area Build-out Flows General Sewer Plan City of Bainbridge Island			
Land Use Classification	Acreage	Flow Factor (gpd/ac)	Flow (gpd)
Eastern Pocket			
Commercial	8.6	300	2,570
Roads, etc.	1.9	0	0
Total ADWF			2,570
Total PHF ⁽¹⁾			7,710
Western Pocket			
Commercial	13.7	300	4,110
Low-density Residential	42.9	200	8,580
Public	4.7	70	330
Roads, etc.	2.1	0	0
Total ADWF			13,020
Total PHF ⁽¹⁾			39,060
Notes:			
1. Peaking factor of 3.			

3.0 ON-SITE TREATMENT VS. CONVEYANCE TO WINSLOW COLLECTION SYSTEM

The City has two basic options for treating the wastewater flows of the eastern and western pockets: individual on-site treatment systems for each pocket, or conveyance of wastewater flows from each pocket to the Winslow Collection System where it can be treated at the Winslow Wastewater Treatment Plant (WWTP). The eastern and western pockets are situated far enough apart such that separate treatment systems would need to be constructed for each pocket. Also, in the case of conveyance to the Winslow Collection System, separate pump stations and force mains would be constructed for each pocket.

The force mains from each pocket would have an approximate length of 11,500 ft. The western pocket would likely connect to the Winslow Collection System near Woodward School and the eastern pocket could connect at the North Town Pump Station. The amount of flow contributed by the Mid-Island pockets would account for about two percent of the 0.72-mgd ADWF projected for 2035 for the Winslow Collection System.

The conveyance to the Winslow Collection System option is considered in more detail in Section 8.0, Option Comparison. Sections 4.0 through 7.0 describe the various on-site treatment options and considerations.

4.0 ON-SITE SYSTEM REGULATIONS

The Mid-Island Study Area sewage can either be conveyed to an existing wastewater treatment facility, or new on-site treatment systems can be constructed. Large on-site sewage systems (LOSS) treating peak flows of 3,500 to 100,000 gpd are regulated by the Washington State Department of Health (DOH) under 246-272B WAC. Local health jurisdictions retain regulatory authority for systems designed to treat less than 3,500 gpd. Sewage treatment systems larger than 100,000 gpd in capacity are regulated by the Department of Ecology (Ecology). Ecology also regulates any surface water discharge regardless of flow. The peak flows of the eastern and western Mid-Island pockets place them within DOH's regulatory jurisdiction.

Under 246-272B WAC, DOH defines five levels of treatment; A through E as defined in Table 2.1. A minimum level of treatment is required for each disposal option. The minimum required level of treatment is also dependent on the soil conditions of the disposal site. Soil types are grouped into seven categories as defined in Table 4.2.

Table 4.1 DOH Treatment Levels General Sewer Plan City of Bainbridge Island				
Level	CBOD₅	TSS	FC	
A	10 mg/L	10 mg/L	200/100 mL	
B	15 mg/L	15 mg/L	1,000/100 mL	
C	25 mg/L	30 mg/L	50,000/100 mL	
D	25 mg/L	30 mg/L	---	
E	125 mg/L	80 mg/L	---	
Notes:				
1. Table is reprinted from WAC 246-272A-0110 Table III.				
2. CBOD ₅ = five-day carbonaceous biochemical oxygen demand. TSS = total suspended solids. FC = fecal coliform.				

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Table 4.2 Soil Types and Hydraulic Loading Rates General Sewer Plan City of Bainbridge Island		
Soil Type	Soil Textural Classification	Maximum Hydraulic Loading rate, for residential strength effluent (gal/sf/day)
1	Gravelly and very gravelly coarse sands, all extremely gravelly soils.	1.0
2	Coarse sands.	1.0
3	Medium sands, loamy coarse sands, loamy medium sands.	0.8
4	Fine sands, loamy fine sands, sandy loams, loams.	0.6
5	Very fine sands, very fine loamy sand, very fine sandy loams; or silt loams and sandy clay loams with a moderate or strong structure (excluding platy structure).	0.4
6	Other silt loams, sandy clay loams, clay loams, silty clay loams.	Not suitable
7	Sandy clay, clay, silty clay, strongly cemented or firm soils, soil with a moderate or strong platy structure, any soil with a massive structure, any soil with appreciable amounts of expanding clays. Soils greater than 90% rock.	Not suitable
Notes: 1. Table is reprinted from WAC 246-272B-03400 Table 1.		

5.0 DISPOSAL OPTIONS

There are two general options for wastewater disposal: surface water or land. The means of wastewater effluent disposal drives the treatment requirements and dictates regulatory authority. Therefore, in this memorandum disposal options are discussed first in this section, followed by treatment options in the next section.

5.1 Surface Disposal

A surface water disposal system would consist of a new outfall to Puget Sound. This option would be the most challenging disposal option to permit, requiring extensive science and engineering studies for permit approval. Ecology regulates any surface water discharge. The permitting process would require, at a minimum, that the water quality standards for the particular receiving water body be maintained. Water quality samplings, effluents mixing modeling, and scientific studies evaluating disposal impacts are required. In addition to Ecology permitting requirements, other state and federal agencies require permits to establish surface water discharge of wastewater. State Agencies require a Comprehensive Alternatives Analysis

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(CAA) to determine if a “reasonable and feasible” alternative for siting a surface water discharge exists.

5.2 Land Disposal

Any land disposal option will require an evaluation of soil and groundwater conditions. Descriptions of the land disposal options follow.

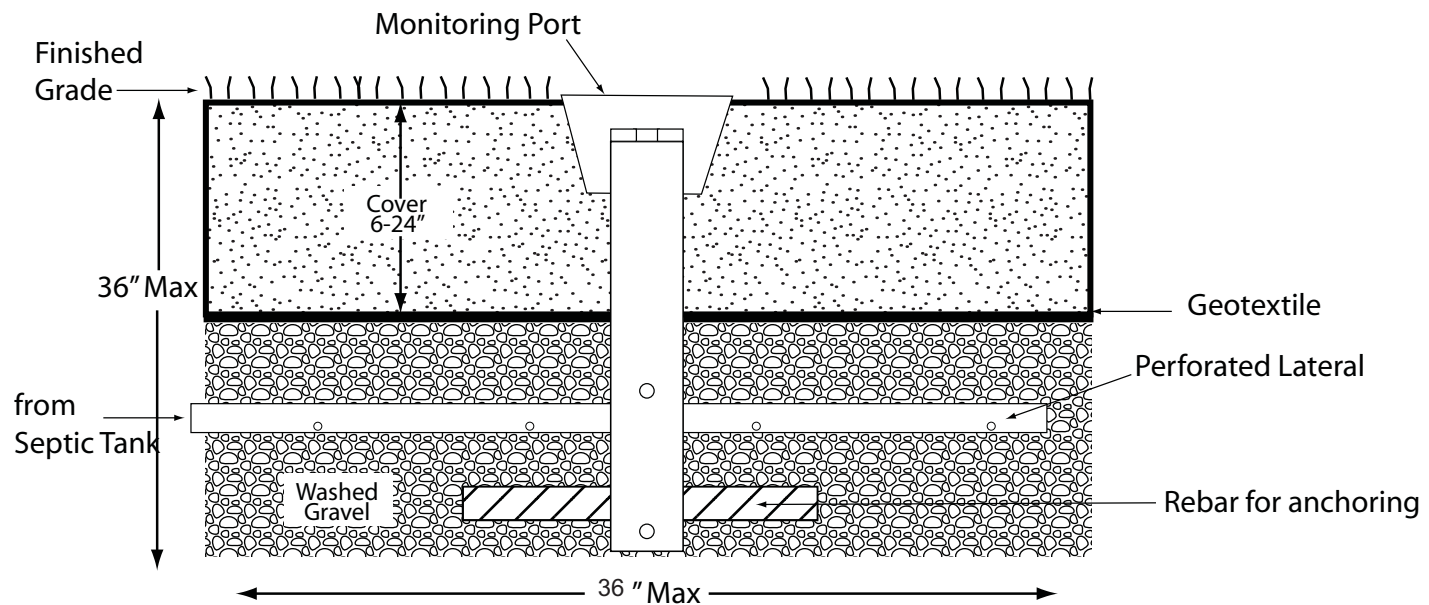
5.2.1 Land Treatment

In a land treatment disposal system, preliminary treated effluent is spray applied to crops for additional treatment in the upper soil root zone. Land treatment is regulated by Ecology. Applied water that does not percolate into the soil or evapotranspire is collected and reapplied to the field. Adsorptive capacity of the field is dependent on rainfall and temperature. Storage basins are typically needed for cold weather or during precipitation.

5.2.2 Drainfield

In a conventional drainfield or “sub-surface soil adsorption system” (SSAS), pretreated effluent flows through a network of underground perforated pipes in trenches or beds and is discharged to original, undisturbed soil. Typically, the pipes are embedded in gravel although other trench media is approved for use (“gravelless drainfield”). A typical cross section is shown in Figure 2. Additional treatment occurs as effluent percolates through the trench bedding and surrounding soil. Drainfields cannot be sited in unstable landforms including areas where slopes are greater than 30 percent. Effluent is distributed throughout the drainfield by a pressure distribution system.

According to WAC 246-272B-06250, wastewater that is not residential strength (i.e. commercial strength) must meet a minimum of treatment level E prior to drainfield disposal. Higher levels of pretreatment may be required depending on soil type, flow, and vertical separation from groundwater or an impervious soil layer.



* Figure from WA DOH Design Standards for Large On-site Sewage Systems December 1993, Amended July 1994.

Figure 2
Drainfield Land Disposal Conventional Trench Detail
 PM 1 - Mid-Island Study Area Sewer Service Options
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5.2.3 Subsurface Drip System

A subsurface drip system (SDS) is an efficient pressurized wastewater distribution system that can deliver small, precise doses of effluent to shallow subsurface dispersal/reuse fields. SDS distribution piping is small diameter, flexible polyethylene tubing (dripline) with small in-line emitters (orifices that can discharge effluent at slow, controlled rates, usually specified in gallons per hour). Driplines can be trenched (by hand or with a trenching machine) into narrow, shallow trenches or plowed directly into the soil and backfilled without gravel or geotextile. Typical installation depth is between 6 and 10 inches. In addition to the simplified construction methods, another advantage of an SDS is that the land area required is much less than a conventional drainfield. According to a July 2012 DOH publication called Subsurface Drip Systems, pretreatment of commercial wastewater to at least treatment level E is required for SDS systems.

5.2.4 Reclaimed Water Use – Groundwater Disposal

Highly treated wastewater can be applied to land for groundwater recharge by application through percolation ponds or sub-surface pipes. Treatment must produce high-quality effluent to reclaimed water quality standards, Class A (unless a lesser level is allowed under pilot status) and treatment must include nitrogen removal. Reclaimed water standards are separate from DOH's five levels of treatment discussed previously in Section 5.2.2 and are organized into Classes A through D, with Class A being the most high-quality effluent. In addition to the general planning documents required by Ecology, water reuse projects also require a Water Reuse Permit.

The surface area of a percolation pond depends on the infiltration rate of the native soil. Using guidelines for design of stormwater infiltration ponds, the infiltration rate for a disposal facility in a groundwater protection area must not exceed 9 inches per hour (in/hr).

5.2.5 Reclaimed Water Use – Irrigation

Reclaimed water could also be "disposed" via irrigation. Treatment must produce Class A Reclaimed Water, but possibly may not require nitrogen removal. In addition to the general planning documents required by Ecology, water reuse projects also require a Water Reuse Permit.

Reclaimed water must be applied at average agronomic rates. For Washington State the rate is approximately 0.0033 mgd per acre. Irrigation is typically only needed during the growing season (May through September) so a back up means of disposal would have to be developed for other months.

5.3 Land Disposal Summary

Treated wastewater effluent can be disposed of on land through a land treatment system, a drainfield, subsurface drip system, percolation pond, or by irrigation. Treatment levels range

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from preliminary treatment to Class A reclaimed water. Drainfields must be sited on land with slopes less than 30 percent.

6.0 TREATMENT OPTIONS

A variety of on-site system treatment options are discussed in this section would meet treatment level requirements. Conceptually, the treatment system would be sited at a central location for each pocket and receive wastewater flow from individual homes and businesses through a collection system. Treated effluent would be either disposed on-site or pumped to a suitable disposal location.

6.1 Septic System

The basic component of most onsite treatment systems is a septic tank as shown in Figure 3. Wastewater enters a buried watertight tank, typically made from concrete, polyethylene or fiberglass. The tank is large enough to allow the solids in the wastewater to settle to the bottom of the tank and grease to float to the top. As new water enters the system, clarified, screened effluent flows out of the tank to further treatment (as described below) or directly to disposal. Septic systems will generally meet DOH treatment level E.

6.2 Sand Filters

A sand filter system is used to treat septic tank effluent on sites with minimal separation from the water table. The DOH has three different public domain sand filter technologies registered to meet different treatment levels:

1. Intermittent sand filter system: Expected treatment levels for various systems are provided in DOH's List of Registered On-site Treatment and Distribution Products effective April 2014. An intermittent sand filter system is capable of meeting DOH treatment levels B, C and D. The sand filter consists of a concrete or PVC containment vessel containing sand (Figure 4). The septic tank effluent is pumped through a network of pipes at the top of the filter, which distribute the effluent evenly to the filter. The septic tank effluent trickles through the sand and is further treated as it comes in contact with the biological community on the surface of the sand particles. The sand filter effluent is collected in the gravel underdrain before being pumped or flowing by gravity to the drainfield.
2. Sand-lined trenches: The sand-lined trench is capable of meeting DOH treatment level B and C. The sand-lined trench relies on the same treatment principle as the intermittent sand filter, however the sand is contained in trenches or beds instead of a containment vessel. The sand-lined trench acts as both a treatment and disposal method (Figure 5).
3. Stratified sand filter system: A stratified sand filter system is capable of meeting DOH treatment level A and B. The stratified sand filter is a relatively new technology and is a modified intermittent filter. The stratified sand filter contains layers of sands with different particle sizes, allowing a higher quality effluent than an intermittent sand filter. Oxygen is also provided at the interface between the different sand layers through a vent pipe (Figure 6).

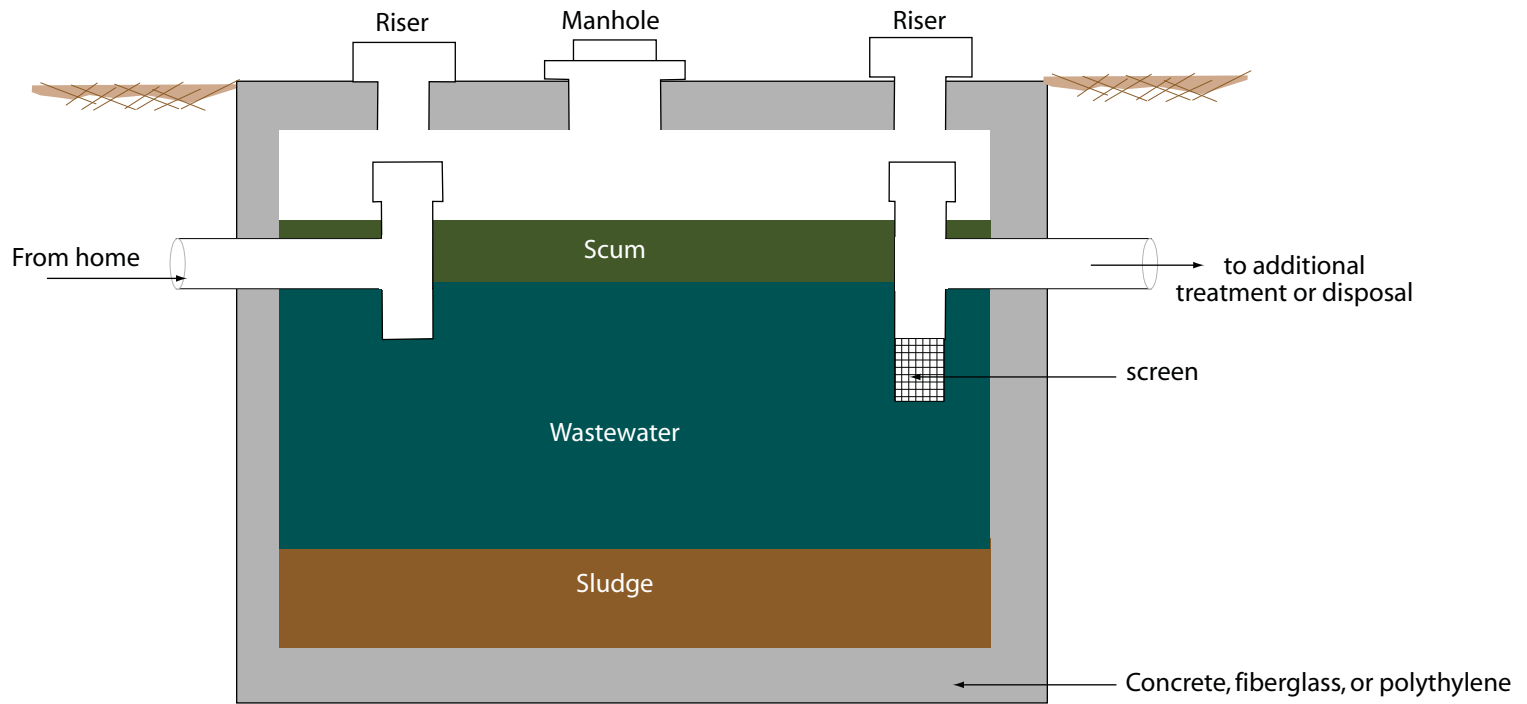


Figure 3
Typical Septic System Schematic
 PM 1 - Mid-Island Study Area Sewer Service Options
 General Sewer Plan
 City of Bainbridge Island

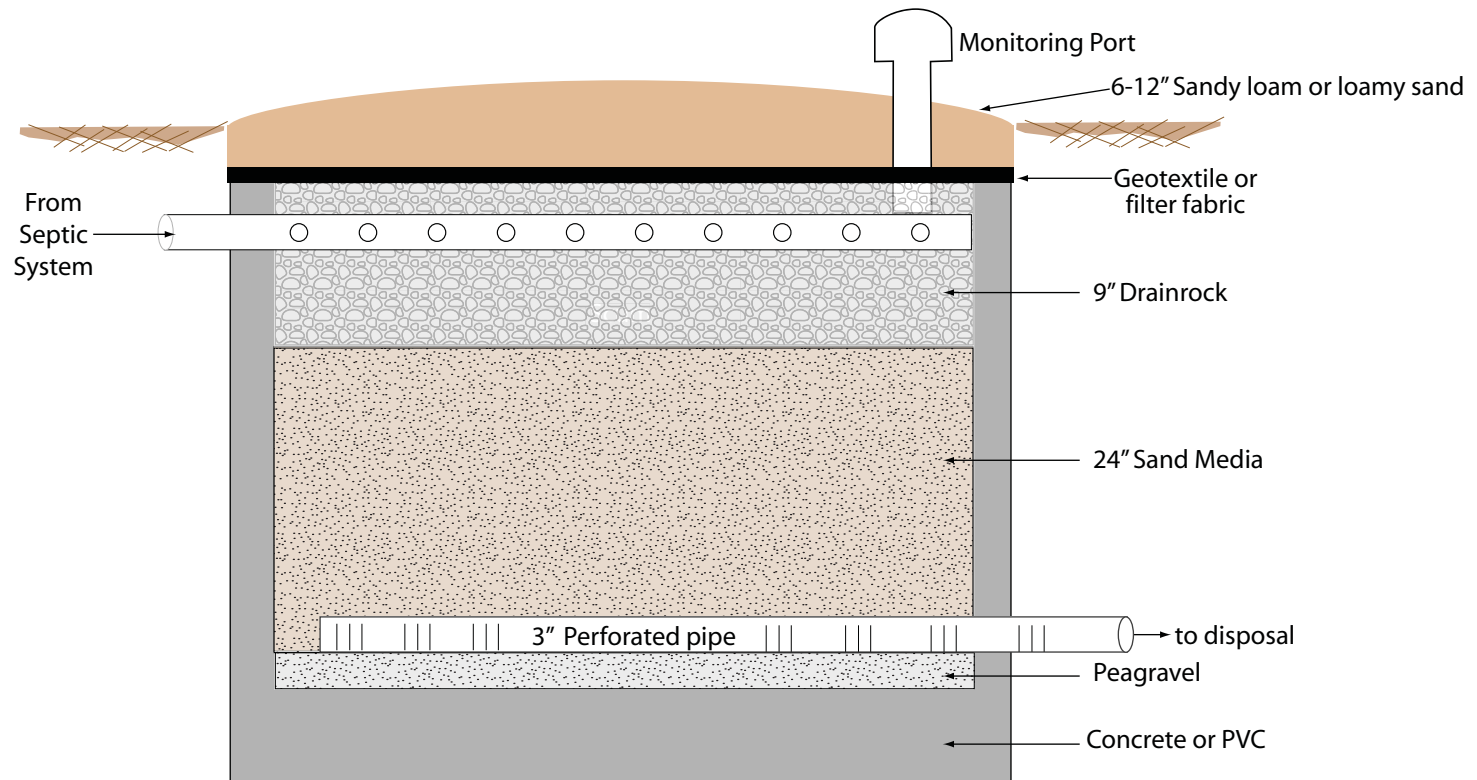


Figure 4
Intermittent Sand Filter
 PM 1 - Mid-Island Study Area Sewer Service Options
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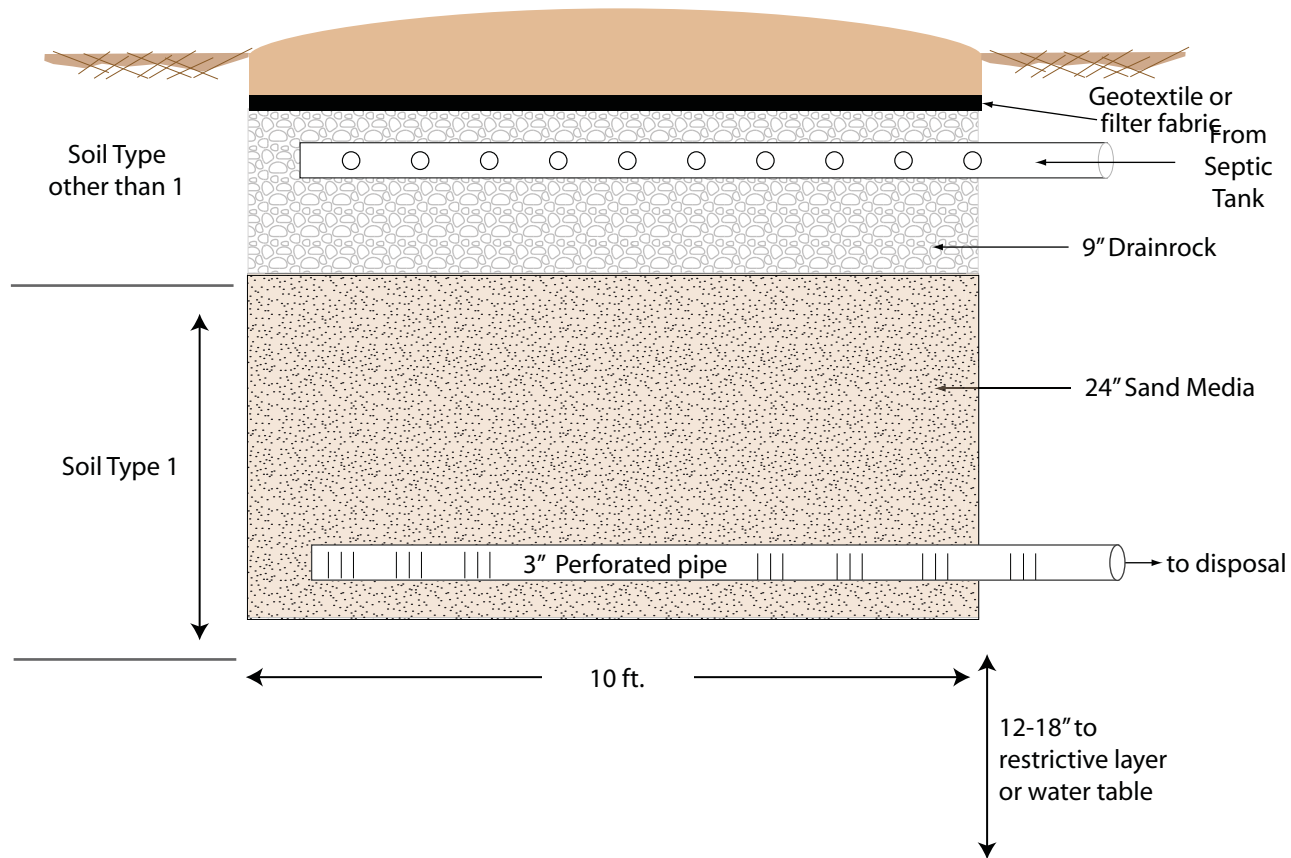


Figure 5
Sand Lined Trench

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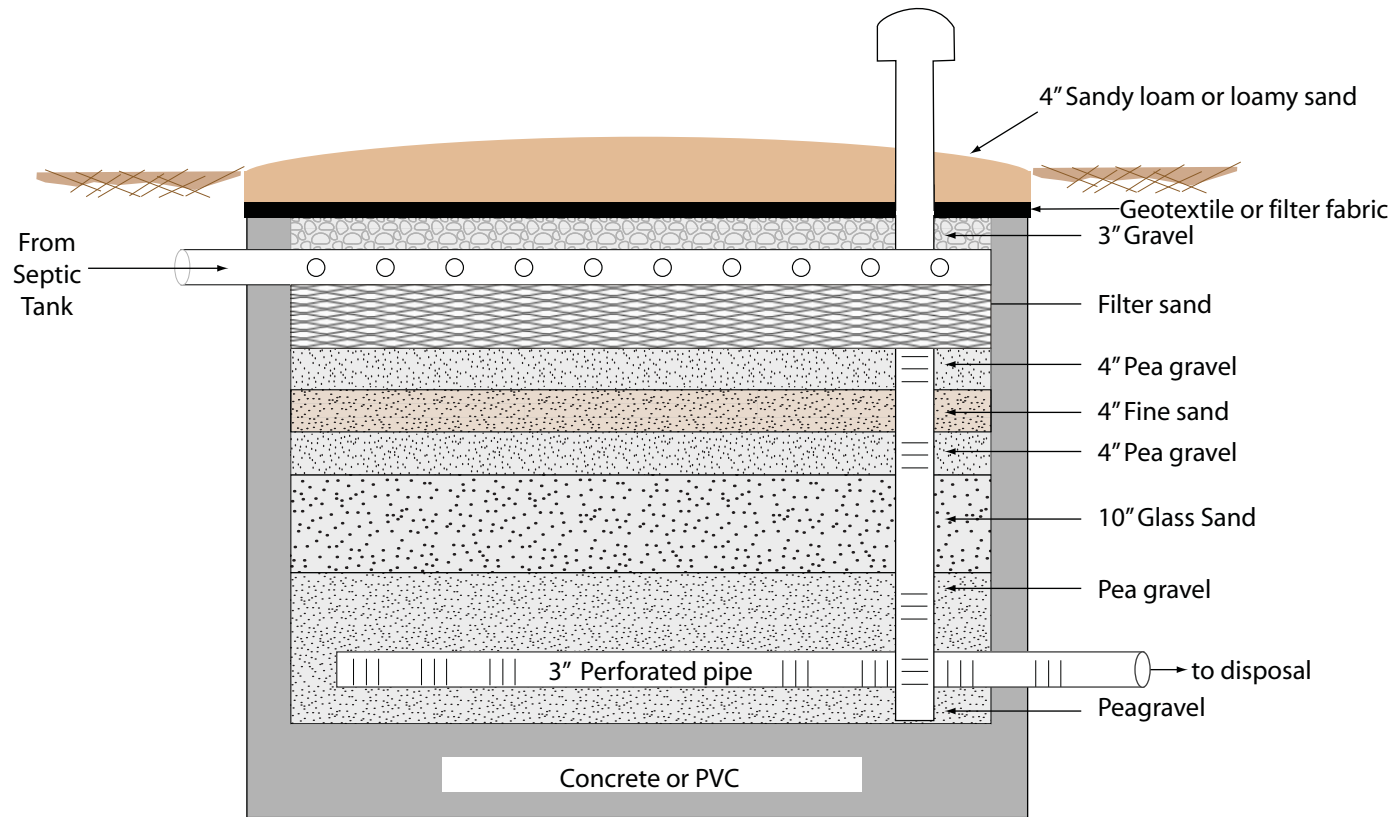


Figure 6
Stratified Sand Filter

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 General Sewer Plan
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6.3 Recirculating Gravel Filter System

The recirculating gravel filter system is capable of meeting the DOH treatment levels C and D. The recirculating gravel filter system is similar to a sand filter in that the septic tank effluent is further treated by bringing the effluent into close contact with a biological community on the surface of the filter media. For a recirculating gravel filter, the filter media is pea gravel contained in a watertight vessel (Figure 7). The filter effluent is split: a portion of the effluent flows to the drainfield and a portion is mixed with the septic tank effluent and returns to the gravel filter. The gravel filter system has a smaller footprint than the intermittent sand filter and is not as susceptible to hydraulic overloading.

6.4 Mound System

For a mound system, septic tank effluent is pumped to the “mound”. The mound consists of filter media over an infiltration bed and a soil cap (Figure 8). The septic tank effluent is further treated as it flows through the filter media and comes in contact with the biological community on the filter media. The mound system is capable of meeting DOH treatment levels B and C and acts as both a treatment and distribution system. The WA DOH warns of several potential problems with a mound system, the most prevalent relating to siting and design issues.

6.5 Aerobic Treatment Unit

The DOH has registered several proprietary systems capable of further treating septic tank effluent. Many of these systems are aerobic treatment units (ATU) as shown in Figure 9. In the ATU, the septic tank effluent is treated in an aerated watertight vessel. The ATU is similar to a conventional activated sludge and secondary clarifier in one unit. The septic tank effluent is food for the aerobic bacteria growing in the ATU, and as the biological flocs increase in size they settle out and are digested on the bottom of the tank. Periodically, the aeration chamber is partially pumped, to remove some of the solids from the system. Depending on the system, ATUs can meet DOH treatment levels A through D.

6.6 Membrane Bioreactor

Membrane bioreactors (MBR) are a compact wastewater treatment process. Many manufacturers make a compact, self-contained MBR plant to treat flows of approximately 20,000 gpd to 100,000 gpd (Figure 10). For the 20,000-gpd system, the unit is contained in a 25-foot long tube with a 12-foot diameter. In the MBR process, the wastewater is first screened then aerated. The mixed liquor from the aeration tank is generally pumped into a membrane tank containing several membrane cassettes. Permeate pumps pull the clean water through the membrane filters leaving behind a very concentrated biologically active solids stream. A portion of the solids is wasted and the remaining portion is returned back to the aeration tank. An MBR process is capable of producing a high quality effluent, meeting class A reclaimed water standards. Thus, several different disposal options, including percolation ponds and irrigation can be used with membrane bioreactors.

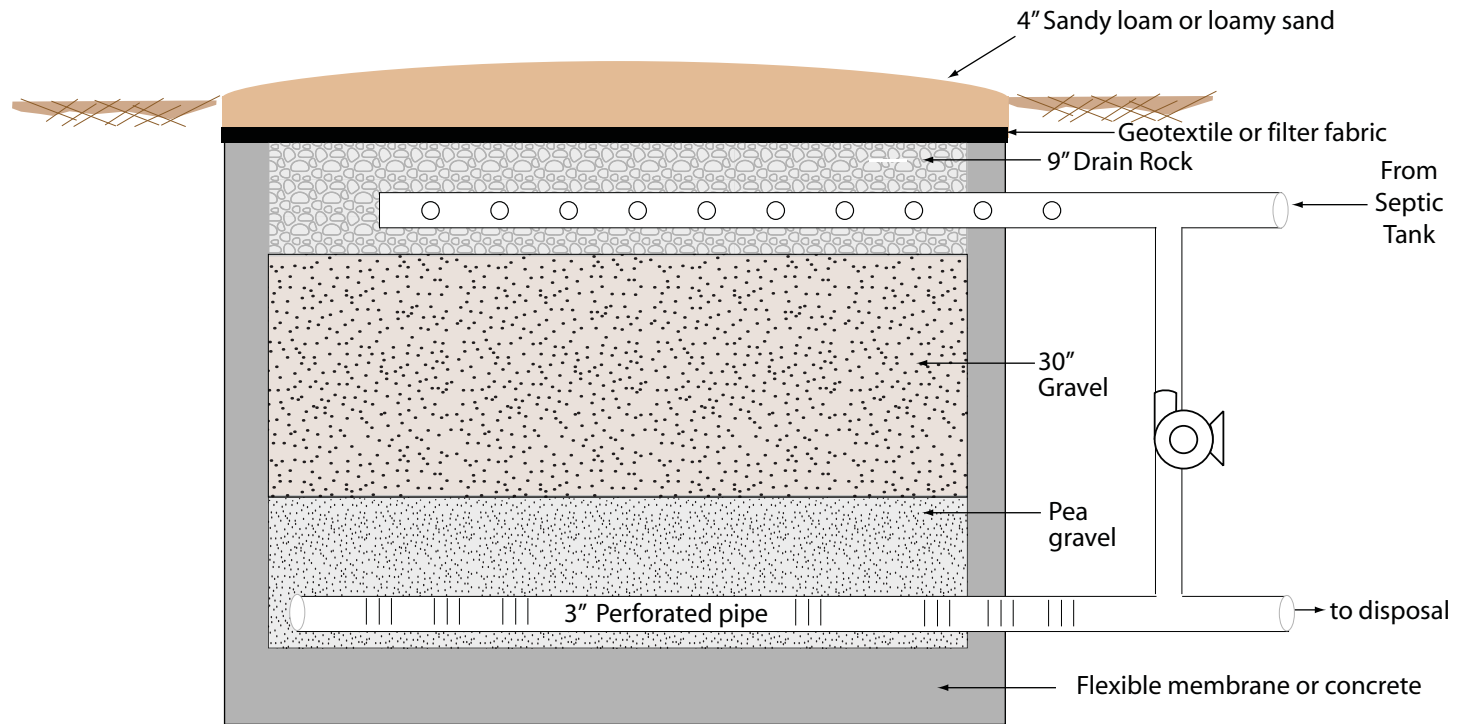


Figure 7
Recirculating Gravel Filter

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 General Sewer Plan
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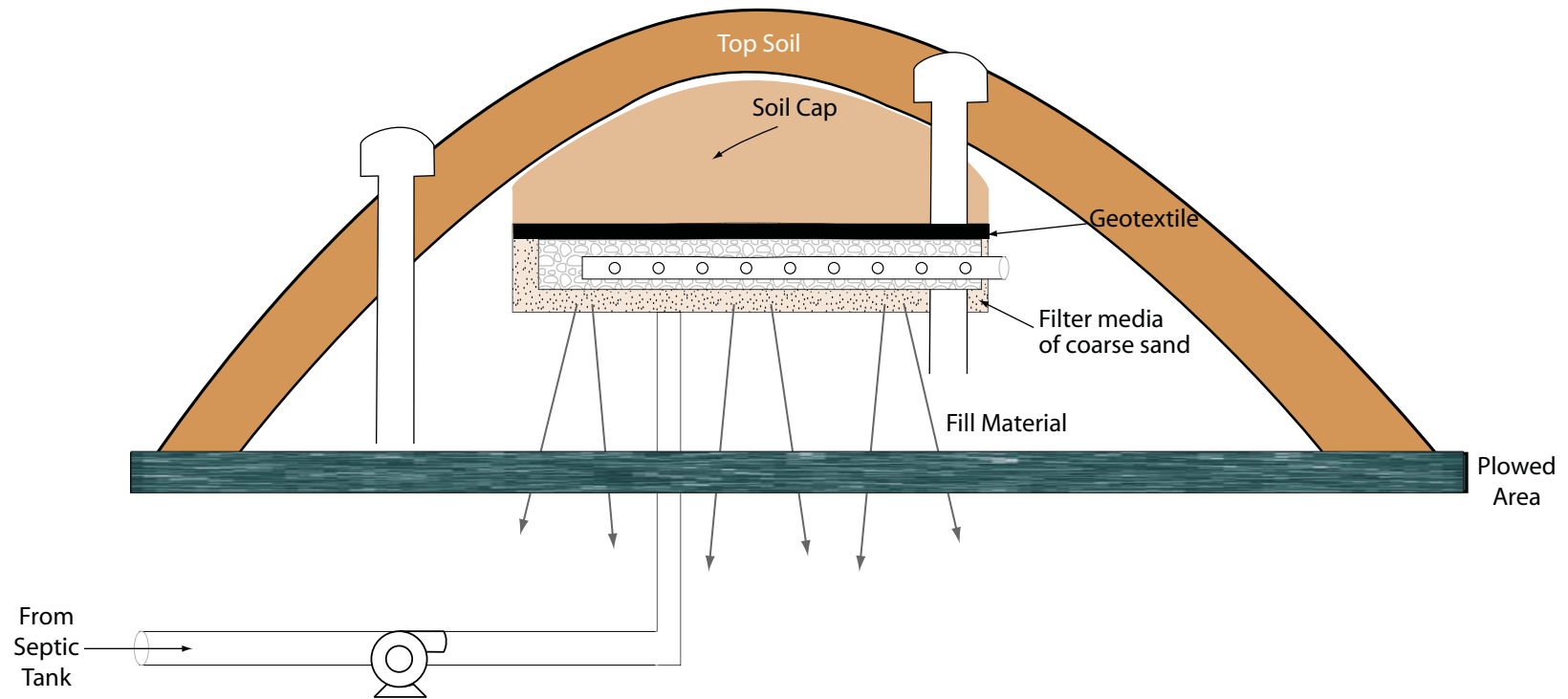


Figure 8
Mound System
 PM 1 - Mid-Island Study Area Sewer Service Options
 General Sewer Plan
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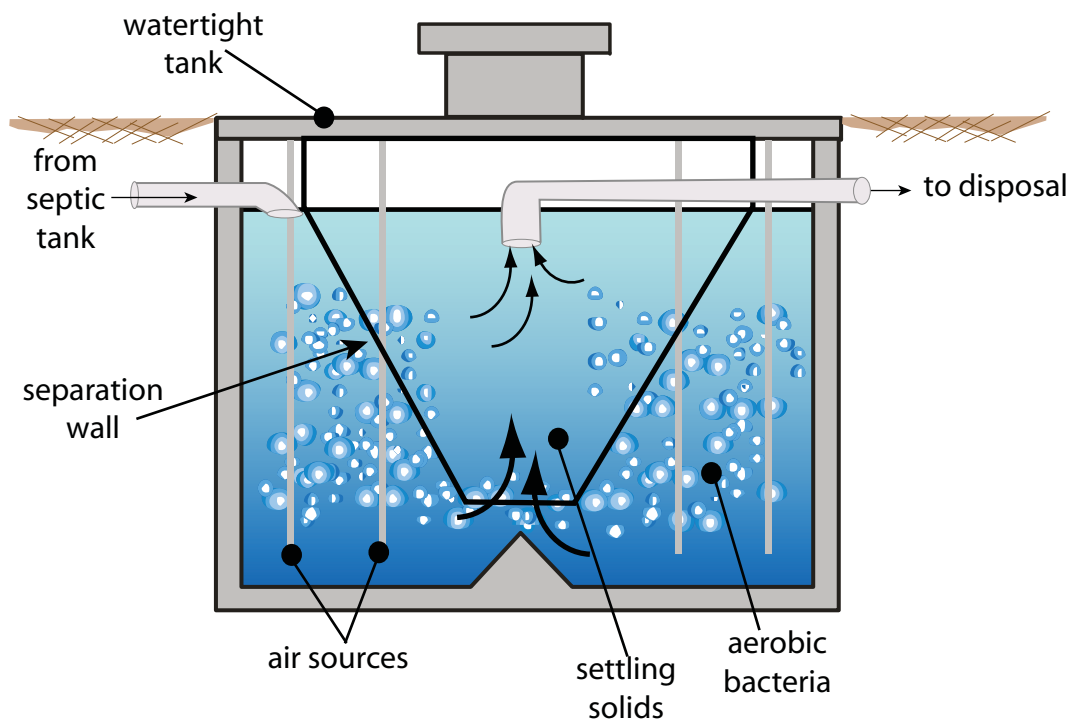


Figure 9
Aerobic Treatment Unit
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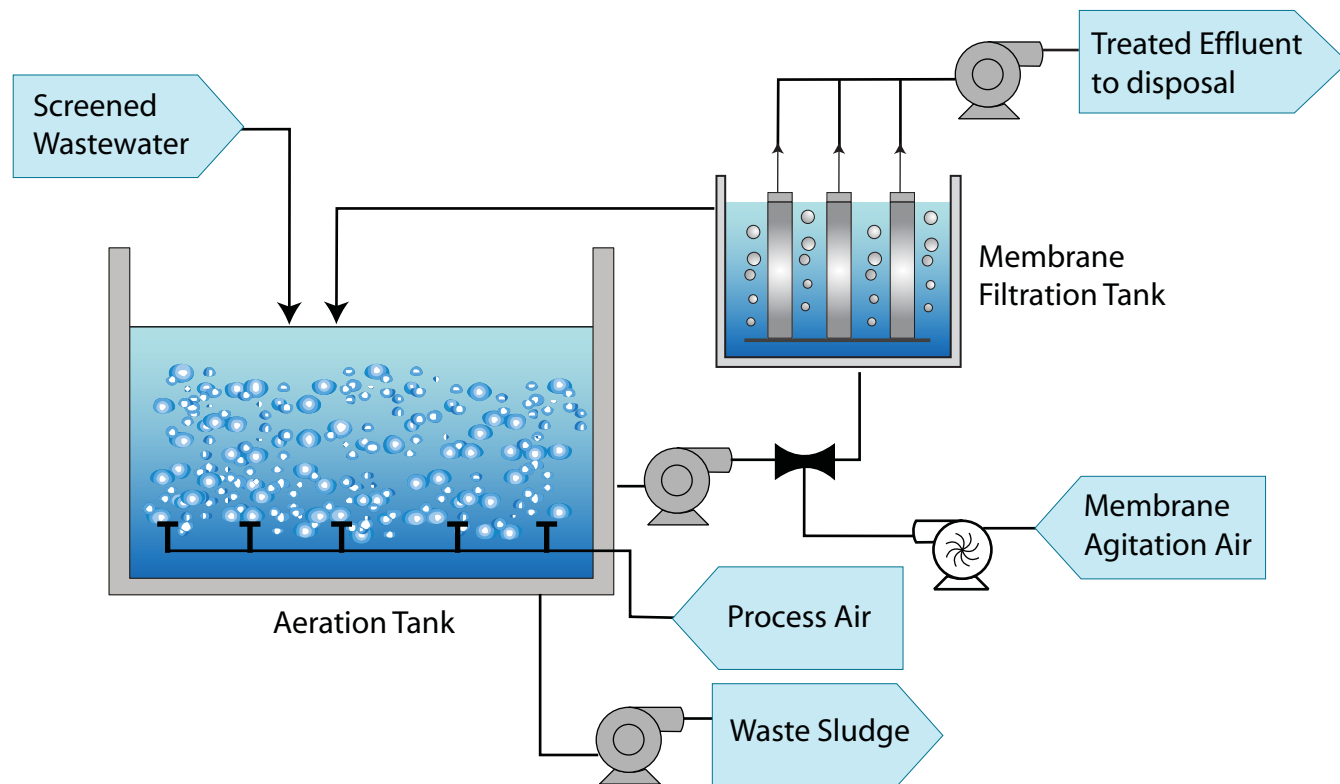


Figure 10
Membrane Bioreactor
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7.0 OPTION SELECTION

For purposes of selecting onsite treatment/disposal combinations to consider in greater detail, each of the six treatment options was combined with the allowable disposal option that required the smallest footprint. The combinations considered are community septic tank/drainfield, sand filter/SDS, recirculating gravel filter/SDS, mound system, ATU/SDS, MBR/percolation pond. In order to select two treatment/disposal combinations for further consideration, each option was rated based on five criteria including reliability, acreage requirements, operation and maintenance requirements, capital cost, and effluent quality.

The two options that emerge as the best options for further evaluation according to Table 7.1 are community septic tank/drainfield and MBR/percolation pond. Costs, acreage requirements and layouts for these two options are provided in Section 8.0.

Table 7.1 Option Selection Matrix General Sewer Plan City of Bainbridge Island													
Option No.	Treatment	Disposal	Reliability		Acreage Requirements		O&M Requirements		Construction Cost		Effluent Quality		Score
			Level	Score	Level	Score	Level	Score	Level	Score	Level	Score	
1	Septic Tank	Drainfield	High	3	High	1	Low	3	Low	3	Low	1	11
2	Sand Filter	Subsurface Drip System	Medium	2	Medium	2	Medium	2	Medium	2	Medium	2	10
3	Recirculating Gravel Filter	Subsurface Drip System	Medium	2	Medium	2	Medium	2	Medium	2	Low	1	9
4	Mound System	Mound System	Low	1	Medium	2	High	1	Medium	2	Medium	2	8
5	Aerobic Treatment Unit	Subsurface Drip System	Medium	2	Medium	2	High	1	Medium	2	Medium	2	9
6	Membrane Bioreactor	Percolation Pond	High	3	Low	3	High	1	Medium	2	High	3	12

8.0 OPTION COMPARISON

To provide a general estimate of land requirements and capital costs, three treatment/disposal combination options were compared for the Mid-Island Study Area. The first option is conveyance of Mid-Island wastewater to the Winslow Collection System for treatment at the Winslow Wastewater Treatment Plant. The second option is installation of community septic tanks and drainfields for each of the Mid-Island pockets. The third option considered is installation of packaged MBR systems with groundwater disposal through percolation ponds. These three options represent solutions that span the range technological approaches and disposal options available to the City. Other options may also be applicable. Each of the three options is described below. Capital cost estimates for each system are included in Table 8.1. Detailed cost development tables are provided in Attachment A. Development of the collection systems for each Mid-Island pocket is not considered herein because they would be similar regardless of the treatment/disposal option selected.

Table 8.1 Mid-Island Treatment Options Capital Cost Estimates General Sewer Plan City of Bainbridge Island		
Treatment Option	Land Required (acres)	System Construction Cost
Conveyance to Winslow Collection System		
Eastern Pocket	0	\$2,000,000
Western Pocket	0	\$2,000,000
Community Septic Tanks with Conventional Drainfields		
Eastern Pocket	2	\$1,000,000
Western Pocket	24	\$10,300,000
MBR Package Plants with Percolation Ponds		
Eastern Pocket	0.5	\$2,800,000
Western Pocket	1.5	\$4,600,000

8.1 Conveyance to the Winslow Collection System

To convey wastewater from the Mid-Island pockets to the Winslow WWTP, a new pump station and force main would need to be constructed for each pocket. The 4-inch diameter force mains from each pocket would have an approximate length of 11,500 ft and would connect to the Winslow Collection System near the Woodward School and North Town Pump Stations.

The amount of flow contributed to the Winslow Collection System by the Mid-Island pockets would account for an additional 2 percent on top of the 0.72-mgd ADWF projected for 2035 for the Winslow Collection System. As shown in Table 8.1, the estimated capital cost for this option is \$2.0 million for each pocket.

8.2 Community Septic Tanks with Conventional Drainfields

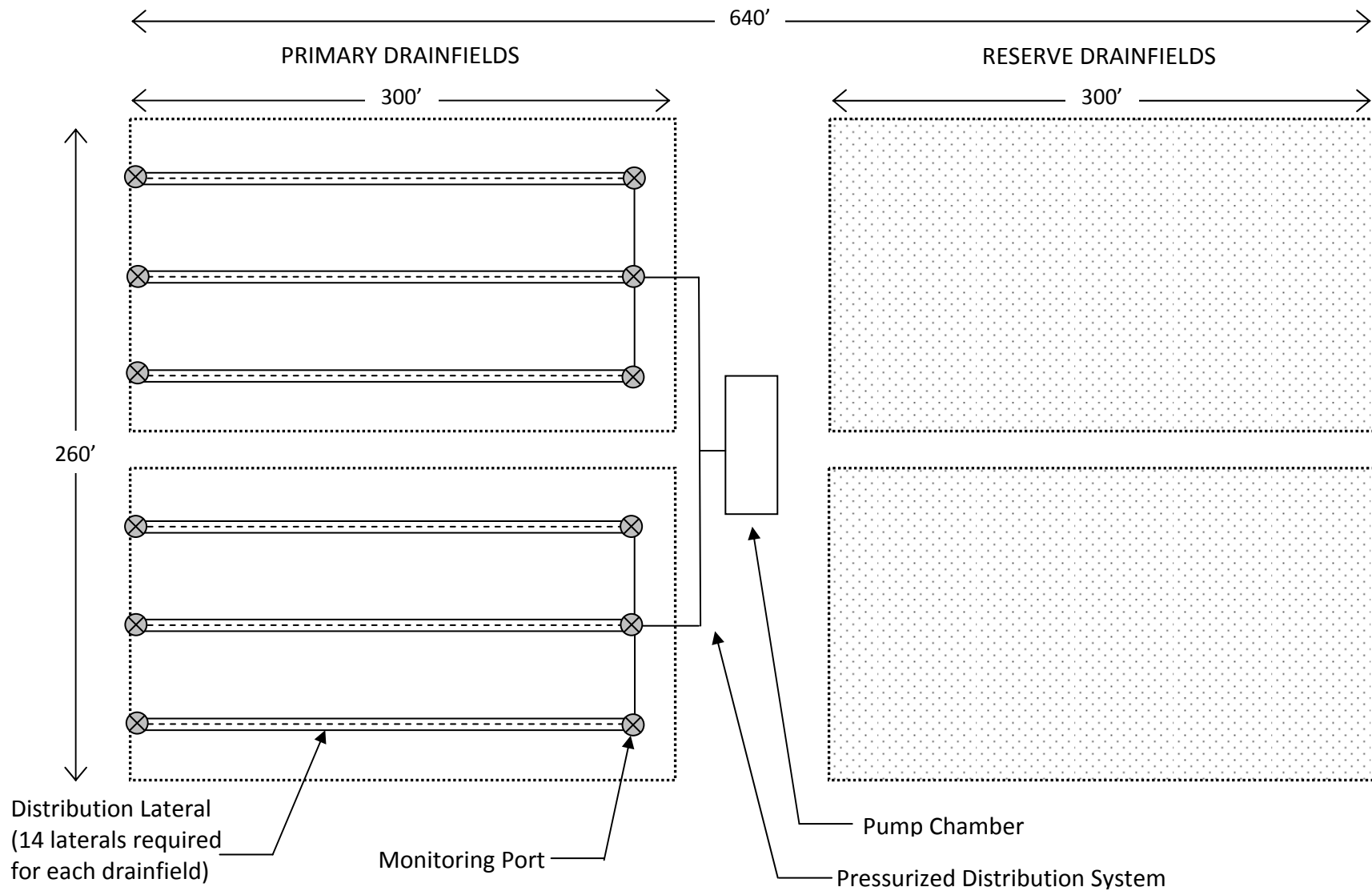
The second option consists of installing a community septic tank with a conventional drainfield for each Mid-Island pocket. The collection systems for each pocket would convey wastewater to an underground septic tank large enough to allow solids in the wastewater to settle to the bottom and grease to float at the top. As wastewater enters the septic tank, clarified, screened effluent flows out of the tank to drainfields. Figure 11 depicts a typical drainfield section sized to handle 15,000 gpd that includes a pump chamber, pressurized distribution system, monitoring ports, distribution laterals, and reserve drainfields. Six such sections are required for to treat the full projected flows of the western pocket. One half of one section shown in Figure 11 is needed for to treat the 7,710 gpd peak flows of the eastern pocket. The land required for a drainfield for the study area was determined using the minimum spacing requirements and allowances and assumed fine sandy soils with a loading rate of 0.6 gal/sf/day. Setbacks and a reserve drainfield area of 100 percent is included in the area estimates.

The eastern pocket would require approximately an 8,000-gallon capacity septic tank with a drainfield spanning nearly two acres. The western pocket would require a 40,000-gallon septic tank with drainfields covering approximately 24 acres. The estimated capital cost of this option for the eastern and western pockets is \$1.0 and \$10.3 million, respectively.

8.3 MBR Package Plants with Percolation Ponds

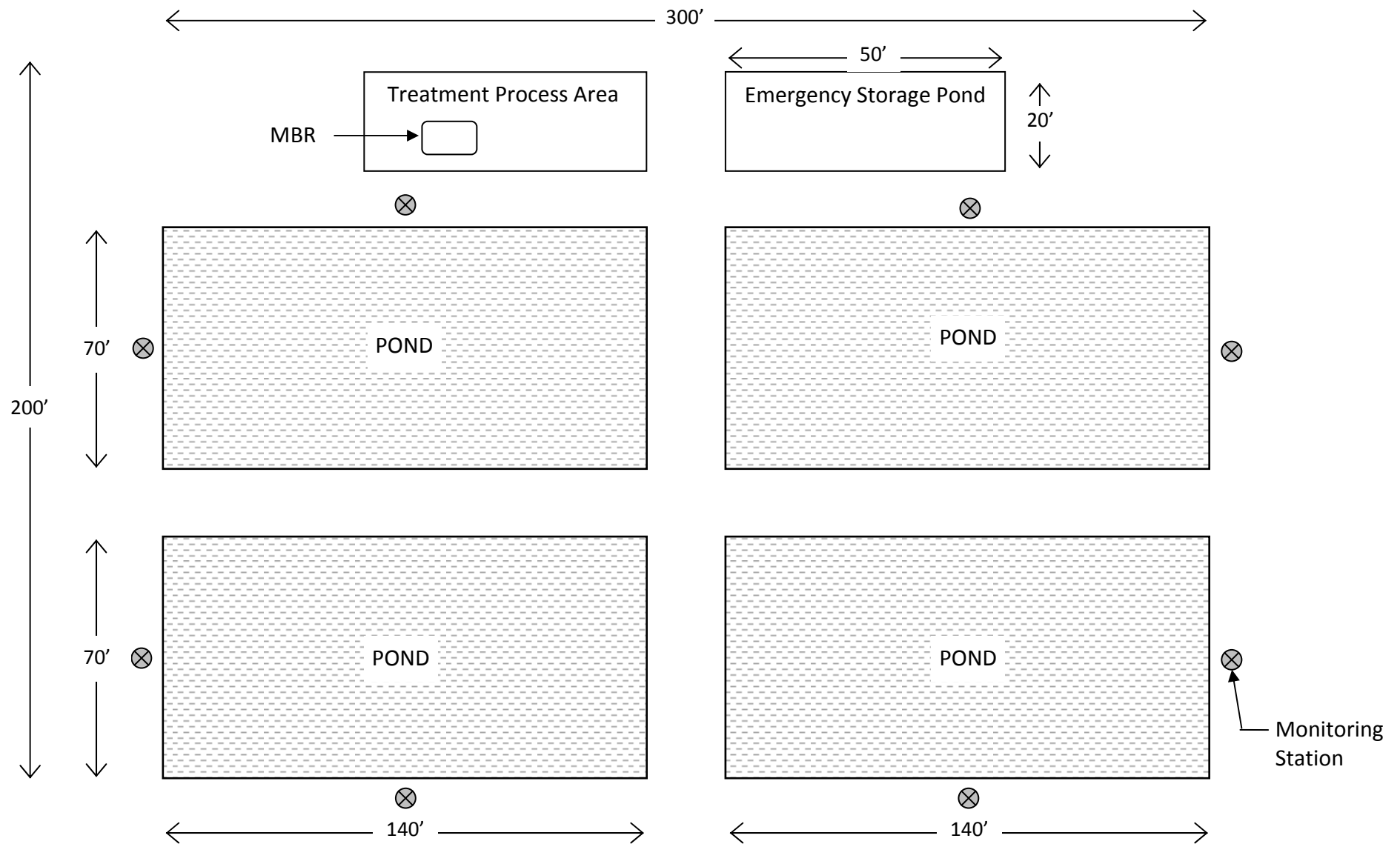
The final option considered involves installation of MBR package plants with groundwater percolation ponds. MBRs are a compact wastewater treatment process. Many manufacturers make self-contained MBR package plants to treat flows of approximately 20,000 to 150,000 gpd. An example layout for an MBR system with percolation ponds is presented in Figure 12.

With an ADWF of 2,570 gpd, the eastern pocket is probably too small to warrant the installation of an MBR system, however estimated land requirements and capital costs are shown in Table 8.1. An MBR packaged plant is well-sized for the western pocket. Percolation ponds for the western pocket would require approximately 1.5 acres and the capital cost of the system is estimated at \$4.6 million.



Total Area: ~4.0 acre
 Drainfield sized for 15,000 gpd
 Six (6) drainfields needed for Western Pocket Flow (39,060 gpd)
 One (1) drainfield half this size needed for Eastern Pocket Flow (7,710 gpd)

Figure 11
Drainfield Schematic
 PM 1 – Mid-Island Study Area Sewer Service Options
 General Sewer Plan
 City of Bainbridge Island



Total Area: ~1.5 acres

Percolation Ponds sized for peak hour flow of 40,000 gpd (Western Pocket)

Approximate Percolation Pond area of 8,000 sf required for Eastern Pocket

Figure 12
MBR/Percolation Pond Schematic
PM 1 – Mid-Island Study Area Sewer Service Options
General Sewer Plan
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9.0 SUMMARY

Many sewer treatment and disposal options exist for the Mid-Island Study Area pockets. The level of treatment required, and therefore the treatment process selected, depends on the chosen disposal method. Three treatment and disposal combinations were considered for each pocket: conveyance to the Winslow Collection System, community septic tanks and drainfields, and MBRs with percolation ponds. These combinations span the range of treatment level and disposal options. Based on this analysis, the most cost-effective method of treatment and disposal for the eastern pocket is the installation of a community septic tank with a conventional drainfield. This option is estimated to cost \$1,000,000. The most cost-effective option for the Western Pocket is construction of a pump station and force main for conveyance to the Winslow Collection System. This option is estimated to cost approximately \$2,000,000.

Prepared By:

Alena Bennett

DETAILED COST DEVELOPMENT

City of Bainbridge Island
General Sewer Plan
PM 1 - Mid-Island Study Area Sewer Service Options

ELEMENT: CONVEYANCE TO WINSLOW COLLECTION SYSTEM

Description	Quantity	Unit	Unit Cost	Subtotal
4" Force Main from Western Pocket	11,500	LF	\$ 70	\$ 805,000
4" Force Main from Eastern Pocket	11,500	LF	\$ 70	\$ 805,000
Connection to Winslow Collection System	2	EA	\$ 3,500	\$ 7,000
Pump Stations	2	EA	\$ 400,000	\$ 800,000
DIRECT COST				\$ 2,417,000
CONTINGENCY				30% \$ 725,100
SUBTOTAL				\$ 3,142,100
GENERAL CONDITIONS (10%) OH&P (15%)				27% \$ 848,367
TOTAL ESTIMATED CONSTRUCTION COST				\$ 3,990,467

City of Bainbridge Island
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ELEMENT: COMMUNITY SEPTIC TANK AND DRAINFIELD

	Description	Quantity	Unit	Unit Cost	Subtotal
Western Pocket					
	Land Acquisition	24	AC	\$ 100,000	\$ 2,400,000
	Septic Tank Excavation	1,200	CY	\$ 12	\$ 14,368
	Septic Tank	40,000	gal	\$ 6	\$ 240,000
	Site Work - Clear and Grub	24	AC	\$ 468	\$ 11,236
	Site Work - Grading	350,000	SF	\$ 2	\$ 578,302
	Site Work - Electrical	1	EA	\$ 50,000	\$ 50,000
	Drainfield Excavation	16,800	CY	\$ 12	\$ 201,148
	Haul Excavated Materials	18,000	CY	\$ 24	\$ 431,032
	6" Perforated PVC	40,000	LF	\$ 17	\$ 670,495
	Monitoring Stations	168	EA	\$ 84	\$ 14,080
	Gravel Backfill	16,800	CY	\$ 79	\$ 1,327,580
	Pressure Distribution System	6	LS	\$ 54,000	\$ 324,000
DIRECT COST					\$ 6,262,241
CONTINGENCY				30%	\$ 1,878,672
SUBTOTAL					\$ 8,140,913
GENERAL CONDITIONS (10%) OH&P (15%)				27%	\$ 2,198,047
TOTAL ESTIMATED CONSTRUCTION COST					\$ 10,338,960

City of Bainbridge Island
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ELEMENT: COMMUNITY SEPTIC TANK AND DRAINFIELD

	Description	Quantity	Unit	Unit Cost	Subtotal
Eastern Pocket					
	Land Acquisition	2	AC	\$ 100,000	\$ 200,000
	Septic Tank Excavation	650	CY	\$ 12	\$ 7,783
	Septic Tank	8,000	gal	\$ 6	\$ 48,000
	Site Work - Clear and Grub	2	AC	\$ 468	\$ 936
	Site Work - Grading	25,000	SF	\$ 2	\$ 41,307
	Site Work - Electrical	1	EA	\$ 50,000	\$ 50,000
	Drainfield Excavation	1,400	CY	\$ 12	\$ 16,762
	Haul Excavated Materials	2,050	CY	\$ 24	\$ 49,090
	6" Perforated PVC	3,300	LF	\$ 17	\$ 55,316
	Monitoring Stations	28	EA	\$ 84	\$ 2,347
	Gravel Backfill	1,400	CY	\$ 79	\$ 110,632
	Pressure Distribution System	0.5	LS	\$ 54,000	\$ 27,000
	DIRECT COST				\$ 609,172
	CONTINGENCY			30%	\$ 182,752
	SUBTOTAL				\$ 791,924
	GENERAL CONDITIONS (10%) OH&P (15%)			27%	\$ 213,820
	TOTAL ESTIMATED CONSTRUCTION COST				\$ 1,005,744

City of Bainbridge Island
General Sewer Plan
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ELEMENT: MEMBRANE BIOREACTOR/PERCOLATION POND

	Description	Quantity	Unit	Unit Cost	Subtotal
Western Pocket					
	Land Acquisition	1.5	AC	\$ 100,000	\$ 150,000
	Site Work - Clear and Grub	1.5	AC	\$ 468	\$ 702
	Site Work - Electrical	1	EA	\$ 50,000	\$ 50,000
	Influent Pumping	1	EA	\$ 390,000	\$ 390,000
	MBR Packaged Plant	1	EA	\$ 1,500,000	\$ 1,500,000
	Solids Storage	1	EA	\$ 100,000	\$ 100,000
	Site Facilities	1	EA	\$ 300,000	\$ 300,000
	Standby Generator	1	EA	\$ 180,000	\$ 180,000
	Pond Excavation	7,300	CY	\$ 12	\$ 87,404
	Emergency Pond Excavation	500	CY	\$ 12	\$ 5,987
	Emergency Pond Liner	1,500	SF	\$ 1	\$ 1,796
	Monitoring Stations	8	EA	\$ 870	\$ 6,960
DIRECT COST					\$ 2,772,849
CONTINGENCY					30% \$ 831,855
SUBTOTAL					\$ 3,604,703
GENERAL CONDITIONS (10%) OH&P (15%)					27% \$ 973,270
TOTAL ESTIMATED CONSTRUCTION COST					\$ 4,577,973

City of Bainbridge Island
General Sewer Plan
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ELEMENT: MEMBRANE BIOREACTOR/PERCOLATION POND

	Description	Quantity	Unit	Unit Cost	Subtotal
Estern Pocket					
	Land Acquisition	0.5	AC	\$ 100,000	\$ 50,000
	Site Work - Clear and Grub	0.5	AC	\$ 468	\$ 234
	Site Work - Electrical	1	EA	\$ 50,000	\$ 50,000
	Influent Pumping	1	EA	\$ 390,000	\$ 390,000
	MBR Packaged Plant	1	EA	\$ 750,000	\$ 750,000
	Solids Storage	1	EA	\$ 50,000	\$ 50,000
	Site Facilities	1	EA	\$ 100,000	\$ 100,000
	Standby Generator	1	EA	\$ 180,000	\$ 180,000
	Pond Excavation	7,300	CY	\$ 12	\$ 87,404
	Emergency Pond Excavation	500	CY	\$ 12	\$ 5,987
	Emergency Pond Liner	1,500	SF	\$ 1	\$ 1,796
	Monitoring Stations	8	EA	\$ 870	\$ 6,960
	DIRECT COST				\$ 1,672,380
	CONTINGENCY			30%	\$ 501,714
	SUBTOTAL				\$ 2,174,095
	GENERAL CONDITIONS (10%) OH&P (15%)			27%	\$ 587,006
	TOTAL ESTIMATED CONSTRUCTION COST				\$ 2,761,100

**2013 SEWAGE PUMP STATION INVENTORY,
PUBLIC WORKS OPERATION AND MAINTENANCE, DRAFT
APRIL 2013**

CITY OF BAINBRIDGE ISLAND
PUBLIC WORKS OPERATIONS AND MAINTENANCE
2013 SEWAGE PUMP STATION INVENTORY
DRAFT APRIL 2013

Old Treatment Plant Sewage Pump Station No. 1

310 Madison Avenue

Background

The Old Treatment Plant Pump Station is part of the Winslow Sewer System. The station is a Lakeside, model LCV dry well/wet well concrete design. It was first constructed in the 1950s as part of the original Winslow Wastewater Treatment Plant at this site. The station was retrofitted under a design by Roats Engineering as part of a major sewer system upgrade in 1979. In spite of its age the mechanical systems continue to function well.

Pump Station Description

The main control panel is manufactured by Superior Custom Controls. The primary controller is an industrial Programmable Logic Controller (PLC) supplied by S&B Inc. The PLC provides control logic and communicates with the Main Telemetry Unit (MTU) at the City Wastewater Treatment Plant. Telemetry is limited to monitoring only. A graphical control screen provides an operator interface to monitor and configure the control system.

The PLC monitors the level in the 6 foot diameter wet well by an analog level transmitter to control the pumps. Two floats provide redundant system control. The first float provides a second high level alarm and a timed pump down sequence in case of level transmitter failure. The second float provides a low level alarm. Station pumping is accomplished with two Cornell centrifugal pumps powered by 208 volt, three phase, 10 horsepower, General Electric motors.

A 20 kilowatt 1980s vintage generator set was modified and installed in 1994 to provide back up power during utility power outages. The generator is equipped with an automatic transfer switch as well as a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure overflow will occur at the manhole located at Parfitt and Madison.

Gravity Collection System and Force Main Description

The station receives residential and commercial gravity flow from the downtown Winslow area. From the station an 8-inch AC force main travels 600 feet north to a manhole at the Madison Avenue and Bjune Drive where the flow turns to gravity.

Ferry Terminal Sewage Pump Station No. 2 Olympic Drive

Background

The Ferry Terminal Pump Station is part of the Winslow Sewer System. It was originally constructed around 1956 as a sewer system extension to the Washington State Department of Transportation Ferry Terminal. The original station was designed by Roats Engineering and included vertical frame mounted line shaft pumps. Around 1980 the station was converted to a wet well submersible pump design upgraded with a new control panel and wet well submersible pumps.

The overall condition of the station is fair. The wet well controls may not meet intrinsic safety standards and the wet well piping and concrete is in rough condition. In spite of its age the mechanical systems continue to function well. Past discussions indicate the State may elect to relocate the station when the Ferry Terminal approach is upgraded.

Pump Station Description

Station pumping is accomplished with two Paco centrifugal pumps powered by 230 volt, 3 phase, 10 horsepower Reliance motors. The pumps that are set to operate in an alternating manner based on the level in the 6 foot diameter wet well. The Superior Custom Controls main control panel provides liquid level control through a series of four floats. From the bottom of the wet well the floats act in the following manner. The lowest float is the normal all pumps off float. The next is the lead pump start float. The next is the lag pump start float. The next and highest is the high level alarm float.

Station telemetry is limited to monitoring only and was designed and installed by S&B Inc. in 1995. The station communicates with the Master Telemetry Unit at the City Wastewater Treatment Plant. During utility power outages emergency power is provided by the Ferry Terminal main generator. The station is not equipped with a mobile generator auxiliary connection in case of main generator failure. The wet well has a 4-inch overflow pipe that will discharge over the bank, on to the beach, and finally into Eagle Harbor in case of complete station failure.

Gravity Collection System and Force Main Description

The Ferry Terminal pump station only receives inflow from Ferry Terminal. From the pump station the 6-inch, class 100 AC force main heads north for about 756 feet to the intersection of Ferncliff Avenue and Winslow Way where the flow turns to gravity. From there sewage flows by gravity to the Highway 305 South lift station.

Highway 305 Sewage Pump Station No. 3 400 Harborview Drive

Background

The Highway 305 Pump Station is the largest pump station in the Winslow Sewer System and is equipped with three pumps. The station is a dry well/wet well package design by Roats Engineering that was supplied by the Chemithon Corporation in 1979. The station was reconfigured and upgraded with new pumps, valves, motors, electrical, telemetry, controls, and cathodic protection in 2008. The upgrade included station painting and the installation of a force main pig launch/emergency pump connection. The station upgrade was designed by BHC Engineers based on a modified version of the Rockaway Beach Pump Station. The general contractor was Gary Harper Construction and the electrical and telemetry system was designed and provided by S&B Inc.

Pump Station Description

During the 2008 upgrade major station electrical components were removed from the drywell and relocated to a Motor Control Center housed in a weather-tight, above ground enclosure. The electrical equipment is manufactured by Siemens Energy and Automation. The primary controller is an industrial Programmable Logic Controller (PLC) that provides control logic and communicates with the Main Telemetry Unit (MTU) at the City Wastewater Treatment Plant. The PLC provides enhanced monitoring and control of the station. In this design control set points reside at the pump station and may be changed locally or from the MTU. A graphical control screen provides an operator interface to monitor and configure the control system.

The PLC monitors the level in the 8 foot diameter wet well by an analog level transmitter to control the pumps. Two floats provide redundant level control. In case of level transmitter failure the High float initiates a timed pump down sequence to control the wet well level. If the High float fails to control the wet well level, indicating a PLC failure, the High-High float bypasses the PLC and starts a pump run that stops when the level reaches the High float. In this mode if the pump run is not stopped within a preset time a second pump will start. Pumping is accomplished by three Cornell centrifugal pumps powered by 480 volt, three phase, 25 horsepower Baldor motors.

During power outages emergency power is supplied by a Katolight, 100 kilowatt generator set installed in 2006 and equipped with an automatic transfer switch. The station has a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure sewage will back up into the gravity collection system. Because the Eagle Harbor Condominiums elevator shaft gravity connection to the wet well is at a low elevation a back check was placed on this line during the station upgrade.

Gravity Collection System and Force Main Description

The station receives inflow from most of the downtown Winslow area. From the pump station the 12-inch DI force main generally travels in a northeast direction for about 3000 feet along the Eagle Harbor beach line until it discharges to gravity just above the City Winslow Wastewater Treatment Plant on Donald Avenue.

Sunday Cove Sewage Pump Station No. 4

691 Winslow Way West

Background

The Sunday Cove Pump Station is the second largest pump station in the Winslow Sewer System. The station is a dry well/wet well package type station designed by Roats Engineering and supplied by the Chemithon Corporation in 1979. The Sunday Cove Pump Station was reconfigured and upgraded with new valves, electrical, telemetry, controls, and cathodic protection in 2007. The upgrade included station painting, additional wet well capacity, and the installation of a force main pig launch/emergency pump connection. The station upgrade was designed by BHC Engineers based on a modified version of the Rockaway Beach Pump Station. The general contractor was Northern Con Ag and the electrical and telemetry system was designed and provided by S&B Inc. The pumps and motors were not replaced during the upgrade.

Pump Station Description

Pump station electrical equipment is manufactured by Siemens Energy and Automation. During the 2007 upgrade major station electrical components were removed from the drywell and relocated to a Motor Control Center housed in a weather-tight, above ground enclosure. The primary controller is an industrial Programmable Logic Controller (PLC) that provides control logic and communicates with the Main Telemetry Unit (MTU) at the City Wastewater Treatment Plant. The PLC provides enhanced monitoring and control of the station. In this design control set points reside at the pump station and may be changed locally or from the MTU. A graphical control screen provides an operator interface to monitor and configure the control system.

The PLC monitors the wet well level by an analog level transmitter to control the pumps. Two floats provide redundant level control. In case of level transmitter failure the High float initiates a timed pump down sequence to control the wet well level. If the High float fails to control the wet well level, indicating a PLC failure, the High-High float bypasses the PLC and starts a pump run that stops when the level reaches the High float. In this mode if the pump run is not stopped within a preset time a second pump will start. Pumping is accomplished with two Crane Deming centrifugal pumps powered by 480 volt, three phase, 7.5 horsepower US Electric motors.

During power outages emergency power is supplied by a 55 kilowatt Northern Lights generator set that was installed in 1997. The station is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure sewage will back up into the gravity collection system and overflow a manhole at Leslie Landing.

Gravity Collection System and Force Main Description

The High School Pump Station was decommissioned and the flow was rerouted by gravity to the Sunday Cove Pump Station in 1999. From the Sunday Cove Pump Station the 6-inch DI force main travels 1200 feet east on Winslow Way where the flow turns to gravity. The original PVC force main for the station had cracked and broke due to poor bedding materials on at least three occasions prior to 2003 when the main was replaced with a ductile iron pipe.

Village Sewage Pump Station No. 5 920 Hildebrand

Background

The Village Pump Station is part of the Winslow Sewer System. It is a drywell/wet well package station that was designed by Roats Engineering and supplied by the Chemithon Corporation. The station was constructed as part of a major sewer system upgrade in 1979 to replace an existing pump station.

The overall condition of the station is fair. The drywell is showing signs of advanced corrosion. The status of the cathodic protection is uncertain and some wet well controls may not meet current intrinsic safety standards. In spite of its age the mechanical systems continue to function well.

Pump Station Description

Station pumping is accomplished with two Crane Deming centrifugal pumps powered by 480 volt, three phase, 20 horsepower motors manufactured by the US Electric Motor Corporation. The pumps are set to operate in an alternating manner based on the level in the 6 foot diameter wet well. The main control panel provides liquid level control through an air compressor and bubbler system. The bubbler system utilizes three mercury switches with differential adjustments for control. One switch for lead pump control, one switch for lag pump control, and one switch for high level alarm. A back up float provides a second high level alarm and a timed pump down sequence in case of bubbler system failure.

Station telemetry is limited to monitoring only and was designed and installed by S&B Inc. in 1995. The station communicates with the Master Telemetry Unit at the City Wastewater Treatment Plant. A used generator set was installed in 1996 to provide back up power during utility power outages. This was replaced with a new 100 kilowatt gen set in 2007. The generator is equipped with an automatic transfer switch as well as a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure overflow will occur out the wet well manhole.

Gravity Collection System and Force Main Description

From the pump station the force main runs east under Highway 305 for 500 feet and then south 600 feet to a clean out. From the clean out the main runs east for 100 feet and then south 600 feet to a second clean out. From the second clean out the main then runs east 850 feet where the flow turns to gravity. The first 20 feet of force main leaving the station is 10-in DI and the remainder is of the force main is 8-in PVC. No known air release valves, blow off valves, or pig ports are part of the system.

Lower Lovell Sewage Pump Station No. 6

4216 Lovell Avenue

Background

The Lower Lovell Pump Station is part of the Winslow Sewer System. It is a drywell/wet well package station that was designed by Roats Engineering and supplied by the Chemithon Corporation. The station was constructed as part of a major sewer system upgrade in 1979.

The overall condition of the station is fair. The status of the cathodic protection is uncertain and some wet well controls may not meet current intrinsic safety standards. Salt water intrusion into the wet well has thought to have been observed. In spite of its age the mechanical systems continue to function well.

Pump Station Description

Station pumping is accomplished with two Crane Deming centrifugal pumps powered by 480 volt, three phase, 7.5 horsepower US Electric motors. The pumps are set to operate in an alternating manner based on the level in the 4 foot diameter wet well. The main control panel provides liquid level control through an air compressor and bubbler system. The bubbler system utilizes three mercury switches with differential adjustments for control. One switch for lead pump control, one switch for lag pump control, and one switch for high level alarm. A back up float provides a second high level alarm and a timed pump down sequence in case of bubbler system failure.

Station telemetry is limited to monitoring only and was designed and installed by S&B Inc. in 1995. The station communicates with the Master Telemetry Unit at the City Wastewater Treatment Plant. A 10 kilowatt generator set was installed in 1998 to provide back up power during utility power outages. The generator is equipped with an automatic transfer switch and a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe. In case of complete station failure sewage will back up the 10-inch beach line to the southeast and overflow the manhole located above the beach at Stetsen Place and Wood Avenue.

Gravity Collection System and Force Main Description

The station receives limited residential gravity flow. From the station the 4-in force main generally heads 200 feet north on Lovell Avenue and then 475 feet east on Parfitt Way to the point where the flow turns to gravity. From the station the first 14 feet of force main is DI and the remainder is PVC.

Lower Hawley Sewage Pump Station No. 7 1195 Irene Place

Background

The Lower Hawley Pump Station is part of the Winslow Sewer System. It is a drywell/wet well package station that was designed by Roats Engineering and supplied by the Chemithon Corporation. The station was constructed as part of a major sewer system upgrade in 1979.

The overall condition of the station is fair. The status of the cathodic protection is uncertain and some wet well controls may not meet current intrinsic safety standards. In spite of its age the mechanical systems continue to function well.

Pump Station Description

Station pumping is accomplished with two Crane Deming centrifugal pumps powered by 480 volt, three phase, 3 horsepower motors manufactured by the US Motor Corporation. The pumps are set to operate in an alternating manner based on the level in the 4 foot diameter wet well. The main control panel provides liquid level control through an air compressor and bubbler system. The bubbler system utilizes three mercury switches with differential adjustments for control. One switch for lead pump control, one switch for lag pump control, and one switch for high level alarm. A back up float provides a second high level alarm and a timed pump down sequence in case of bubbler system failure.

Station telemetry is limited to monitoring only and was designed and installed by S&B Inc. in 1995. The station communicates with the Master Telemetry Unit at the City Wastewater Treatment Plant. A 10 kilowatt generator set was installed in 1996 to provide back up power during utility power outages. The generator is equipped with an automatic transfer switch as well as a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe. In case of complete station failure sewage will back up and overflow a manhole at the east end of Irene Place.

Gravity Collection System and Force Main Description

The station receives limited residential gravity flow. From the station the 4-in DI force main travels east about 275 feet where it connects to the 12-in Highway 305 force main.

Wing Point Sewage Pump Station No. 8

6481 Wing Point Drive

Background

The Wing Point Pump Station is part of the Winslow Sewer System. It is a drywell/wet well package station that was designed by Roats Engineering and supplied by the Chemithon Corporation. The station was constructed as part of a major sewer system upgrade in 1979. The station has a water tight dry well hatch and wet well manhole lids to prevent flooding and infiltration during extreme tides. The overall condition of the station is fair. The drywell is showing signs of advanced corrosion. The status of the cathodic protection is uncertain and some wet well controls may not meet current intrinsic safety standards. In spite of its age the mechanical systems continue to function well.

Pump Station Description

Station pumping is accomplished with two Crane Deming centrifugal pumps powered by 480 volt, three phase, 5 horsepower Gould motors. The pumps are set to operate in an alternating manner based on the level in the 4 foot diameter wet well. The main control panel provides liquid level control through an air compressor and bubbler system. The bubbler system utilizes three mercury switches with differential adjustments for control. One switch for lead pump control, one switch for lag pump control, and one switch for high level alarm. A back up float provides a second high level alarm and a timed pump down sequence in case of bubbler system failure.

Station telemetry is limited to monitoring only and was designed and installed by S&B Inc. in 1995. The station communicates with the Master Telemetry Unit at the City Wastewater Treatment Plant. A 12 kilowatt generator set was installed in 1995 to provide back up power during utility power outages. The generator set was partially rebuilt in 2006. The generator is equipped with an automatic transfer switch as well as a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure overflow will occur out the shallow gravity manholes located just east of the station near the beach.

Gravity Collection System and Force Main Description

The station receives gravity flow from the Wing Point residential community. From the station the 6-in DI force main follows the Wing Point shoreline on the beach to the City Wastewater Treatment Plant located on Donald Avenue. From the station the main generally heads 724 feet N-NW to a clean out, then 551 feet NW to second clean out, then 905 feet NW to a third clean out, and then 161 feet NW to a forth clean out. Just beyond the forth clean out the main turns west and runs 714 feet to a fifth clean out. Just beyond the fifth clean out the main turns north and runs 952 feet to just above the Wastewater Treatment Plant where the flow turns to gravity. The clean outs have been lost for years.

Several beachfront residences discharge directly into the force main. Over the past ten years the main has broken near the pump station on three separate occasions. A project is currently underway to replace the force main.

Island Terrace Sewage Pump Station No. 9

1174 Ferncliff Avenue

Background

The Island Terrace Pump Station is part of the Winslow Sewer System. The developer built station was commissioned around 1983. Institutional memory suggests that the pump impellers were upsized from 100 to 150 gpm capacity after original construction. The pump station is solidly built and functions well.

Pump Station Description

The station is a concrete dry well/wet well package design by Ideal Pump and Equipment. Pumping is accomplished with two Cornell centrifugal pumps powered by 480 volt, three phase, 3 horsepower General Electric motors. The pumps are set to operate in an alternating manner based on the level in the 8 foot diameter wet well. The Superior Custom Controls main control panel provides level control through a bubbler system and a series of pressure switches. The pressure switches control the lead pump, lag pump, and high level alarm settings. A back up float provides a second high level alarm and a timed pump down sequence in case of bubbler system failure.

Station telemetry is limited to monitoring only and was designed and provided by S&B Inc. in 1995. The station communicates with the Master Telemetry Unit at the Winslow Wastewater Treatment Plant. A generator set equipped with an automatic transfer switch was installed in 2002 to provide back up power during utility outages. The station is equipped with a mobile generator auxiliary connection in case of stationary generator failure. The wet well has an overflow pipe and in case of complete systems failure sewage will overflow to the forest area to the east of the station.

Gravity Collection System and Force Main Description

The station receives residential and commercial gravity flow. From the station the 4-inch force main runs 440 feet south on Ferncliff Avenue to the intersection of Eaglecliff and Ferncliff where the flow turns to gravity.

Klickitat Sewage Pump Station No. 10 692 Klickitat Place

Background

The Klickitat Pump Station is part of the Winslow Sewer System. The developer constructed station was commissioned around 1992. Although the condition of the cathodic protection is unknown, overall the station is well built and functions well.

Pump Station Description

The station is a dry well/wet well package design by Ideal Pump and Equipment. Pumping is accomplished with two Cornell centrifugal pumps powered by 480 volt, three phase, 7.5 horsepower, Marathon Electric motors. The pumps are set to operate in an alternating manner based on the level in the 6 foot diameter wet well. The main control panel provides level control through a bubbler system and a series of pressure switches. The three pressure switches control the lead pump, lag pump, and high level alarm. Two floats provide redundant system control. The first float activates a second high level alarm and a timed pump down sequence in case of bubbler system failure. The second float provides redundant pump stop control and low level alarm.

Station telemetry is limited to monitoring only and was designed and installed by S&B Inc. in 1995. The station communicates with the Master Telemetry Unit at the Wastewater Treatment Plant. A generator set equipped with an automatic transfer switch was installed in 2003 to provide back up power during utility outages. The station is equipped with a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure sewage will back up and overflow the wet well manhole.

Gravity Collection System and Force Main Description

The station receives gravity flow from a limited residential area. From the station it is believed that the force main runs 200 feet north through an easement and then connects to the force main from the Village Pump Station. The force main serving both stations then travels about 600 feet east where the flow turns to gravity on Ferncliff Avenue.

Woodward School Sewage Pump Station No. 11

9125 NE Sportsman Club Road NE

Background

The Woodward School Pump Station is part of the Winslow Sewer System. It is a wet well submersible pump design. The pump station is outside and the electrical controls are located in the basement of the school 200 feet north of the station. The station and force main was constructed by Oien Construction for the Bainbridge Island School District around 1995 and subsequently turned over to the City. Overall the station is in good condition and functions well.

Pump Station Description

Station pumping is accomplished with two Paco centrifugal pumps powered by 480 volt, 3 phase, 15 horsepower Reliance motors. The pumps that are set to operate in an alternating manner based on the level in the 6 foot diameter wet well. The Elpack main control panel provides liquid level control through a series of five floats. From the bottom of the wet well the floats act in the following manner. The lowest activates the low wet well alarm and redundant off signal. The next is the normal all pumps off float. The next is the lead pump start float. The next is the lag pump start float. The next and highest is the high level alarm float. Manual control is possible through local HOA switches located on the control panel in the basement of the school.

Station telemetry is limited to monitoring only and was designed and installed by S&B Inc. in 1995. The station communicates with the Master Telemetry Unit at the City Wastewater Treatment Plant. During utility power outages emergency power is provided by the Woodward School main generator. The station is not equipped with a mobile generator auxiliary connection in case of main generator failure. The wet well does not have an overflow pipe and in case of complete systems failure overflow will occur out the wet well manhole.

Collection System and Force Main Description

The Woodward School pump station only receives flow from two school campuses. From the pump station the 4-inch DI force main travels about 700 feet to the intersection of Sportsman Club and New Brooklyn where it connects with the 4-inch HDPE force main from the North Town Woods pump station. The combined force main travels about 4000 feet to the intersection of High School Road and Madison where the flow turns to gravity. Several small pump stations and the Sakai Village pump station contribute to this force main to cause varying head conditions. See the North Town Woods Pump Station description for additional detail.

Lynnwood Center Sewage Pump Station No. 12

4586 Point White Drive

Background

The Lynnwood Center Pump Station is a concrete dry well/wet well station that was designed by ADA Engineering with mechanical equipment provided by Correct Equipment. The station was constructed in 1998 by Lydel Construction under contract to developer Harley Unruh. The station and the force main to the Sewer District No. 7 Wastewater Treatment Plant was originally constructed to serve the Lynnwood Center area. In 2006 the City bought out the developer and expanded the service area to serve the South Island Sewer Local Improvement District No. 20. The station is solidly built and has performed well since it went into service.

Description

The station electrical equipment is manufactured Consolidated Electric. The Motor Control Center is housed in a weather-tight, above ground enclosure. The primary controller is an industrial Programmable Logic Controller (PLC) supplied by S&B Inc. The PLC provides control logic and communicates with the Main Telemetry Unit (MTU) at the City Wastewater Treatment Plant. A graphical control screen provides an operator interface to monitor and configure the control system.

The PLC monitors the level in the 8 foot diameter wet well by an analog level transmitter to control the pumps. Two floats provide redundant level control. In case of level transmitter failure the High float initiates a timed pump down sequence to control the wet well level. If the High float fails to control the wet well level, indicating a PLC failure, the High-High float bypasses the PLC and starts a pump run that stops when the level reaches the High float. In this mode if the pump run is not stopped within a preset time a second pump will start. Pumping is accomplished by two Fairbanks Morse centrifugal pumps powered by 480 volt, 3 phase, 40 horsepower, US Motor Corporation motors.

During power outages emergency power is supplied by a Cummins/Onan generator set equipped with an automatic transfer switch. The station is not equipped with a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure overflow will occur out the wet well manhole.

Gravity Collection and Force Main Sewers

The gravity collection system collects residential and commercial flows from the Lynnwood Center area and the South Island LID No. 20 collection system. The 6-inch force main discharges to the Sewer District No. 7 Fort Ward Wastewater Treatment Plant. The 12,468 foot force main includes 12,200 feet of 6-inch DI and 268 feet of 6-inch C-900 PVC pipe. From the pump station the main heads 4,100 feet south then east on Pleasant Beach Drive NE, then 2,800 feet west on Oddfellows Road, then 2,000 feet west on Blakely Avenue NE, then 3,568 feet south on NE Country Club Road and then parallel to Fort Ward Hill Road to the point where the flow turns to gravity near the entrance to the Wastewater Treatment Plant. The invert elevation at the point of gravity flow is 155.58 feet. The force main includes four air release valves and four pressure clean outs.

North Town Woods Sewage Lift Station No. 13

9673 North Town Loop

Background

The North Town Woods Pump Station is part of the Winslow Sewer System. It is a drywell/wet station designed by Toothman-Orton Engineering. The station was built by Oien Construction under contract to Madison Avenue Development. The developer built station was fabricated on site and placed in service in 1999. Prior to transfer to the City the station dry well flooded and subsequently required significant motor and electrical refurbishment before being placed back in service. Overall the station was poorly constructed and since transfer to the City numerous deficiencies have been identified and corrected.

Pump Station Description

The station electrical equipment is manufactured by Seimens Energy and Automation. The Motor Control Center is housed in a weather-tight, above ground enclosure. The primary controller is an industrial Programmable Logic Controller (PLC) supplied by S&B Inc. The PLC provides control logic and communicates with the Main Telemetry Unit (MTU) at the City Wastewater Treatment Plant. Telemetry is limited to monitoring only.

The PLC monitors the level in the 6 foot diameter wet well by an analog level transmitter to control the pumps. In case of level transmitter failure a high level float sounds an alarm and provides a timed pump down sequence. Station pumping is accomplished with two Fairbanks Morse centrifugal pumps powered by 480 volt, 3 phase, 30 horsepower, General Electric motors. Because of force main limitations the electrical supply transformer for the station was downsized and the control logic is limited to one pump run only. Two pump capabilities are not available. During power outages emergency power is supplied by a Cummins/Onan generator set equipped with an automatic transfer switch. The station is not equipped with a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure overflow will occur out the wet well manhole.

Gravity Collection System and Force Main

The North Town Woods lift station receives inflow from the North Town Woods residential neighborhood as well as pumped discharge from the Sportsman Club Road Church, Sakai School, and two small pump stations located in the Copper Top Loop Business Park. The North Town Woods lift station discharges into 1,800 feet of 4-inch DI force main that runs south on Sportsman Club Road to the intersection of Sportsman Club and New Brooklyn. The Woodward School pump station also discharges into this section of force main.

At New Brooklyn Road the force main makes a transition to 4-inch HDPE and heads east to the intersection of New Brooklyn and Madison. At this point the force main heads south before it turns to gravity just north of Madison and High School Road. Along this route the City owned Sakai Village sewage lift station as well as three small pump stations operated by others located at the School Bus Maintenance Facility, Madison Avenue Fire Station, and the LDS Church on Madison Avenue all discharge into this section of force main. In addition the Coultas property planned for future development and will discharge into this section of force main.

Sakai Village Sewage Pump Station No. 14

1879 Sakai Village Loop NE

Background

The Sakai Village Pump Station is part of the Winslow Sewer System. The station was constructed by developer Doug Nelson to serve the Sakai Village development project in 2003. It is a wet well submersible station designed by Map Ltd. with mechanical systems provided by HD Fowler. The station is well built and the design of the mechanical and structural systems has become part of the City standard for new pump stations.

Pump Station Description

The station electrical equipment is manufactured by Superior Custom Controls. The main control panel is housed in a weather-tight, above ground enclosure. The panel provides control based on the level in the 6 foot diameter wet well through a series of five floats. From the bottom of the wet well the floats act in the following manner. The lowest is a redundant stop float/low alarm. This float will stop the pumps even if in the hand position. The next is the normal all pumps off float. The next is the lead pump start float. The next is the lag pump start float. The next and highest is the high level alarm float. The control logic prevents both pumps from starting at the same time should the panel become energized while when both a lead and lag condition exists. A timer will delay the start of the second pump for 10 seconds to prevent excess start up current draw. Pumping is provided by two Hydromatic S4PX100, 10 horsepower, 480 volt, 3 phase, submersible pumps.

Station telemetry was designed and provided by S&B Inc. and is limited to monitoring only. The station communicates with the Master Telemetry Unit at the Winslow Wastewater Treatment Plant. A generator set equipped with an automatic transfer switch provides back up power during utility power outages. The station is equipped with a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure overflow will occur at the manhole just east of the station.

Collection System and Force Main Description

The Sakai Village pump station receives flow from the Sakai Village residential area only. From the pump station the 4-inch class 52, DI main extends 362 feet west to a 90 degree bend, 43 feet south to a second 90 degree bend, and finally 160 feet west to the point of intersection with the 4-inch SDR-9 HDPE force main serving the North Town Woods Pump Station on Madison Avenue. From the point of connection, the 4-inch SDR-9 HDPE force main extends 1200 feet south at which point the flow turns to gravity. Both bends in the 4-inch DI main are equipped with pressure clean out connections. The North Town Woods force main has some unusual characteristics that cause varying head conditions. See the North Town Woods Pump Station system description for additional detail.

Rockaway Beach Sewage Pump Station No. 15

3900 Halls Hill NE

Background

The Rockaway Beach Pump Station is part of the South Island Sewer System and was commissioned in 2005. It is a wet well submersible pump design that was constructed by the City as part of the South Island Sewer Local Improvement District No. 20. The overall station design was managed by BHC Engineers and the general contractor was Evergreen Utility Contractors. The electrical and telemetry system was designed and provided by S&B Inc. and station pumping equipment was provided by Pump Tech. The station is based on the Sakai Village Pump Station mechanical and structural details with S&B electrical and telemetry modifications added. Together this combination has become the City design standard for new and retrofitted sewage pump stations.

Pump Station Description

The station electrical equipment is manufactured by Siemens Energy and Automation. The Motor Control Center is housed in a weather-tight, above ground enclosure. The primary controller is an industrial Programmable Logic Controller (PLC) that provides control logic and communicates with the Main Telemetry Unit (MTU) at the City Wastewater Treatment Plant. The PLC provides enhanced monitoring and control of the station. In this design control set points reside at the pump station and may be changed locally or from the MTU. A graphical control screen provides an operator interface to monitor and configure the control system.

The PLC monitors the level in the 8 foot diameter wet well by an analog level transmitter to control the pumps. Two floats provide redundant level control. In case of level transmitter failure the High float initiates a timed pump down sequence to control the wet well level. If the High float fails to control the wet well level, indicating a PLC failure, the High-High float bypasses the PLC and starts a pump run that stops when the level reaches the High float. In this mode if the pump run is not stopped within a preset time a second pump will start. Pumping is accomplished by two ABS AFP 1034, 30 horsepower, 480 volt, 3 phase submersible pumps.

During power outages emergency power is supplied by a Smith Detroit Diesel Allison, 80 KILOWATT generator set equipped with an automatic transfer switch. The station has a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure overflow will occur out the wet well manhole. The station has an odor control system that includes a biofilter and a charcoal filter.

Gravity Collection System and Force Main Description

The pump station receives inflow from about 80 homes with on site grinder pumps located on Rockaway Beach Drive. The low pressure grinder pump force main to the station includes about 2,525 feet of 2-inch HDPE and 2,920 feet of 3-inch HDPE. From the station a 4-inch HDPE high pressure force main conveys flow about 5,360 feet along Halls Hill Road and Blakely Road NE to NE Country Club Road where it connects to a 6-inch DI force main that leads to the Sewer District No. 7 Fort Ward Wastewater Treatment Plant. The 6-inch force main was installed during construction of the Lynnwood Center Pump Station.

Vineyard Lane Sewage Pump Station No. 16

Vineyard Lane

Background

The Vineyard Lane Pump Station is part of the Winslow Sewer System and was commissioned in 2006. It is a wet well submersible pump design based on the City design established during construction of the Rockaway Beach Pump Station. The station was constructed as part of the Vineyard Lane development project. The overall station design was managed by Browne Engineers and the general contractor was Seton Construction. The electrical and telemetry system was designed and provided by S&B Inc. and station pumping equipment was provided by Pump Tech.

Pump Station Description

The station electrical equipment is manufactured by Siemens Energy and Automation. The Motor Control Center is housed in a weather-tight, above ground enclosure. The primary controller is an industrial Programmable Logic Controller (PLC) that provides control logic and communicates with the Main Telemetry Unit (MTU) at the City Wastewater Treatment Plant. The PLC provides enhanced monitoring and control of the station. In this design control set points reside at the pump station and may be changed locally or from the MTU. A graphical control screen provides an operator interface to monitor and configure the control system.

The PLC monitors the level in the 6 foot diameter wet well by an analog level transmitter to control the pumps. Two floats provide redundant level control. In case of level transmitter failure the High float initiates a timed pump down sequence to control the wet well level. If the High float fails to control the wet well level, indicating a PLC failure, the High-High float bypasses the PLC and starts a pump run that stops when the level reaches the High float. In this mode if the pump run is not stopped within a preset time a second pump will start. Pumping is accomplished by two Hydromatic S4MX, 3 horsepower, 208 volt, 3 phase submersible pumps.

As per the recorded Emergency Generator Agreement during power outages emergency power is supplied by a standby generator set owned and operated by the Vineyard Lane Owners Association. The generator feeds power to the pump station and portions of the Vineyard Lane project through an automatic transfer switch. The station has a mobile generator auxiliary connection in case of stationary generator failure. The wet well does not have an overflow pipe and in case of complete station failure overflow will occur out the wet well manhole. The station has a biofilter odor control system.

Gravity Collection System and Force Main Description

The pump station receives gravity inflow from about 45 residential units in the Vineyard Lane retirement community. From the station a 4-inch HDPE high pressure force main conveys flow about 823 feet to the west under Highway 305 to discharge to the gravity main on Ericksen Avenue.

LIFT STATION INVENTORY

2013 Sewer Pump Station Inventory

Old Treatment Plant Sewage Pump Station No. 1 3010 Madison Avenue

GENERAL INFORMATION	
Previous Name	Pump Station No. 3
Configuration	Package type drywell/wet well station, Lakeside Concrete Model LCV
Year Commissioned	1956
Developer / City	City
Designer	
Contractor	
Year Upgraded	1978
Designer	George Roats, Roats Engineering
Contractor	

DRYWELL	
Material of Construction	Concrete
Condition	Good
Diameter	8 ft - 2 in long x 6 ft wide x 7 ft high
Depth	
Top hatch rim to ground level	2 in
Top hatch rim to ceiling	8 ft - 6 in
Top hatch rim to floor	15 ft - 8 in

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	6 ft
Overflow pipe	No
Overflow location	Will overflow through manhole at Parfitt and Madison
Bubbler air flow setting	na

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off		na	
Floor to low level off	24 in	na	24 in
Floor to lead pump start	41 in	na	40 in
Floor to lag pump start	44 in	na	44 in
Floor to high level alarm	46 in	na	46 in
Floor to back up float / high alarm #2	50 in	na	50 in
Floor to lowest invert pipe	74 in	na	74 in
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim	14 ft - 1 in	na	

2013 Sewer Pump Station Inventory

Old Treatment Plant Sewage Pump Station No. 1

ELECTRICAL	
Primary Voltage	208 volts
Control Circuit Voltage	120 volts
Type of Controls	PLC
Disconnect Switch Location	At the main service entrance in the generator building
Amperage	200 amp
Voltage / Phase	208 volts / 3 phase
Main Control Center	
Manufacturer	Superior Custom Controls
Model	PC439
Fuse Inventory	
Location	
Purpose	
Size	

LEVEL CONTROLS	
Bubbler Controls	No
Compressor Make	
Manufacturer	
Model	
Float Controls	Yes
Manufacturer	
Model	
Number of Floats	Two - #1 is second high alarm and timed pump down
Purpose	- #2 provides low alarm
Pressure Transducer	Yes
Manufacturer	Druke
Model	PTX 1290
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	PLC controlled
Model	
Secondary Transformer	
Manufacturer	
Style	
Catalog No	
Primary/Secondary	
KVA	
Phase	
Cathodic Protection	na

2013 Sewer Pump Station Inventory

Old Treatment Plant Sewage Pump Station No. 1

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Furnase	Furnase	na
Size	1-3/4	1-3/4	
Catalog Number	14EP3217	14EP3217	
Coil Voltage	120 volts	120 volts	
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	General Electric	General Electric	na
Constant / Variable	Constant	Constant	
Model	5K6277XH337A	5K6277XH337A	
Frame	215 TPZ10	215 TPZ10	
Phase	3 phase	3 phase	
Horsepower	10 hp	10 hp	
Voltage	208 volts	208 volts	
Speed, rpm	1750 rpm	1750 rpm	
Rated Amperage	27 / 13.5 amps	27 / 13.5 amps	
Running Amperage	23 amps	23 amps	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, frame mounted, end suction, centrifugal		na
Manufacturer	Cornell	Cornell	
Model	4NNTLHMM10-4	4NNTLHMM10-4	
Serial	1773	1774	
Impeller size			
Inlet Size	6 in	6 in	
Discharge Size	6 in	6 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head			na
Static Head	37 ft	37 ft	
Pumping Head	51 ft	51 ft	
Dead Head	58 ft	58 ft	
Test Date	6/1/04	6/1/04	
Design Flow			
Test flow 1 pump	256 gpm	256 gpm	
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Old Treatment Plant Sewage Pump Station No. 1

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	6 in	6 in	na
Type	Gate	Gate	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	
Discharge Valve Size	6 in	6 in	
Type	Gate	Gate	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	6 in	6 in	
Type	Swing	Swing	
Manufacturer	M&H	M&H	
Model	4X6125S	4X6125S	
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN		
Type	Discharge	Incoming
Size	8 in	
Material	AC	
Length	600 ft	
Pig Station	No	

SUMP PUMP	
Manufacturer	Zoller
Model	
Capacity	
Voltage	120 volt
Horsepower	
Discharge Pipe Size	1-1/4 in
Sump Diameter	13 in

EXHAUST FAN / ODOR CONTROL BLOWER		
Type	Exhaust fan	Fan operates on hatch micro switch
Manufacturer	Dayton	
Model	4C447	
Capacity cfm		
Voltage	121 volts	
Horsepower	1/20 hp	
RPM		

2013 Sewer Pump Station Inventory

Old Treatment Plant Sewage Pump Station No. 1

DEHUMIDIFIER	
Manufacturer	GE
Model	Sahara 20

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Z004091757		
US West Circuit ID Number	4.UCXX-15033		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	Yes
Power Failure	Yes	Intrusion	Yes
Compressor Fail	No	Smoke	Yes
Pump Fail	Yes	Flood	Yes
High Wet Well	Yes	Operator in Trouble	Yes

EMERGENCY GENERATOR	
Inventory Number	145
Year Installed	1994 converted used 1980s vintage mobile generator
New or Used	Used
Year Rebuilt	na
Manufacturer	Multiquip gen set, Isuzu motor, Multiquip generator
Model	QD145,6BD1
Serial	3610833
Fuel	Diesel
Cylinders	6 cyl
Displacement	5.9 liter
Battery Voltage	12 volts
Rated Size	20 kw
Sound Attenuation	No
Fuel Capacity	33 gal
Run Timer per Tank	8 hrs
Automatic Transfer Switch	Yes
Manufacturer	Cutler Hammer-Westinghouse
Model	ATVEKDA-30225WSU
Phase	3 phase
Voltage	208 volts
Rated Amperage	225 amps
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Ferry Terminal Sewage Pump Station No. 2 Olympic Drive

GENERAL INFORMATION	
Previous Name	Pump station No. 12
Configuration	Wet well submersible
Year Commissioned	1956
Developer / City	City
Designer	George Roats, Roats Engineering
Contractor	
Year Upgraded	1980
Designer	
Contractor	

DRYWELL	
Material of Construction	na
Condition	na
Diameter	na
Depth	na
Top hatch rim to ground level	na
Top hatch rim to ceiling	na
Top hatch rim to floor	na

WET WELL	
Material of Construction	Concrete
Condition	Poor
Diameter	6 ft
Overflow pipe	4 in
Overflow location	Will overflow pipe to Eagle Harbor
Bubbler air flow setting	na

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	na
Floor to low level off	17 in	na	na
Floor to lead pump start	41 in	na	na
Floor to lag pump start	48 in	na	na
Floor to high level alarm	65 in	na	na
Floor to back up float / high alarm #2	na	na	na
Floor to lowest invert pipe	67 in	na	na
Floor to overflow pipe	68 in	na	na
Floor to ground level manhole rim	90 in	na	na

2013 Sewer Pump Station Inventory

Ferry Terminal Sewage Pump Station No. 2

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	Relay
Disconnect Switch Location	At main service
Amperage	100 amp
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Superior Custom Controls
Model	H-928
Fuse Inventory	
Location	Main disconnect
Purpose	Main power
Size	70 amp / 600 volt (3 ea)

LEVEL CONTROLS	
Bubbler Controls	No
Compressor Make	
Manufacturer	
Model	
Float Controls	Yes, provides primary level control
Manufacturer	
Model	
Number of Floats	Four
Purpose	Pump stop, lead start, lag start, and high level alarm
Pressure Transducer	No
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	SSAC
Model	ARP-435
Secondary Transformer	
Manufacturer	Hevi Duty Electric
Style	General Purpose
Catalog No	W350
Primary/Secondary	480 / 240 / 120
KVA	0.350 kva
Phase	Single
Cathodic Protection	na

2013 Sewer Pump Station Inventory

Ferry Terminal Sewage Pump Station No. 2

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Cutler Hammer	Cutler Hammer	na
Size	2	2	
Catalog Number	AIODNO	AIODNO	
Coil Voltage	120 volts	120 volts	
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Reliance	Reliance	na
Constant / Variable	Constant	Constant	
Model			
Frame	210TY	210TY	
Phase	3 phase	3 phase	
Horsepower	10 hp	10 hp	
Voltage	230 volts	230 volts	
Speed, rpm	1750 rpm	1750 rpm	
Rated Amperage	27 / 13 amps	27 / 13 amps	
Running Amperage	12.2 amps	12.3 amps	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Submersible	Submersible	na
Manufacturer	Paco	Paco	
Model	51-49501-5782	51-49501-5782	
Serial	KSB73704A	KSB73704A	
Impeller size			
Inlet Size	na	na	
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	84 ft	84 ft	na
Static Head			
Pumping Head			
Dead Head			
Test Date	6/1/04	6/1/04	
Design Flow	200 gpm	200 gpm	
Test flow 1 pump	150 gpm	150 gpm	
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Ferry Terminal Sewage Pump Station No. 2

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	na	na	na
Type	na	na	
Manufacturer	na	na	
Model	na	na	
Connection	na	na	
Discharge Valve Size	4 in	4 in	
Type	Gate	Gate	
Manufacturer	Mueller	Mueller	
Model			
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type	Swing	Swing	
Manufacturer	Mueller	Mueller	
Model			
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN		
Type	Discharge	Incoming
Size	6 in	
Material	Class 100 AC	
Length	756 ft	
Pig Station	No	

SUMP PUMP	
Manufacturer	na
Model	na
Capacity	na
Voltage	na
Horsepower	na
Discharge Pipe Size	na
Sump Diameter	na

EXHAUST FAN / ODOR CONTROL BLOWER	
Type	na
Manufacturer	na
Model	na
Capacity cfm	na
Voltage	na
Horsepower	na
RPM	na

2013 Sewer Pump Station Inventory

Ferry Terminal Sewage Pump Station No. 2

DEHUMIDIFIER	
Manufacturer	na
Model	na

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Power fed from Ferry Terminal		
US West Circuit ID Number	4.UCXX-15040		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	Yes
Compressor Fail	No	Smoke	Yes
Pump Fail	Yes	Flood	No
High Wet Well	Yes	Operator in Trouble	Yes

EMERGENCY GENERATOR	
Inventory Number	Station is powered by main ferry terminal generator
Year Installed	na
New or Used	na
Year Rebuilt	na
Manufacturer	na
Model	na
Serial	na
Fuel	na
Cylinders	na
Displacement	na
Battery Voltage	na
Rated Size	na
Sound Attenuation	na
Fuel Capacity	na
Run Timer per Tank	na
Automatic Transfer Switch	na
Manufacturer	na
Model	na
Phase	na
Voltage	na
Rated Amperage	na
Mobile Generator Receptacle	No

2013 Sewer Pump Station Inventory

Highway South Sewage Pump Station No. 3 400 Harborview Drive

GENERAL INFORMATION	
Previous Name	Highway South Pump station No. 8
Configuration	Package type drywell/wet well station
Year Commissioned	1979
Developer / City	City
Designer	Herb Armstrong, Roats Engineering
Contractor	
Year Upgraded	2008
Designer	Larry Amans, BHC Engineering
Contractor	Garry Harper Construction

DRYWELL	
Material of Construction	Metal
Condition	Good
Diameter	11 ft
Height	8 ft
Top hatch rim to ground level	1 ft
Top hatch rim to ceiling	20 ft
Top hatch rim to floor	28 ft - 4 in

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	8 ft
Overflow pipe	No
Overflow location	Will back up into elevator shaft of Eagle Harbor Condominiums.
Bubbler air flow setting	na

WET WELL SETTINGS (Draft info only - to be updated)			
	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	na
Floor to low level off		na	
Floor to lead pump start		na	
Floor to lag pump start		na	
Floor to RTU high wet well alarm		na	
Floor to 1st float high alarm		na	
Floor to 2nd float high-high alarm		na	
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim		na	

2013 Sewer Pump Station Inventory

Highway South Sewage Pump Station No. 3

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	PLC
Disconnect Switch Location	
Amperage	
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Seimens
Model	Tristar
Fuse Inventory	
Location	
Purpose	
Size	

LEVEL CONTROLS	
Bubbler Controls	No
Compressor Make	
Manufacturer	
Model	
Float Controls	Yes
Manufacturer	Anchor Scientific, Roto-float
Model	
Number of Floats	Two - #1 high float is a timed pump down sequence
Purpose	- #2 high-high float cycles between high-high and high floats
Pressure Transducer	Yes provides primary level control
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	PLC controlled
Manufacturer	
Model	
Secondary Transformer	
Manufacturer	
Style	
Catalog No	
Primary/Secondary	
KVA	
Phase	
Cathodic Protection	Yes

2013 Sewer Pump Station Inventory

Highway South Sewage Pump Station No. 3

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Siemens	Siemens	na
Size			
Catalog Number			
Coil Voltage			
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Baldor	Baldor	Baldor
Constant / Variable	Constant	Constant	
Model			
Frame	15044112.81	15043912.50	15043812.50
Phase	3 phase	3 phase	3 phase
Horsepower	25 hp	25 hp	25 hp
Voltage	480	480	480
Speed, rpm	1200 rpm	1200 rpm	1200 rpm
Rated Amperage	30.5	30.5	30.5
Running Amperage			

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, close coupled, end suction centrifugal		
Manufacturer	Cornell	Cornell	Cornell
Model	6NNHTA-VM-25-6	6NNHTA-VM-25-6	6NNHTA-VM-25-6
Serial	Z0709251776	Z0709251786	Z0709251781
Impeller size	12.75 in	12.75 in	12.75 in
Inlet Size	8 in	8 in	8 in
Discharge Size	6 in	6 in	6 in
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	43 ft	43 ft	43 ft
Static Head	44 ft	44 ft	44 ft
Pumping Head			
Dead Head			
Test Date			
Design Flow	1360 gpm	1360 gpm	1360 gpm
Test flow 1 pump			
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Highway South Sewage Pump Station No. 3

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	8 in	8 in	8 in
Type	Gate	Gate	Gate
Manufacturer			
Model			
Connection	8 bolt flange	8 bolt flange	8 bolt flange
Discharge Valve Size	6 in	6 in	6 in
Type	Gate	Gate	Gate
Manufacturer			
Model			
Connection	8 bolt flange	8 bolt flange	8 bolt flange
Check Valve Size	6 in	6 in	6 in
Type			
Manufacturer	Kennedy	Kennedy	Kennedy
Model			
Connection	8 bolt flange	8 bolt flange	8 bolt flange

FORCE MAIN		
Type	Discharge	Incoming
Size	12 in	
Material	DI	
Length	3,000 ft	
Pig Station	Yes	

SUMP PUMP	
Manufacturer	
Model	
Capacity	
Voltage	
Horsepower	
Discharge Pipe Size	1-1/4 in
Sump Diameter	20 in

EXHAUST FAN / ODOR CONTROL BLOWER	
Type	Exhaust fan Fan operates on hatch micro switch
Manufacturer	Dayton
Model	4C447
Capacity cfm	
Voltage	120 volts
Horsepower	1/20 hp
RPM	1.86 -1.95 amps

2013 Sewer Pump Station Inventory

Highway South Sewage Pump Station No. 3

DEHUMIDIFIER	
Manufacturer	Frigidaire
Model	na

TELEMETRY			
Type	Monitoring and control		
Power Meter Number	Z008290549		
US West Circuit ID Number	4.UCXX-15061		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	Yes
Compressor Fail	No	Smoke	Yes
Pump Fail	Yes	Flood	No
High Wet Well	Yes	Operator in Trouble	Yes
Additional monitoring capabilities available at this station			

EMERGENCY GENERATOR	
Inventory Number	156
Year Installed	2006
New or Used	New
Year Rebuilt	na
Manufacturer	Katolight gen set, John Deere motor, Katolight generator
Model	
Serial	
Fuel	Diesel
Cylinders	
Displacement	
Battery Voltage	
Rated Size	100 kw
Sound Attenuation	Yes
Fuel Capacity	
Run Timer per Tank	24
Automatic Transfer Switch	Yes
Manufacturer	
Model	
Phase	
Voltage	
Rated Amperage	
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Sunday Cove Sewage Pump Station No. 4 691 Winslow Way West

GENERAL INFORMATION	
Previous Name	Sunday Cove Sewage Pump Station No. 2
Configuration	Package type drywell/wet well station
Year Commissioned	1979
Developer / City	City
Designer	Herb Armstrong, Roats Engineering
Contractor	
Year Upgraded	2007
Designer	Larry Amans, BHC Engineering
Contractor	Northern Con Ag

DRYWELL	
Material of Construction	Metal
Condition	Good
Diameter	7 ft - 11 in
Height	
Top hatch rim to ground level	2 in
Top hatch rim to ceiling	7 ft - 6 in
Top hatch rim to floor	14 ft - 6 in

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	6 ft Second 8 ft diam wet well MH added in 2008
Overflow pipe	No
Overflow location	Will back up and overflow from Leslie Landing beach MH
Bubbler air flow setting	na

WET WELL SETTINGS (Draft info only - to be updated)			
	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	2.2 ft	na	2.2 ft
Floor to low level off	2.4 ft	na	2.5 ft
Floor to lead pump start	4.5 ft	na	4.5 ft
Floor to lag pump start	4.7 ft	na	4.7 ft
Floor to RTU high wet well alarm	4.8 ft	na	4.8 ft
Floor to 1st float high alarm	5.0 ft	na	5.0 ft
Floor to 2nd float high-high alarm	5.3 ft	na	5.3 ft
Floor to lowest invert pipe	5.0 ft	na	5.0 ft
Floor to ground level manhole rim	14.0 ft	na	14.0 ft

2013 Sewer Pump Station Inventory

Sunday Cove Sewage Pump Station No. 4

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	PLC
Disconnect Switch Location	
Amperage	
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Seimens
Model	Tristar
Fuse Inventory	
Location	
Purpose	
Size	

LEVEL CONTROLS	
Bubbler Controls	No
Compressor Make	
Manufacturer	
Model	
Float Controls	Yes
Manufacturer	Anchor Scientific, Roto-float
Model	
Number of Floats	Two - #1 high float is a timed pump down sequence
Purpose	- #2 high-high float cycles between high-high and high floats
Pressure Transducer	Yes provides primary level control
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	PLC controlled
Manufacturer	
Model	
Secondary Transformer	
Manufacturer	
Style	
Catalog No	
Primary/Secondary	
KVA	
Phase	
Cathodic Protection	Yes

2013 Sewer Pump Station Inventory

Sunday Cove Sewage Pump Station No. 4

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Siemens	Siemens	na
Size			
Catalog Number			
Coil Voltage			
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	US Electric	US Electric	
Constant / Variable	Constant	Constant	
Model	I9701217-046	I9701217-046	
Frame	284 JMB	284 JMB	
Phase	3 phase	3 phase	
Horsepower	25 hp	25 hp	
Voltage	480	480	
Speed, rpm	1760 rpm	1760 rpm	
Rated Amperage	62 / 31 amps	62 / 31 amps	
Running Amperage	31.2	33.9	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, close coupled, end suction centrifugal		na
Manufacturer	Crane Deming	Crane Deming	
Model	7182-4066-1472	7182-4066-1472	
Serial	DP-757097	DP-757098	
Impeller size			
Inlet Size	4 in	4 in	
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	117 ft	42 ft	
Static Head	58 ft	44 psi	
Pumping Head	113 ft	113 ft	
Dead Head	150 ft	116 ft	
Test Date	9/3/04	9/3/04	
Design Flow	490 gpm	490 gpm	
Test flow 1 pump	428 gpm	424 gpm	
Test flow 2 pumps	511 gpm	511 gpm	

2013 Sewer Pump Station Inventory

Sunday Cove Sewage Pump Station No. 4

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	4 in	4 in	
Type	Gate	Gate	
Manufacturer			
Model			
Connection	8 bolt flange	8 bolt flange	
Discharge Valve Size	4 in	4 in	
Type	Gate	Gate	
Manufacturer			
Model			
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type			
Manufacturer			
Model			
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN		
Type	Discharge	Incoming
Size	6"	
Material	DI	
Length	1,200 ft	
Pig Station	Yes	

SUMP PUMP	
Manufacturer	Zoller
Model	
Capacity	120 volts
Voltage	
Horsepower	
Discharge Pipe Size	1-1/4 in
Sump Diameter	20 in

EXHAUST FAN / ODOR CONTROL BLOWER		
Type	Exhaust fan	Fan operates on hatch micro switch
Manufacturer	Dayton	
Model	4C447	
Capacity cfm		
Voltage	120 volts	
Horsepower	1/20 hp	
RPM	1.86 -1.95 amps	

2013 Sewer Pump Station Inventory

Sunday Cove Sewage Pump Station No. 4

DEHUMIDIFIER	
Manufacturer	Whirlpool
Model	25

TELEMETRY			
Type	Monitoring and control		
Power Meter Number	Z006621147		
US West Circuit ID Number	4.UCXX-15035		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	Yes
Compressor Fail	No	Smoke	Yes
Pump Fail	Yes	Flood	No
High Wet Well	Yes	Operator in Trouble	Yes
Additional monitoring capabilities available at this station			

EMERGENCY GENERATOR	
Inventory Number	152
Year Installed	1997
New or Used	New
Year Rebuilt	na
Manufacturer	Northern Lights gen set, John Deere motor
Model	
Serial	
Fuel	Diesel
Cylinders	4
Displacement	3.9
Battery Voltage	12
Rated Size	55 kw
Sound Attenuation	Yes
Fuel Capacity	84
Run Timer per Tank	24
Automatic Transfer Switch	Yes
Manufacturer	ASCO
Model	
Phase	
Voltage	
Rated Amperage	
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Village Sewage Pump Station No. 5 920 Hildebrand

GENERAL INFORMATION	
Previous Name	Highway North, Pump station No. 2
Configuration	Package type drywell/wet well station
Year Commissioned	1979
Developer / City	City
Designer	Herb Armstrong, Roats Engineering
Contractor	
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	Metal
Condition	Fair
Diameter	8 ft
Depth	
Top hatch rim to ground level	12 in
Top hatch rim to ceiling	7 ft - 9 in
Top hatch rim to floor	14 ft - 9 in

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	6 ft
Overflow pipe	No
Overflow location	Will overflow out of wet well manhole
Bubbler air flow setting	1.2 cfm

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	na
Floor to low level off	33 in	21 in	na
Floor to lead pump start	59 in	46 in	na
Floor to lag pump start	67 in	55 in	na
Floor to high level alarm	77 in	65 in	na
Floor to back up float / high alarm #2	77 in	65 in	na
Floor to lowest invert pipe	69 in	57 in	na
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim	12 ft - 6 in		na

2013 Sewer Pump Station Inventory

Village Sewage Pump Station No. 5

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	Relay
Disconnect Switch Location	Above ground near hatch at main service location
Amperage	100 amp
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Chemithon Corp, October 1977
Model	
Fuse Inventory	
Location	Main disconnect
Purpose	Main power
Size	100 amp / 600 volt (3 ea)

LEVEL CONTROLS	
Bubbler Controls	Yes, provides primary level control
Compressor Make	Thomas
Manufacturer	LGH-106
Model	
Float Controls	Yes
Manufacturer	
Model	
Number of Floats	One
Purpose	Provides second high level alarm and timed pump down sequence
Pressure Transducer	No
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	SSAC
Model	ARP-435
Secondary Transformer	
Manufacturer	Acme
Style	General purpose
Catalog No	T-1-53013
Primary/Secondary	480 / 240 / 120
KVA	3 kva
Phase	Single phase
Cathodic Protection	Yes

2013 Sewer Pump Station Inventory

Village Sewage Pump Station No. 5

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Furnas	Furnas	na
Size	2	2	
Catalog Number	14PS32A	14PS32A	
Coil Voltage	120	120	
Phase	3	3	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	US Electric	US Electric	na
Constant / Variable	Constant	Constant	
Model			
Frame	256 JMV	256 JMV	
Phase	3 phase	3 phase	
Horsepower	20 hp	20 hp	
Voltage	480 volts	480 volts	
Speed, rpm	1750 rpm	1750 rpm	
Rated Amperage	54 / 27 amps	54 / 27 amps	
Running Amperage	20.4 amps	20.4 amps	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, close coupled, end suction centrifugal		na
Manufacturer	Crane Deming	Crane Deming	
Model	7182-40561374	7182-40561372	
Serial	DP-757092	DP-757093	
Impeller size			
Inlet Size	4 in	4 in	
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	53 ft	53 ft	na
Static Head	28 ft	28 ft	
Pumping Head	51 ft	51 ft	
Dead Head	88 ft	88 ft	
Test Date	6/1/04	6/1/04	
Design Flow	765 gpm	765 gpm	
Test flow 1 pump	538 gpm	538 gpm	
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Village Sewage Pump Station No. 5

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	4 in	4 in	na
Type	Plug	Plug	
Manufacturer	Homestead	Homestead	
Model			
Connection	8 bolt flange	8 bolt flange	
Discharge Valve Size	4 in	4 in	
Type	Plug	Plug	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type	Swing	Swing	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN			
Type	Discharge		Incoming
Size	10 in	8 in	
Material	DI	PVC	
Length	20 ft	2630 ft	
Pig Station	No	No	

SUMP PUMP	
Manufacturer	Zoller
Model	
Capacity	
Voltage	120 volts
Horsepower	
Discharge Pipe Size	1-1/4 in
Sump Diameter	20 in

EXHAUST FAN / ODOR CONTROL BLOWER		
Type	Exhaust fan	Fan operates on hatch micro switch
Manufacturer	Dayton	
Model	4C447	
Capacity cfm		
Voltage	121 volts	
Horsepower	1/20 hp	
RPM		

2013 Sewer Pump Station Inventory

Village Sewage Pump Station No. 5

DEHUMIDIFIER	
Manufacturer	Frigidaire
Model	

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Z063286359		
US West Circuit ID Number	4.UCXX-15032		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	Yes
Compressor Fail	Yes	Smoke	Yes
Pump Fail	Yes	Flood	Yes
High Wet Well	Yes	Operator in Trouble	Yes

EMERGENCY GENERATOR	
Inventory Number	150
Year Installed	2007
New or Used	New
Year Rebuilt	na
Manufacturer	Katolight gen set, John Deere motor, Katolight generator
Model	
Serial	
Fuel	Diesel
Cylinders	
Displacement	
Battery Voltage	12 volts
Rated Size	100 kw
Sound Attenuation	Yes
Fuel Capacity	100 gal
Run Timer per Tank	24 hrs
Automatic Transfer Switch	Yes
Manufacturer	
Model	
Phase	3 phase
Voltage	480 volts
Rated Amperage	104 amps
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Lower Lovell Sewage Pump Station No. 6 4216 Lovell Avenue

GENERAL INFORMATION	
Previous Name	Pump station No. 6
Configuration	Package type drywell/wet well station
Year Commissioned	1979
Developer / City	City
Designer	Herb Armstrong, Roats Engineering
Contractor	
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	Metal
Condition	Fair
Diameter	7 ft - 11 in
Depth	
Top hatch rim to ground level	Flush with ground
Top hatch rim to ceiling	10 ft - 4 in
Top hatch rim to floor	17 ft - 3 in

WET WELL	
Material of Construction	Concrete
Condition	Fair, some signs of salt water intrusion
Diameter	4 ft
Overflow pipe	No
Overflow location	Will overflow out Stetsen and Wood beach manhole
Bubbler air flow setting	1.1 cfm

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	na
Floor to low level off	22 in	20 in	na
Floor to lead pump start	32 in	30 in	na
Floor to lag pump start	50 in	48 in	na
Floor to high level alarm	67 in	65 in	na
Floor to back up float / high alarm #2	57 in	55 in	na
Floor to lowest invert pipe	44 in	42 in	na
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim	17 ft - 3 in	na	na

2013 Sewer Pump Station Inventory

Lower Lovell Sewage Pump Station No. 6

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	Relay
Disconnect Switch Location	Above ground at main service location by generator
Amperage	60 amp
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Chemithon Corp, October 1977
Model	DP82R
Fuse Inventory	
Location	Main disconnect
Purpose	Main power
Size	60 amp / 600 volt (3 ea)

LEVEL CONTROLS	
Bubbler Controls	Yes, provides primary level control
Compressor Make	Thomas
Manufacturer	LGH-106
Model	
Float Controls	Yes
Manufacturer	
Model	
Number of Floats	One
Purpose	Provides second high level alarm and timed pump down sequence
Pressure Transducer	No
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	SSAC
Model	ARP-435
Secondary Transformer	
Manufacturer	Acme
Style	General purpose
Catalog No	T-1-53013
Primary/Secondary	480 / 240 / 120
KVA	3 kva
Phase	3 phase
Cathodic Protection	Yes

2013 Sewer Pump Station Inventory

Lower Lovell Sewage Pump Station No. 6

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Furnas	Furnas	na
Size	2	2	
Catalog Number	14FS-32A	14FS-32A	
Coil Voltage	120 volts	120 volts	
Phase	Single	Single	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	US Electric	US Electric	na
Constant / Variable	Constant	Constant	
Model	S213JMV	213JMV	
Frame	FR	FR	
Phase	3 phase	3 phase	
Horsepower	7.5 hp	7.5 hp	
Voltage	480 volts	480 volts	
Speed, rpm	1740 rpm	1740 rpm	
Rated Amperage	21.6 / 11.5 amps	21.6 / 11.5 amps	
Running Amperage	11.2 amps	11.2 amps	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, close coupled, end suction centrifugal		na
Manufacturer	Crane Deming	Crane Deming	
Model	7182-4056-199	7182-4056-199	
Serial	DP-756859	DP-756860	
Impeller size			
Inlet Size	4 in	4 in	
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	61 ft	61 ft	na
Static Head	58 ft	58 ft	
Pumping Head	65 ft	65 ft	
Dead Head			
Test Date	6/1/04	6/1/04	
Design Flow	100 gpm	100 gpm	
Test flow 1 pump	104 gpm	104 gpm	
Test flow 2 pumps	107 gpm	107 gpm	

2013 Sewer Pump Station Inventory

Lower Lovell Sewage Pump Station No. 6

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	4 in	4 in	na
Type	Plug	Plug	
Manufacturer	Kennedy	Kennedy	
Model	1522	1522	
Connection	8 bolt flange	8 bolt flange	
Discharge Valve Size	4 in	4 in	
Type	Gate	Gate	
Manufacturer	Kennedy	Kennedy	
Model	AU7612	AU7612	
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type	Swing	Swing	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN			
Type	Discharge		Incoming
Size	4 in	4 in	
Material	DI	PVC	
Length	19 ft	656 ft	
Pig Station	No		

SUMP PUMP	
Manufacturer	Zoller
Model	
Capacity	
Voltage	120 volts
Horsepower	
Discharge Pipe Size	1-1/4 in
Sump Diameter	24 in

EXHAUST FAN / ODOR CONTROL BLOWER		
Type	Exhaust fan	Fan operates on hatch micro switch
Manufacturer	Dayton	
Model	4C447	
Capacity cfm		
Voltage	121 volts	
Horsepower	1/20 hp	
RPM		

2013 Sewer Pump Station Inventory

Lower Lovell Sewage Pump Station No. 6

DEHUMIDIFIER	
Manufacturer	Whirlpool
Model	25

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Z2004240517		
US West Circuit ID Number	4.UCXX-15036		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	Yes
Compressor Fail	Yes	Smoke	Yes
Pump Fail	Yes	Flood	Yes
High Wet Well	Yes	Operator in Trouble	Yes

EMERGENCY GENERATOR	
Inventory Number	143
Year Installed	1998
New or Used	New
Year Rebuilt	2003, partial overhaul after being struck by auto
Manufacturer	Yanmar motor, Northern Lights generator
Model	NL488.15
Serial	4883-20295
Fuel	Diesel
Cylinders	4 cyl
Displacement	
Battery Voltage	12 volts
Rated Size	20 kw
Sound Attenuation	Yes
Fuel Capacity	42 gal
Run Timer per Tank	24 hrs
Automatic Transfer Switch	Yes
Manufacturer	ASCO
Model	Series 300
Phase	3 phase
Voltage	480 volts
Rated Amperage	104 amps
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Lower Hawley Sewage Pump Station No. 7 1195 Irene Place

GENERAL INFORMATION	
Previous Name	Pump station No. 4
Configuration	Package type drywell/wet well station
Year Commissioned	1979
Developer / City	City
Designer	Herb Armstrong, Roats Engineering
Contractor	
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	Metal
Condition	Good
Diameter	8 ft
Depth	
Top hatch rim to ground level	3 ft
Top hatch rim to ceiling	7 ft
Top hatch rim to floor	14 ft

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	4 ft
Overflow pipe	No
Overflow location	Will overflow out of manhole on east end of Irene
Bubbler air flow setting	1.2 cfm

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	na
Floor to low level off	25 in	20 in	na
Floor to lead pump start	36 in	30 in	na
Floor to lag pump start	50 in	45 in	na
Floor to high level alarm	60 in	55 in	na
Floor to back up float / high alarm #2	75 in	70 in	na
Floor to lowest invert pipe	65 in	60 in	na
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim	14 ft - 3 in		na

2013 Sewer Pump Station Inventory

Lower Hawley Sewage Pump Station No. 7

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	Relay
Disconnect Switch Location	Above ground at main service location by generator
Amperage	100 amp
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Chemithon Corp, October 1977
Model	DP82R
Fuse Inventory	
Location	Main disconnect
Purpose	Main power
Size	70 amp / 600 volt (3 ea)

LEVEL CONTROLS	
Bubbler Controls	Yes, provides primary level control
Compressor Make	Thomas
Manufacturer	LGH-106
Model	
Float Controls	Yes
Manufacturer	
Model	
Number of Floats	One
Purpose	Provides second high level alarm and timed pump down sequence
Pressure Transducer	No
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	SSAC
Model	ARP-435
Secondary Transformer	
Manufacturer	Acme
Style	General purpose
Catalog No	T-1-53013
Primary/Secondary	480 / 240 / 120
KVA	3 kva
Phase	Single phase
Cathodic Protection	Yes

2013 Sewer Pump Station Inventory

Lower Hawley Sewage Pump Station No. 7

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Siemens	Siemens	na
Size	1	1	
Catalog Number	14CS-32A	14CS-32A	
Coil Voltage	120	120	
Phase	3	3	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	US Motor	US Motor	na
Constant / Variable	Constant	Constant	
Model			
Frame	67-09205-158	67-09205-158	
Phase	3 phase	3 phase	
Horsepower	3 hp	3 hp	
Voltage	480 volts	480 volts	
Speed, rpm	1740 rpm	1740 rpm	
Rated Amperage	8.7 / 4.4 amps	8.7 / 4.4 amps	
Running Amperage	4.0 amps	4.0 amps	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, close coupled, end suction centrifugal		na
Manufacturer	Crane Deming	Crane Deming	
Model	7181-40360872	7181-40360874	
Serial			
Impeller size			
Inlet Size	4 in	4 in	
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	30 ft	30 ft	na
Static Head	18 ft	18 ft	
Pumping Head	37 ft	37 ft	
Dead Head	42 ft	42 ft	
Test Date	6/1/04	6/1/04	
Design Flow	100 gpm	100 gpm	
Test flow 1 pump	121 gpm	121 gpm	
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Lower Hawley Sewage Pump Station No. 7

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	4 in	4 in	na
Type	Plug	Plug	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	
Discharge Valve Size	4 in	4 in	
Type	Gate	Gate	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type	Swing	Swing	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN		
Type	Discharge	Incoming
Size	4 in	
Material	DI	
Length	275 ft	
Pig Station	No	

SUMP PUMP	
Manufacturer	Zoller
Model	
Capacity	
Voltage	120 volts
Horsepower	
Discharge Pipe Size	1-1/4 in
Sump Diameter	19 in

EXHAUST FAN / ODOR CONTROL BLOWER		
Type	Exhaust fan	Fan operates on hatch micro switch
Manufacturer	Dayton	
Model	4C447	
Capacity cfm		
Voltage	120 volts	
Horsepower	1/20 hp	
RPM		

2013 Sewer Pump Station Inventory

Lower Hawley Sewage Pump Station No. 7

DEHUMIDIFIER	
Manufacturer	Whirlpool
Model	25

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Z035416665		
US West Circuit ID Number	4.UCXX-15034		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	Yes
Compressor Fail	Yes	Smoke	Yes
Pump Fail	Yes	Flood	Yes
High Wet Well	Yes	Operator in Trouble	Yes

EMERGENCY GENERATOR	
Inventory Number	142
Year Installed	1996
New or Used	New
Year Rebuilt	na
Manufacturer	Yanmar motor, Northern Lights generator
Model	NL378
Serial	3783-15917
Fuel	Diesel
Cylinders	3 cyl
Displacement	1.2 liter
Battery Voltage	12 volts
Rated Size	10 kw
Sound Attenuation	Yes
Fuel Capacity	40 gal
Run Timer per Tank	24 hrs
Automatic Transfer Switch	Yes
Manufacturer	ASCO
Model	Series 300
Phase	3 phase
Voltage	480 volts
Rated Amperage	104 amps
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Wing Point Sewage Pump Station No. 8 6481 Wing Point Drive

GENERAL INFORMATION	
Previous Name	Pump station No. 7
Configuration	Package type drywell/wet well station
Year Commissioned	1979
Developer / City	City
Designer	Herb Armstrong, Roats Engineering
Contractor	
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	Metal
Condition	Fair
Diameter	7 ft - 5 in
Depth	
Top hatch rim to ground level	10 in
Top hatch rim to ceiling	7 ft - 5 in
Top hatch rim to floor	14 ft

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	4 ft
Overflow pipe	No
Overflow location	Will overflow out of beach manhole east of station
Bubbler air flow setting	1.2 cfm

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	na
Floor to low level off	34 in	20 in	na
Floor to lead pump start	52 in	35 in	na
Floor to lag pump start	56 in	40 in	na
Floor to high level alarm	66 in	50 in	na
Floor to back up float / high alarm #2	67 in	51 in	na
Floor to lowest invert pipe	62 in	46 in	na
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim	12 ft - 6 in		na

2013 Sewer Pump Station Inventory

Wing Point Sewage Pump Station No. 8

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	Relay
Disconnect Switch Location	Above ground at main service location by generator
Amperage	100 amp
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Chemithon Corp, October 1977
Model	DP82R, Serial 6C2343, Oct 1977
Fuse Inventory	
Location	Main disconnect
Purpose	Main power
Size	60 amp / 600 volt (3 ea)

LEVEL CONTROLS	
Bubbler Controls	Yes, provides primary level control
Compressor Make	Thomas
Manufacturer	LGH-106
Model	
Float Controls	Yes
Manufacturer	
Model	
Number of Floats	One
Purpose	Provides second high level alarm and timed pump down sequence
Pressure Transducer	No
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	SSAC
Model	ARP-435
Secondary Transformer	
Manufacturer	Acme
Style	General purpose
Catalog No	T-1-53013
Primary/Secondary	480 / 240 / 120
KVA	3 kva
Phase	Single phase
Cathodic Protection	Yes

2013 Sewer Pump Station Inventory

Wing Point Sewage Pump Station No. 8

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Furnas	Furnas	na
Size	1	1	
Catalog Number	14DS-32A	14DS-32A	
Coil Voltage	120 volts	120 volts	
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Gould	Gould	na
Constant / Variable	Constant	Constant	
Model			
Frame	S184JM	S184JM	
Phase	3 phase	3 phase	
Horsepower	5 HP	5 HP	
Voltage	480 volts	480 volts	
Speed, rpm	1750 rpm	1750 rpm	
Rated Amperage	14.4 / 7.2 amps	14.4 / 7.2 amps	
Running Amperage	7.0 amps	7.1 amps	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, close coupled, end suction centrifugal		na
Manufacturer	Crane Deming	Crane Deming	
Model	DP-757094	DP-757095	
Serial	718140360971	718140360971	
Impeller size			
Inlet Size	4 in	4 in	
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	40 ft	40 ft	na
Static Head	25 ft	25 ft	
Pumping Head	39 ft	39 ft	
Dead Head			
Test Date	6/1/04	6/1/04	
Design Flow	200 gpm	200 gpm	
Test flow 1 pump	209 gpm	209 gpm	
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Wing Point Sewage Pump Station No. 8

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	4 in	4 in	na
Type	Plug	Plug	
Manufacturer	Homestead	Homestead	
Model	1946Y	1946Y	
Connection	8 bolt flange	8 bolt flange	
Discharge Valve Size	4 in	4 in	
Type	Plug	Plug	
Manufacturer	Kennedy	Kennedy	
Model	10240	10240	
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type	Swing	Swing	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN		
Type	Discharge	Incoming
Size	6 in	
Material	DI	
Length	4007 ft	
Pig Station	No	

SUMP PUMP	
Manufacturer	Zoller
Model	
Capacity	
Voltage	120 volts
Horsepower	
Discharge Pipe Size	1-1/4 in
Sump Diameter	24 in

EXHAUST FAN / ODOR CONTROL BLOWER		
Type	Exhaust fan	Fan operates on hatch micro switch
Manufacturer	Dayton	
Model	4C447	
Capacity cfm		
Voltage	121 volts	
Horsepower	1/20 hp	
RPM		

2013 Sewer Pump Station Inventory

Wing Point Sewage Pump Station No. 8

DEHUMIDIFIER	
Manufacturer	Whirlpool
Model	25

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Z004240486		
US West Circuit ID Number	4.UCXX-15037		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	Yes
Compressor Fail	Yes	Smoke	Yes
Pump Fail	Yes	Flood	Yes
High Wet Well	Yes	Operator in Trouble	Yes

EMERGENCY GENERATOR	
Inventory Number	141
Year Installed	1995 Partially rebuilt in 2006
New or Used	New
Year Rebuilt	2006
Manufacturer	Lugger motor, Northern Lights generator
Model	NL 843
Serial	8433-12825
Fuel	Diesel
Cylinders	4 cyl
Displacement	1 liter
Battery Voltage	12 volts
Rated Size	12 kw
Sound Attenuation	Yes
Fuel Capacity	40 gal
Run Timer per Tank	24 hours
Automatic Transfer Switch	Yes
Manufacturer	ASCO
Model	
Phase	3 phase
Voltage	480 volts
Rated Amperage	70 amps
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Island Terrace Sewage Pump Station No. 9 1174 Ferncliff Avenue

GENERAL INFORMATION	
Previous Name	Pump Station No.9
Configuration	Package type drywell/wet well station
Year Commissioned	1983
Developer / City	Developer
Designer	
Contractor	
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	Concrete
Condition	Good
Diameter	8 ft -2 in long x 7 ft -7 in wide x 6 ft -10 in high
Depth	
Top hatch rim to ground level	Flush with ground
Top hatch rim to ceiling	5 ft - 2 in
Top hatch rim to floor	11 ft - 9 in

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	8 ft
Overflow pipe	Yes
Overflow location	4 in overflow pipe to east forest land
Bubbler air flow setting	1.2 cfm

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	na
Floor to low level off	29 in	22 in	na
Floor to lead pump start	39 in	30 in	na
Floor to lag pump start	46 in	38 in	na
Floor to high level alarm	64 in	56 in	na
Floor to back up float / high alarm #2	51 in	43 in	na
Floor to lowest invert pipe	58 in	50 in	na
Floor to overflow pipe	84 in	76 in	na
Floor to ground level manhole rim	138 in	na	na

2013 Sewer Pump Station Inventory

Island Terrace Sewage Pump Station No. 9

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	Relay
Disconnect Switch Location	Above ground near hatch at main service location
Amperage	60 amp
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Superior Custom Controls
Model	EC1159, 12/8/82
Fuse Inventory	
Location	Main disconnect
Purpose	Main power supply
Size	60 amp / 600 volt (3 ea)

LEVEL CONTROLS	
Bubbler Controls	Yes, provides primary level control
Compressor Make	ITT
Manufacturer	
Model	LGH-106-H02
Float Controls	Yes
Manufacturer	
Model	
Number of Floats	One
Purpose	Provides second high level alarm and timed pump down sequence
Pressure Transducer	No
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	SSAC
Model	ARP4355095
Secondary Transformer	
Manufacturer	Acme
Style	General Purpose
Catalog No	T-2-53014-S
Primary/Secondary	480 / 240 / 120
KVA	5 kva
Phase	Single
Cathodic Protection	None

2013 Sewer Pump Station Inventory

Island Terrace Sewage Pump Station No. 9

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Furnas	Furnas	na
Size	0	0	
Catalog Number	14CF32AA	14CF32AA	
Coil Voltage	120 volts	120 volts	
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	General Electric	General Electric	na
Constant / Variable	Constant	Constant	
Model	L213HPZ210	L213HPZ210	
Frame			
Phase	3 phase	3 phase	
Horsepower	3 HP	3 HP	
Voltage	480 volts	480 volts	
Speed, rpm	1160	1160	
Rated Amperage	10 / 5 amps	10 / 5 amps	
Running Amperage	4.5 amps	4.6 amps	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, close coupled, end suction centrifugal		na
Manufacturer	Cornell	Cornell	
Model	4NNT-VM-3-6	4NNT-VM-3-6	
Serial	37818,19	37818,19	
Impeller size	8 in	8 in	
Inlet Size	4 in	4 in	
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	26 ft	26 ft	na
Static Head	25 ft	25 ft	
Pumping Head	35 ft	35 ft	
Dead Head	42 ft	42 ft	
Test Date	6/1/04	6/1/04	
Design Flow	100 gpm	100 gpm	
Test flow 1 pump	122 gpm	122 gpm	
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Island Terrace Sewage Pump Station No. 9

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	4 in	4 in	na
Type	Gate	Gate	
Manufacturer	MH Dresser	MH Dresser	
Model			
Connection	8 bolt flange	8 bolt flange	
Discharge Valve Size	4 in	4 in	
Type	Gate	Gate	
Manufacturer	MH Dresser	MH Dresser	
Model			
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type	Swing	Swing	
Manufacturer	MH Dresser	MH Dresser	
Model			
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN		
Type	Discharge	Incoming
Size	4 in	
Material	PVC/DI	
Length	440 ft	
Pig Station	No	

SUMP PUMP	
Manufacturer	
Model	
Capacity	
Voltage	115 volts
Horsepower	
Discharge Pipe Size	1-1/4 in
Sump Diameter	24 in x 24 in square

EXHAUST FAN / ODOR CONTROL BLOWER		
Type	Exhaust fan	Fan operates on hatch micro switch
Manufacturer	Dayton	
Model	4CO13A	
Capacity cfm		
Voltage	121 volts	
Horsepower	1/20 hp	
RPM		

2013 Sewer Pump Station Inventory

Island Terrace Sewage Pump Station No. 9

DEHUMIDIFIER	
Manufacturer	Frigidaire
Model	

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Z004892654		
US West Circuit ID Number	4.UCXX-15039		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	Yes
Compressor Fail	Yes	Smoke	Yes
Pump Fail	Yes	Flood	Yes
High Wet Well	Yes	Operator in Trouble	Yes

EMERGENCY GENERATOR	
Inventory Number	148
Year Installed	2002
New or Used	New
Year Rebuilt	na
Manufacturer	Onan/Cummins gen set, Cummins motor, Onan generator
Model	35-DGGD
Serial	G020396816
Fuel	Diesel
Cylinders	4 cyl
Displacement	3.3 liter
Battery Voltage	12 volts
Rated Size	35 kw
Sound Attenuation	Yes
Fuel Capacity	100 gal
Run Timer per Tank	24 hour
Automatic Transfer Switch	Yes
Manufacturer	Cummins
Model	OTPCA5565221
Phase	3 phase
Voltage	480 volts
Rated Amperage	125 amps
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Klickitat Sewage Pump Station No. 10 692 Klickitat Place

GENERAL INFORMATION	
Previous Name	
Configuration	Package type drywell/wet well station
Year Commissioned	1993
Developer / City	Developer
Designer	
Contractor	
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	Metal
Condition	Good
Diameter	8 ft
Depth	
Top hatch rim to ground level	2 ft - 5 in
Top hatch rim to ceiling	10 ft - 1 in
Top hatch rim to floor	19 ft - 6 in

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	6 ft
Overflow pipe	No
Overflow location	Will overflow out manhole in front of station
Bubbler air flow setting	0.8 cfm

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	na
Floor to low level off	25 in	20 in	na
Floor to lead pump start	36 in	30 in	na
Floor to lag pump start	65 in	60 in	na
Floor to high level alarm			na
Floor to back up float / high alarm #2	64 in	59 in	na
Floor to lowest invert pipe	53 in	48 in	na
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim	17 ft - 11 in	na	na

2013 Sewer Pump Station Inventory

Klickitat Sewage Pump Station No. 10

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	Relay
Disconnect Switch Location	Above ground at main service entrance
Amperage	60 amp
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Cascade Ideal Punt Inc, Tacoma WA
Model	27040691
Fuse Inventory	
Location	Main disconnect
Purpose	Main power supply
Size	60 amp / 600 volt (3 ea)

LEVEL CONTROLS	
Bubbler Controls	Yes, provides primary level control
Compressor Make	Century Electric
Manufacturer	
Model	7-140970-20
Float Controls	Yes
Manufacturer	
Model	
Number of Floats	Two - #1 is second high alarm and timed pump down
Purpose	- #2 is redundant pump stop control and low alarm
Pressure Transducer	No
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	Timemark
Model	261-S
Secondary Transformer	
Manufacturer	Acme
Style	General Purpose
Catalog No	T-2-53014-4S
Primary/Secondary	480 / 240 / 120
KVA	5 KVA
Phase	Single
Cathodic Protection	Yes

2013 Sewer Pump Station Inventory

Klickitat Sewage Pump Station No. 10

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Siemens-Furnas	Siemens-Furnas	na
Size	1	1	
Catalog Number	ESP 100	ESP 100	
Coil Voltage	120 volts	120 volts	
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Marathon	Marathon	na
Constant / Variable	Constant	Constant	
Model	WF254TTDR8089APW	WF254TTDR8089APW	
Frame	254 TCUV	254 TCUV	
Phase	3 phase	3 phase	
Horsepower	7.5 hp	7.5 hp	
Voltage	480 volts	480 volts	
Speed, rpm	1155 rpm	1155 rpm	
Rated Amperage	22 / 11 amps	22 / 11 amps	
Running Amperage	7.5 amps	7.5 amps	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, close coupled, end suction centrifugal		na
Manufacturer	Cornell	Cornell	
Model	4NNTVM756-LH	4NNTVM756-RH	
Serial	69311-10-09	69311-10-09	
Impeller size			
Inlet Size	4 in	4 in	
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	49 ft	49 ft	na
Static Head	30 ft	30 ft	
Pumping Head	46 ft	46 ft	
Dead Head	55 ft	55 ft	
Test Date	9/3/04	9/3/04	
Design Flow	100 gpm	100 gpm	
Test flow 1 pump	144 gpm	144 gpm	
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Klickitat Sewage Pump Station No. 10

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	4 in	4 in	na
Type	Plug	Plug	
Manufacturer	Tyler, Dezurik	Tyler, Dezurik	
Model	9070594	9070594	
Connection	8 bolt flange	8 bolt flange	
Discharge Valve Size	4 in	4 in	
Type	Plug	Plug	
Manufacturer	Tyler, Dezurik	Tyler, Dezurik	
Model	9070594	9070594	
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type	Swing	Swing	
Manufacturer	M&H	M&H	
Model	17095	17065	
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN		
Type	Discharge	Incoming
Size	4 - 6 in	
Material	Unknown	
Length	200 ft	
Pig Station	No	

SUMP PUMP	
Manufacturer	ABS / Robusta
Model	351W/KS
Capacity	
Voltage	120 volts
Horsepower	1/2 hp
Discharge Pipe Size	1-1/4 in
Sump Diameter	18 in

EXHAUST FAN / ODOR CONTROL BLOWER		
Type	Exhaust fan	Fan operates on hatch micro switch
Manufacturer	Dayton	
Model	4C447	
Capacity cfm		
Voltage	121 volts	
Horsepower	1/20 hp	
RPM		

2013 Sewer Pump Station Inventory

Klickitat Sewage Pump Station No. 10

DEHUMIDIFIER	
Manufacturer	Westinghouse
Model	ED-258

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Z082039046		
US West Circuit ID Number	4.UCXX-15045		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	Yes
Power Failure	Yes	Intrusion	Yes
Compressor Fail	Yes	Smoke	Yes
Pump Fail	Yes	Flood	Yes
High Wet Well	Yes	Operator in Trouble	Yes

EMERGENCY GENERATOR	
Inventory Number	149
Year Installed	2003
New or Used	New
Year Rebuilt	na
Manufacturer	Onan/Cummins gen set, Cumins motor, Onan generator
Model	DGGD-5604059
Serial	D030491746
Fuel	Diesel
Cylinders	4 cyl
Displacement	3.3 liter
Battery Voltage	12 volts
Rated Size	35 kw
Sound Attenuation	Yes
Fuel Capacity	100 gal
Run Timer per Tank	24 hrs
Automatic Transfer Switch	Yes
Manufacturer	Cummins
Model	OTPCA-5604057
Phase	3 phase
Voltage	480 volts
Rated Amperage	125 amps
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Woodward School Sewage Pump Station No. 11 9125 NE Sportsman Club Road NE

GENERAL INFORMATION	
Previous Name	
Configuration	Wet well submersible
Year Commissioned	1996
Developer / City	Constructed by School District and turned over to city around 1997
Designer	
Contractor	Oien Construction
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	na
Condition	na
Diameter	na
Depth	na
Top hatch rim to ground level	na
Top hatch rim to ceiling	na
Top hatch rim to floor	na

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	6 ft
Overflow pipe	No
Overflow location	Will overflow out of manhole on top of wet well
Bubbler air flow setting	na

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	48 in	na	na
Floor to low level off	52 in	na	na
Floor to lead pump start	62 in	na	na
Floor to lag pump start	70 in	na	na
Floor to high level alarm	89 in	na	na
Floor to back up float / high alarm #2	na	na	na
Floor to lowest invert pipe	51 in	na	na
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim	14 ft - 10 in	na	na

2013 Sewer Pump Station Inventory

Woodward School Sewage Pump Station No. 11

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	Relay
Disconnect Switch Location	Inside the school basement 200 ft north of the wet well
Amperage	60 amps
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Elpack, (Everett WA)
Model	9311-1343-D100
Fuse Inventory	
Location	
Purpose	
Size	

LEVEL CONTROLS	
Bubbler Controls	No
Compressor Make	
Manufacturer	
Model	
Float Controls	Yes, provides primary level control
Manufacturer	
Model	
Number of Floats	Five
Purpose	Redundant off/alarm, normal off, lead start, lag start, and high level alarm
Pressure Transducer	No
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	Crouzet
Model	PRJ-110
Secondary Transformer	
Manufacturer	Square D
Style	General purpose
Catalog No	
Primary/Secondary	480 / 240 / 120
KVA	
Phase	
Cathodic Protection	na

2013 Sewer Pump Station Inventory

Woodward School Sewage Pump Station No. 11

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Westinghouse	Westinghouse	na
Size	2	2	
Catalog Number	6710C51G05	6710C51G05	
Coil Voltage	120 volts	120 volts	
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Reliance	Reliance	na
Constant / Variable	Constant	Constant	
Model	P2162704	P2162704	
Frame	X210TY	X210TY	
Phase	3 phase	3 phase	
Horsepower	15 hp	15 hp	
Voltage	480 volts	480 volts	
Speed, rpm	1755 rpm	1755 rpm	
Rated Amperage	42 / 21 amps	42 / 21 amps	
Running Amperage	19.2 amps	19.4 amps	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Submersible	Submersible	na
Manufacturer	Paco	Paco	
Model	58-49511-5822	58-49511-5822	
Serial	RJ94A00452018	RJ94A00452018	
Impeller size	9.4 in	9.4 in	
Inlet Size			
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	92 ft	92 ft	na
Static Head			
Pumping Head			Note: Status of stations
Dead Head			force main was
Test Date	6/1/04	6/1/04	contributing to common
Design Flow	68 gpm	68 gpm	unknown at time of
Test flow 1 pump	60 gpm	60 gpm	station pump tests
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Woodward School Sewage Pump Station No. 11

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	na	na	na
Type	na	na	
Manufacturer	na	na	
Model	na	na	
Connection	na	na	
Discharge Valve Size	6 in	6 in	
Type	PVC ball valve	PVC ball valve	
Manufacturer			
Model			
Connection	Compression	Compression	
Check Valve Size	6 in	6 in	
Type			
Manufacturer			
Model			
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN		
Type	Discharge	Incoming
Size	4 in	
Material	DI / HDPE	
Length	4000 ft	
Pig Station	No	

SUMP PUMP	
Manufacturer	na
Model	na
Capacity	na
Voltage	na
Horsepower	na
Discharge Pipe Size	na
Sump Diameter	na

EXHAUST FAN / ODOR CONTROL BLOWER	
Type	na
Manufacturer	na
Model	na
Capacity cfm	na
Voltage	na
Horsepower	na
RPM	na

2013 Sewer Pump Station Inventory

Woodward School Sewage Pump Station No. 11

DEHUMIDIFIER	
Manufacturer	na
Model	na

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Power fed from Woodward School		
US West Circuit ID Number	4.UCXX-15051		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	No
Compressor Fail	No	Smoke	No
Pump Fail	Yes	Flood	No
High Wet Well	Yes	Operator in Trouble	No

EMERGENCY GENERATOR	
Inventory Number	Station is powered from school facility generator
Year Installed	na
New or Used	na
Year Rebuilt	na
Manufacturer	na
Model	na
Serial	na
Fuel	na
Cylinders	na
Displacement	na
Battery Voltage	na
Rated Size	na
Sound Attenuation	na
Fuel Capacity	na
Run Timer per Tank	na
Automatic Transfer Switch	na
Manufacturer	na
Model	na
Phase	na
Voltage	na
Rated Amperage	na
Mobile Generator Receptacle	na

2013 Sewer Pump Station Inventory

Lynnwood Center Sewage Pump Station No. 12 4586 Point White Drive

GENERAL INFORMATION	
Previous Name	
Configuration	Package type drywell/wet well station
Year Commissioned	1999
Developer / City	Developer, Harley Unruh
Designer	Herbert Armstrong, ADA Engineering
Contractor	General - Lydel Construction, Mechanical - Correct Equipment
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	Concrete
Condition	Good
Diameter	9 ft
Depth	
Top hatch rim to ground level	Flush
Top hatch rim to ceiling	6 in
Top hatch rim to floor	15 ft - 2 in

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	8 ft
Overflow pipe	No
Overflow location	Will overflow out of wet well manhole
Bubbler air flow setting	na

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	
Floor to low level off	63 in	na	
Floor to lead pump start	87 in	na	60 in
Floor to lag pump start		na	65 in
Floor to high level alarm		na	108 in
Floor to back up float / high alarm #2	88 in	na	
Floor to lowest invert pipe	88 in	na	
Floor to overflow pipe	na	na	
Floor to ground level manhole rim	15 ft - 4 in	na	

2013 Sewer Pump Station Inventory

Lynnwood Center Sewage Pump Station No. 12

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	PLC
Disconnect Switch Location	Above ground at main service location by generator
Amperage	200 amp
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Consolidated Electric
Model	
Fuse Inventory	
Location	Main disconnect
Purpose	Main power
Size	200 amp / 600 volt (3 ea)

LEVEL CONTROLS	
Bubbler Controls	No
Compressor Make	
Manufacturer	
Model	
Float Controls	Yes
Manufacturer	
Model	
Number of Floats	Two - #1 high float is a timed pump down sequence
Purpose	- #2 high-high float cycles between high-high and high floats
Pressure Transducer	Yes
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	PLC controlled
Model	
Secondary Transformer	
Manufacturer	Square D, Power Panel
Style	General Purpose
Catalog No	7S1F
Primary/Secondary	480 / 240 / 120
KVA	7.5 kva
Phase	Single
Cathodic Protection	na

2013 Sewer Pump Station Inventory

Lynnwood Center Sewage Pump Station No. 12

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Furnas	Furnas	na
Size	3	3	
Catalog Number			
Coil Voltage	120 volts	120 volts	
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	US Motor	US Motor	na
Constant / Variable	Constant	Constant	
Model			
Frame	324 VP	324 VP	
Phase	3 phase	3 phase	
Horsepower	40 hp	40 hp	
Voltage	480 volts	480 volts	
Speed, rpm	1773 rpm	1773 rpm	
Rated Amperage	39.3 amps	39.3 amps	
Running Amperage	39.5 amps	40.6 amps	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, frame mounted, end suction, centrifugal		na
Manufacturer	Fairbanks Morse	Fairbanks Morse	
Model	5440, 2440	5440, 2440	
Serial	K461-078686-0	K461-078686-1	
Impeller size	13.25	13.25	
Inlet Size	6 in	6 in	
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	191 ft	191 ft	na
Static Head			
Pumping Head	295 ft	295 ft	
Dead Head			
Test Date	12/3/03	12/3/03	
Design Flow	182 gpm	182 gpm	
Test flow 1 pump	237 gpm	237 gpm	
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Lynnwood Center Sewage Pump Station No. 12

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	6 in	6 in	na
Type	Plug	Plug	
Manufacturer	Milliken	Milliken	
Model	Ser. 600	Ser. 600	
Connection	8 bolt flange	8 bolt flange	
Discharge Valve Size	4 in	4 in	
Type	Plug	Plug	
Manufacturer	Milliken	Milliken	
Model	Ser. 400	Ser. 400	
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type			
Manufacturer	Val-matic	Val-matic	
Model	504	504	
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN				
Type	Discharge		Incoming	
Size	6 in	6 in	2 in	3 in
Material	DI	C-900 PVC	HDPE	HDPE
Length	12200 ft	268 ft	3300 ft	6925 ft
Pig Station	No	No		

SUMP PUMP	
Manufacturer	Zoller
Model	
Capacity	
Voltage	120 volt
Horsepower	
Discharge Pipe Size	1-1/4 in
Sump Diameter	12 in

EXHAUST FAN / ODOR CONTROL BLOWER	
Type	Fan operates on hatch micro switch
Manufacturer	Cook
Model	10CV170
Capacity cfm	
Voltage	121 volts
Horsepower	1/6 hp
RPM	

2013 Sewer Pump Station Inventory

Lynnwood Center Sewage Pump Station No. 12

DEHUMIDIFIER	
Manufacturer	Whirlpool
Model	ADO-25

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Z002173748		
US West Circuit ID Number	4.UCXX-15015		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	Yes
Power Failure	Yes	Intrusion	Yes
Compressor Fail	No	Smoke	Yes
Pump Fail	Yes	Flood	Yes
High Wet Well	Yes	Operator in Trouble	Yes
Additional monitoring capabilities available at this station			

EMERGENCY GENERATOR	
Inventory Number	153
Year Installed	1997
New or Used	New, installed with station
Year Rebuilt	na
Manufacturer	Cummins/Onan gen set, Cummins motor, Onan generator
Model	6BTS.9
Serial	45566806
Fuel	Diesel
Cylinders	6 cyl
Displacement	5.9 liter
Battery Voltage	12 volts
Rated Size	100 kw
Sound Attenuation	Yes
Fuel Capacity	180 gal
Run Timer per Tank	24 hrs
Automatic Transfer Switch	Yes
Manufacturer	Onan/Cummins
Model	OT225
Phase	3 phase
Voltage	480 volts
Rated Amperage	225 amps
Mobile Generator Receptacle	No

2013 Sewer Pump Station Inventory

North Town Woods Sewage Pump Station No. 13 9673 North Town Loop

GENERAL INFORMATION	
Previous Name	
Configuration	Site built, dry well / wet well station
Year Commissioned	1999
Developer / City	Developer, Madison Avenue Development
Designer	Unknown
Contractor	Oien Construction
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	Concrete
Condition	Poor, not sealed, much ground water infiltration
Diameter	9 ft
Depth	
Top hatch rim to ground level	Flush
Top hatch rim to ceiling	1 ft
Top hatch rim to floor	11 ft

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	6 ft
Overflow pipe	No
Overflow location	Will overflow out of manhole to south in front of station
Bubbler air flow setting	na

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	24 in	na	24 in
Floor to low level off	29 in	na	30 in
Floor to lead pump start	48 in	na	48 in
Floor to lag pump start	na	na	na
Floor to high level alarm	76 in	na	76 in
Floor to back up float / high alarm #2	84 in	na	84 in
Floor to lowest invert pipe	42 in	na	42 in
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim	138 in	na	

2013 Sewer Pump Station Inventory

North Town Woods Sewage Pump Station No. 13

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	PLC
Disconnect Switch Location	Above ground at main service entrance
Amperage	
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Furnase
Model	
Fuse Inventory	
Location	
Purpose	
Size	

LEVEL CONTROLS	
Bubbler Controls	No
Compressor Make	
Manufacturer	
Model	
Float Controls	Yes
Manufacturer	
Model	
Number of Floats	One
Purpose	Provides second high level alarm and timed pump down sequence
Pressure Transducer	Yes, provides primary level control through PLC
Manufacturer	Druke
Model	PTX 1290
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	PLC controlled
Model	
Secondary Transformer	
Manufacturer	Hammond
Style	General Purpose
Catalog No	
Primary/Secondary	480 / 240 / 120
KVA	
Phase	Single
Cathodic Protection	No

2013 Sewer Pump Station Inventory

North Town Woods Sewage Pump Station No. 13

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Furnase	Furnase	na
Size	3	3	
Catalog Number	14HS-32A	14HS-32A	
Coil Voltage	120 volts	120 volts	
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	US Motor	US Motor	na
Constant / Variable	Constant	Constant	
Model	ID-C129813191301F	ID-C129813191300F	
Frame	286 VP	286 VP	
Phase	3 ph	3 ph	
Horsepower	30 hp	30 hp	
Voltage	480 volts	480 volts	
Speed, rpm	1760 rpm	1760 rpm	
Rated Amperage	37 amps	37 amps	
Running Amperage	23.5 amp / 17 kw	23.2 amp / 17 kw	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Vertical, frame mounted, end suction, centrifugal		na
Manufacturer	Fairbanks Morse	Fairbanks Morse	
Model	4-5445	4-5445	
Serial	66040	66040	
Impeller size	11.75	11.75	
Inlet Size	4 in	4 in	
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	160 ft	160 ft	na
Static Head	60 ft	60 ft	
Pumping Head	166 ft	166 ft	Note: Status of stations
Dead Head			force main was
Test Date	6/1/04	6/1/04	contributing to common
Design Flow	125 gpm	125 gpm	unknown at time of
Test flow 1 pump	106 gpm	105 gpm	station pump tests
Test flow 2 pumps	Not capable of two pump run		

2013 Sewer Pump Station Inventory

North Town Woods Sewage Pump Station No. 13

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	4 in	4 in	na
Type	Plug	Plug	
Manufacturer	Milliken	Milliken	
Model			
Connection	8 bolt flange	8 bolt flange	
Discharge Valve Size	4 in	4 in	
Type	Plug	Plug	
Manufacturer	Milliken	Milliken	
Model			
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type	Swing	Swing	
Manufacturer	Kennedy	Kennedy	
Model	11071	11071	
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN		
Type	Discharge	Incoming
Size	4 in	
Material	DI / HDPE	
Length	4000 ft	
Pig Station	No	

SUMP PUMP	
Manufacturer	Zoller
Model	
Capacity	
Voltage	120 volts
Horsepower	
Discharge Pipe Size	1-1/4 in
Sump Diameter	

EXHAUST FAN / ODOR CONTROL BLOWER		
Type	Exhaust fan	Fan operates on hatch micro switch
Manufacturer	Dayton	
Model	4C447	
Capacity cfm		
Voltage	121 volts	
Horsepower	1/20 hp	
RPM		

2013 Sewer Pump Station Inventory

North Town Woods Sewage Pump Station No. 13

DEHUMIDIFIER	
Manufacturer	None
Model	

TELEMETRY			
Type	PLC, monitoring only		
Power Meter Number	Z068129374		
US West Circuit ID Number	4.UCXX-15070		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	Yes
Power Failure	Yes	Intrusion	Yes
Compressor Fail	No	Smoke	Yes
Pump Fail	Yes	Flood	Yes
High Wet Well	Yes	Operator in Trouble	Yes
Additional monitoring capabilities available at this station			

EMERGENCY GENERATOR	
Inventory Number	147
Year Installed	1999
New or Used	New, installed with station
Year Rebuilt	na
Manufacturer	Onan/Cummins gen set, Cumins motor, Onan generator
Model	
Serial	
Fuel	Diesel
Cylinders	4 cyl
Displacement	3.3 liter
Battery Voltage	12 volts
Rated Size	35 kw
Sound Attenuation	Yes
Fuel Capacity	140 gal
Run Timer per Tank	24 hrs
Automatic Transfer Switch	Yes
Manufacturer	Seimens
Model	OTPCB-4483712
Phase	3 phase
Voltage	480 volts
Rated Amperage	225 amps
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Sakai Village Sewage Pump Station No. 14 1879 Sakai Village Loop NE

GENERAL INFORMATION	
Previous Name	
Configuration	Wet well submersible
Year Commissioned	2003
Developer / City	Developer, Doug Nelson
Designer	Pat Fuhrer, Map Ltd.
Contractor	Mechanical by Bob MacShane of HD Fowler
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	na
Condition	na
Diameter	na
Depth	na
Top hatch rim to ground level	na
Top hatch rim to ceiling	na
Top hatch rim to floor	na

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	6 ft
Overflow pipe	No
Overflow location	Will overflow out of manhole to east in front of station
Bubbler air flow setting	na

WET WELL SETTINGS (Draft info only - to be updated)			
Depth	Measured	Bubbler Gauge	PLC
Floor to low alarm / redundant off	10 in	na	na
Floor to low level off	16 in	na	na
Floor to lead pump start	38 in	na	na
Floor to lag pump start		na	na
Floor to high level alarm	57 in	na	na
Floor to back up float / high alarm #2	na	na	na
Floor to lowest invert pipe	68 in	na	na
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim	19 ft - 2 in	na	na

2013 Sewer Pump Station Inventory

Sakai Village Sewage Pump Station No. 14

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	Relay
Disconnect Switch Location	Outside on the side of the main control cabinet
Amperage	100 amp
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Superior Custom Controls
Model	
Fuse Inventory	
Location	
Purpose	
Size	

LEVEL CONTROLS	
Bubbler Controls	No
Compressor Make	
Manufacturer	
Model	
Float Controls	Yes, provides primary level control
Manufacturer	Anchor Scientific
Model	S30NO / S30NC
Number of Floats	Five
Purpose	Redundant off/alarm, normal off, lead start, lag start, and high alarm
Pressure Transducer	No
Manufacturer	
Model	
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	
Manufacturer	Furnas
Model	47AB10AF
Secondary Transformer	
Manufacturer	Acme
Style	General Purpose
Catalog No	T-2-53014-S
Primary/Secondary	480 / 240 / 120
KVA	5 kva
Phase	Single
Cathodic Protection	na

2013 Sewer Pump Station Inventory

Sakai Village Sewage Pump Station No. 14

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Siemens	Siemens	na
Size	1	1	
Catalog Number	14DSE32A	14DSE32A	
Coil Voltage	120 volts	120 volts	
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Hydromatic	Hydromatic	na
Constant / Variable	Constant	Constant	
Model	S4PX100	S4PX100	
Frame			
Phase	3 phase	3 phase	
Horsepower	10 hp	10 hp	
Voltage	480 volt	480 volt	
Speed, rpm	1750 rpm	1750 rpm	
Rated Amperage	14.7 amps	14.7 amps	
Running Amperage	10.3 new	10.1 new	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Submersible	Submersible	na
Manufacturer	Hydromatic	Hydromatic	
Model	S4PX100	S4PX100	
Serial			
Impeller size			
Inlet Size			
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	73 ft	73 ft	na
Static Head	16 ft	16 ft	
Pumping Head	53 ft	60 ft	Note: Status of stations
Dead Head	76 ft	76 ft	force main was
Test Date	6/1/04	6/1/04	contributing to common
Design Flow	150 gpm	150 gpm	unknown at time of
Test flow 1 pump	147 gpm	147 gpm	station pump tests
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Sakai Village Sewage Pump Station No. 14

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	na	na	na
Type	na	na	
Manufacturer	na	na	
Model	na	na	
Connection	na	na	
Discharge Valve Size	4 in	4 in	
Type	Gate	Gate	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	
Check Valve Size	4 in	4 in	
Type	Swing	Swing	
Manufacturer	Kennedy	Kennedy	
Model			
Connection	8 bolt flange	8 bolt flange	

FORCE MAIN		
Type	Discharge	Incoming
Size	4 in	
Material	Class 52 DI	
Length	565 ft	
Pig Station	Yes	

SUMP PUMP	
Manufacturer	na
Model	na
Capacity	na
Voltage	na
Horsepower	na
Discharge Pipe Size	na
Sump Diameter	na

EXHAUST FAN / ODOR CONTROL BLOWER	
Type	na
Manufacturer	na
Model	na
Capacity cfm	na
Voltage	na
Horsepower	na
RPM	na

2013 Sewer Pump Station Inventory

Sakai Village Sewage Pump Station No. 14

DEHUMIDIFIER	
Manufacturer	na
Model	na

TELEMETRY			
Type	Monitoring only		
Power Meter Number	Z63252665		
US West Circuit ID Number	4.UCXX-15071		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	No
Compressor Fail	No	Smoke	Yes
Pump Fail	Yes	Flood	No
High Wet Well	Yes	Operator in Trouble	Yes

EMERGENCY GENERATOR	
Inventory Number	144
Year Installed	2003
New or Used	New, installed with station
Year Rebuilt	na
Manufacturer	SDMO gen set, Yan Mar motor
Model	4045T
Serial	CD405T704740
Fuel	Diesel
Cylinders	4 cyl
Displacement	4.5 liter
Battery Voltage	12 volts
Rated Size	20 kw
Sound Attenuation	Yes
Fuel Capacity	100 gal
Run Timer per Tank	24 hrs
Automatic Transfer Switch	Yes
Manufacturer	GE-Zenith
Model	ATG2R10EX-7
Phase	3 phase
Voltage	480 volts
Rated Amperage	100 amps
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Rockaway Beach Sewage Pump Station No. 15 3900 Halls Hill NE

GENERAL INFORMATION	
Previous Name	
Configuration	Wet well submersible pump
Year Commissioned	2005
Developer / City	City
Designer	Larry Amans, BHC
Contractor	Evergreen Utility Contractors
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	na
Condition	na
Diameter	na
Depth	na
Top hatch rim to ground level	na
Top hatch rim to ceiling	na
Top hatch rim to floor	na

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	8 ft
Overflow pipe	No
Overflow location	Will overflow out of wet well manhole
Bubbler air flow setting	na

WET WELL SETTINGS (Draft info only - to be updated)			
	Measured 4/05	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	na
Floor to low level off	24 in	na	na
Floor to lead pump start	36 in	na	na
Floor to lag pump start	42 in	na	na
Floor to RTU high wet well alarm	102 in	na	na
Floor to 1st float high alarm	114 in	na	na
Floor to 2nd float high-high alarm	120 in	na	na
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim	140 in	na	na

2013 Sewer Pump Station Inventory

Rockaway Beach Sewage Pump Station No. 15

ELECTRICAL	
Primary Voltage	480 volts
Control Circuit Voltage	120 volts
Type of Controls	PLC
Disconnect Switch Location	
Amperage	
Voltage / Phase	480 volts / 3 phase
Main Control Center	
Manufacturer	Seimens
Model	Tristar
Fuse Inventory	
Location	
Purpose	
Size	

LEVEL CONTROLS	
Bubbler Controls	No
Compressor Make	
Manufacturer	
Model	
Float Controls	Yes
Manufacturer	Anchor Scientific, Roto-float
Model	
Number of Floats	Two - #1 high float is a timed pump down sequence
Purpose	- #2 high-high float cycles between high-high and high floats
Pressure Transducer	Yes provides primary level control
Manufacturer	Druck
Model	PTX 1290
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	PLC controlled
Manufacturer	
Model	
Secondary Transformer	
Manufacturer	
Style	
Catalog No	
Primary/Secondary	
KVA	
Phase	
Cathodic Protection	na

2013 Sewer Pump Station Inventory

Rockaway Beach Sewage Pump Station No. 15

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Siemens	Siemens	na
Size	3	3	
Catalog Number	14HS-32A	14HS-32A	
Coil Voltage	120 volts	120 volts	
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	ABS	ABS	na
Constant / Variable	Constant	Constant	
Model			
Frame			
Phase	3 phase	3 phase	
Horsepower	30 hp	30 hp	
Voltage	460 volt	460 volt	
Speed, rpm	3500 rpm	3500 rpm	
Rated Amperage			
Running Amperage	34, 36.2, 32.2 - 4/05	31.6, 33.9, 30 - 4/05	

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Submersible	Submersible	na
Manufacturer	ABS	ABS	
Model	AFP 1034	AFP 1034	
Serial	13188	13187	
Impeller size	7.37 in	7.37 in	
Inlet Size			
Discharge Size	4 in	4 in	
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	160 ft	160 ft	na
Static Head			
Pumping Head	148 ft	148 ft	
Dead Head	176 ft	171 ft	
Test Date	4/13/05	4/13/05	
Design Flow	115 gpm	115 gpm	
Test flow 1 pump	180 gpm	133 gpm	
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Rockaway Beach Sewage Pump Station No. 15

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	na	na	na
Type	na	na	
Manufacturer	na	na	
Model	na	na	
Connection	na	na	
Discharge Valve Size	4 in	4 in	
Type			
Manufacturer			
Model			
Connection			
Check Valve Size			
Type			
Manufacturer			
Model			
Connection			

FORCE MAIN			
Type	Discharge	Incoming	
Size	4 in	2 in	3 in
Material	HDPE	HDPE	HDPE
Length	5,360 feet	2,525	2,920
Pig Station	Yes		

SUMP PUMP	
Manufacturer	na
Model	na
Capacity	na
Voltage	na
Horsepower	na
Discharge Pipe Size	na
Sump Diameter	na

EXHAUST FAN / ODOR CONTROL BLOWER	
Type	
Manufacturer	
Model	
Capacity cfm	
Voltage	
Horsepower	
RPM	

2013 Sewer Pump Station Inventory

Rockaway Beach Sewage Pump Station No. 15

DEHUMIDIFIER	
Manufacturer	na
Model	na

TELEMETRY			
Type	Monitoring and control		
Power Meter Number	Z004874044		
US West Circuit ID Number	4.UCXX-15060		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	Yes
Compressor Fail	No	Smoke	Yes
Pump Fail	Yes	Flood	No
High Wet Well	Yes	Operator in Trouble	Yes
Additional monitoring capabilities available at this station			

EMERGENCY GENERATOR	
Inventory Number	
Year Installed	2005
New or Used	New, installed with station
Year Rebuilt	na
Manufacturer	Detroit Diesel gen set, John Deere motor, Detroit Diesel generator
Model	80DSEJB
Serial	
Fuel	Diesel
Cylinders	4 cyl
Displacement	4.5 liter
Battery Voltage	12 volts
Rated Size	80 kw
Sound Attenuation	Yes
Fuel Capacity	188 gal
Run Timer per Tank	24 hrs
Automatic Transfer Switch	Yes
Manufacturer	ASCO
Model	7000 Series
Phase	3 phase
Voltage	480 volts
Rated Amperage	
Mobile Generator Receptacle	Yes

2013 Sewer Pump Station Inventory

Vineyard Lane Sewage Pump Station No. 16 Vineyard Lane

GENERAL INFORMATION	
Previous Name	
Configuration	Wet well submersible pump
Year Commissioned	2006
Developer / City	Developer
Designer	Dave Browne, Browne Engineering
Contractor	Seton Construction
Year Upgraded	
Designer	
Contractor	

DRYWELL	
Material of Construction	na
Condition	na
Diameter	na
Depth	na
Top hatch rim to ground level	na
Top hatch rim to ceiling	na
Top hatch rim to floor	na

WET WELL	
Material of Construction	Concrete
Condition	Good
Diameter	6 ft
Overflow pipe	No
Overflow location	Will overflow out of wet well manhole
Bubbler air flow setting	na

WET WELL SETTINGS (Draft info only - to be updated)			
	Measured 12/06	Bubbler Gauge	PLC
Floor to low alarm / redundant off	na	na	na
Floor to low level off	21 in	na	na
Floor to lead pump start	35 in	na	na
Floor to lag pump start	38 in	na	na
Floor to RTU high wet well alarm	102 in	na	na
Floor to 1st float high alarm	115 in	na	na
Floor to 2nd float high-high alarm	124 in	na	na
Floor to overflow pipe	na	na	na
Floor to ground level manhole rim		na	na

2013 Sewer Pump Station Inventory

Vineyard Lane Sewage Pump Station No. 16

ELECTRICAL	
Primary Voltage	203 volts
Control Circuit Voltage	120 volts
Type of Controls	PLC
Disconnect Switch Location	
Amperage	
Voltage / Phase	208 volts / 3 phase
Main Control Center	
Manufacturer	Seimens
Model	Tristar
Fuse Inventory	
Location	
Purpose	
Size	

LEVEL CONTROLS	
Bubbler Controls	No
Compressor Make	
Manufacturer	
Model	
Float Controls	Yes
Manufacturer	Anchor Scientific, Roto-float
Model	
Number of Floats	Two - #1 high float is a timed pump down sequence
Purpose	- #2 high-high float cycles between high-high and high floats
Pressure Transducer	Yes provides primary level control
Manufacturer	KPSI
Model	7030-140
Pressure Range	

ELECTRICAL SUBSYSTEMS	
Alternator Switch	PLC controlled
Manufacturer	
Model	
Secondary Transformer	
Manufacturer	
Style	
Catalog No	
Primary/Secondary	
KVA	
Phase	
Cathodic Protection	na

2013 Sewer Pump Station Inventory

Vineyard Lane Sewage Pump Station No. 16

MOTOR STARTERS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Siemens	Siemens	na
Size			
Catalog Number			
Coil Voltage			
Phase	3 phase	3 phase	

PUMP MOTORS			
	Pump #1	Pump #2	Pump #3
Manufacturer	Hydromatic	Hydromatic	na
Constant / Variable	Constant	Constant	
Model			
Frame			
Phase	3 phase	3 phase	
Horsepower	3 hp	3 hp	
Voltage	208 volt	208 volt	
Speed, rpm	1150 rpm	1150 rpm	
Rated Amperage			
Running Amperage			

PUMPS			
	Pump #1	Pump #2	Pump #3
Type	Submersible	Submersible	na
Manufacturer	Hydromatic	Hydromatic	
Model	S4MX	S4MX	
Serial			
Impeller size	8.125	8.125	
Inlet Size			
Discharge Size			
Packing / Seal	Mechanical seal	Mechanical seal	

PUMP PERFORMANCE			
	Pump #1	Pump #2	Pump #3
Design Head	28 ft	28 ft	na
Static Head	19 ft	19 ft	
Pumping Head	25 ft	25 ft	
Dead Head	30 ft	30 ft	
Test Date	12/8/06	12/8/06	
Design Flow	90 gpm	90 gpm	
Test flow 1 pump	90 gpm	93 gpm	
Test flow 2 pumps			

2013 Sewer Pump Station Inventory

Vineyard Lane Sewage Pump Station No. 16

VALVES			
	Pump #1	Pump #2	Pump #3
Suction Valve Size	na	na	na
Type	na	na	
Manufacturer	na	na	
Model	na	na	
Connection	na	na	
Discharge Valve Size			
Type			
Manufacturer			
Model			
Connection			
Check Valve Size			
Type			
Manufacturer			
Model			
Connection			

FORCE MAIN		
Type	Discharge	Incoming
Size	4 in	
Material	HDPE	
Length	823 feet	
Pig Station	Yes	

SUMP PUMP	
Manufacturer	na
Model	na
Capacity	na
Voltage	na
Horsepower	na
Discharge Pipe Size	na
Sump Diameter	na

EXHAUST FAN / ODOR CONTROL BLOWER	
Type	Blower
Manufacturer	MKPlastics
Model	PRVS-63
Capacity cfm	65
Voltage	208, 3 phase
Horsepower	1 hp
RPM	1765

2013 Sewer Pump Station Inventory

Vineyard Lane Sewage Pump Station No. 16

DEHUMIDIFIER	
Manufacturer	na
Model	na

TELEMETRY			
Type	Monitoring and control		
Power Meter Number	Power provided by Vineyard Owners Association		
US West Circuit ID Number	4.UCXX-15061		
RTU			
Manufacturer			
Model			
Alarms			
Comm Failure	Yes	Low Wet Well	No
Power Failure	Yes	Intrusion	Yes
Compressor Fail	No	Smoke	Yes
Pump Fail	Yes	Flood	No
High Wet Well	Yes	Operator in Trouble	Yes
Additional monitoring capabilities available at this station			

EMERGENCY GENERATOR	
Inventory Number	Generator owned and operated by Vineyard Homeowners
Year Installed	2006
New or Used	New, installed with station
Year Rebuilt	
Manufacturer	
Model	
Serial	
Fuel	
Cylinders	
Displacement	
Battery Voltage	
Rated Size	
Sound Attenuation	Yes
Fuel Capacity	
Run Timer per Tank	
Automatic Transfer Switch	Yes
Manufacturer	
Model	
Phase	
Voltage	
Rated Amperage	
Mobile Generator Receptacle	Yes

**TECHNICAL MEMORANDUM 1 - HYDRAULIC MODELING
SOFTWARE EVALUATION**

CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN
TECHNICAL MEMORANDUM NO. 1
HYDRAULIC MODELING SOFTWARE EVALUATION
FINAL
October 2013

**CITY OF BAINBRIDGE ISLAND
GENERAL SEWER PLAN**

**TECHNICAL MEMORANDUM
NO. 1
HYDRAULIC MODELING SOFTWARE EVALUATION**

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HYDRAULIC MODELING SOFTWARE EVALUATION

1.0 INTRODUCTION

The City of Bainbridge Island (City) has contracted with Carollo Engineers, Inc. (Carollo) to assist the City in developing its General Sewer Plan (Plan). As part of this Plan, a hydraulic computer model of the City's trunk sewer system will be developed. The purpose of this memorandum is to compare and evaluate the various modeling software packages available to the City and recommend the modeling software that best meets the City's needs.

In the past decade, improvements have been made to the hydraulic modeling software available on the market. Some examples of the improvements include modifications to the hydraulic routing engine as well as an enhanced graphical user interface (GUI), integrated scenario management, model output reports, and geographic information systems (GIS) compatibility. This technical memorandum (TM) presents a summary of the major software vendors, briefly explains software features, compares the advantages and disadvantages of each software program, and provides a recommendation for the software program to be used for preparation of the Plan.

Additionally, Section 6.0 compares maintaining the model in-house versus using the on-call modeling services of a consultant.

Appendix A includes a paper that provides a basic overview of what a sewer system hydraulic model is, as well as an explanation of the different computational methods that are used in the hydraulic models available in the marketplace today.

2.0 SOFTWARE VENDORS

There are many software packages that can potentially address the needs of the City, and all vary in their methods of analysis and user friendliness. Sanitary sewer hydraulic modeling software packages from six (6) major software vendors were evaluated and are listed below in alphabetical order:

- **Autodesk:** Autodesk is a 3D design, engineering and entertainment company headquartered in San Rafael, CA. In 2009 Autodesk acquired StormNET from BOSS International, which is now called Autodesk Storm and Sanitary Analysis.
- **Bentley Systems, Inc.:** Bentley Systems, Inc. (Bentley) is an engineering and architecture software company with corporate headquarters in Exton, Pennsylvania. Bentley added a suite of water, wastewater, and storm water analysis software through its acquisition of Connecticut based Haestad Methods, Inc. in 2004. The

company offers two wastewater collection system software packages: SewerCAD and SewerGEMS.

- **Computational Hydraulics Institute:** Computational Hydraulics International (CHI) is a consulting engineering firm specializing in stormwater management. CHI is headquartered in Ontario, Canada with a US office in New York. The company has been providing the PC-SWMM software package since 1984.
- **Environmental Protection Agency (EPA):** The EPA first developed the Storm Water Management Model (SWMM) around 1970, which has undergone several major upgrades since then. The latest version of EPA SWMM, SWMM 5, was released in 2005. The SWMM 5 hydraulic engine is widely used throughout the industry through the EPA's open source SWMM 5 software application. In addition, several third party software vendors use the SWMM 5 hydraulic engine in their modeling software packages.
- **Innovyze:** Innovyze is headquartered in Broomfield, Colorado, and is a leading provider of software products geared towards hydraulics and hydrology. In 2009, Colorado based MWH Soft and British based Wallingford Software merged into a single company (MWH Soft), which in 2011 was renamed Innovyze. Innovyze offers three main sewer system modeling software packages. These are InfoSewer/H₂OMAP Sewer, InfoSWMM/H₂OMAP SWMM, and InfoWorks. The InfoWorks software is not included to this analysis. Its higher costs and capabilities are not aligned with the City's needs.
- **XP Software, Inc.:** XP-Software, Inc is headquarted in Portland, Oregon. The company has been providing the XP-SWMM software package since 1993.

Also considered but not part of the evaluation are the products from the Danish Hydraulic Institute (DHI). DHI is an international hydraulic consulting and research institution headquartered in Denmark. The company's MIKE URBAN software application supports two computational engines for urban hydrology and open channel/closed pipe hydraulics: the Environmental Protection Agency's (EPA) open source SWMM5 engine, and DHI's proprietary MOUSE computational engine. MIKE URBAN is one of the most expensive software packages on the market. The capabilities and higher cost of MIKE URBAN are not aligned with the City's needs.

A comparison of the technical features of the six software vendors and the modeling software that each vendor offers is presented in Table 1. This table allows a side-by-side comparison of similar features in each software package. The features that have the greatest impact on the selection of an appropriate software package are discussed in detail as part of this memo.

Table 1 Model Comparison
General Sewer Plan
City of Bainbridge Island

Technical Characteristics	Innovyze		Bentley		CHI	XP Software	EPA	Autodesk
	H ₂ OMAP Sewer/ InfoSewer ⁽¹⁾	H ₂ OMAP SWMM/ InfoSWMM ⁽¹⁾	SewerCAD ⁽²⁾	SewerGEMS	PCSWMM ⁽³⁾	XP-SWMM	SWMM 5	Autodesk Storm and Sanitary Analysis
Computation Method	Quasi-Dynamic and Steady State	Dynamic Wave and Kinematic Wave	Standard Step	Dynamic Wave and Kinematic Wave	Dynamic Wave and Kinematic Wave	Dynamic Wave and Kinematic Wave	Dynamic Wave and Kinematic Wave	Dynamic Wave and Kinematic Wave
GIS Compatible	Yes	Yes	Yes	Yes	Yes	Yes	No	Limited
Reads shapefiles directly	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Writes to shapefiles directly	Yes	Yes	Yes	Yes	No	No	No	Yes
Tools to fix GIS data topology problems	Yes	Yes	Partial	Yes	Partial	No	No	No
Utilizes Standard Database Format	Yes	Yes	Proprietary	Proprietary	Yes	ASCII-based	Yes	ASCII-based
Automatically sizes new mains	Yes	Yes	Yes	Yes	No	No	No	Yes
Calculates pipe replacement costs	Yes	Yes	Yes	Yes	No	No	No	No
Calculates loads based on GIS land use	Yes	Yes	via GIS	via GIS	Yes	Yes	No	No
Time step	User Defined	User Defined	User Defined	User Defined	User Defined	User Defined	User Defined	User Defined
Scenario manager	Yes	Yes	Yes	Yes	No	Yes	No	No
Customizable tabular reports	Yes	Yes	Yes	Yes	No	Yes	No	Yes
Graphically compares the results of multiple simulations	Yes	Yes	Yes	Yes	Yes	No	No	No
Displays GIS data layers on screen	Yes	Yes	No	Yes	Yes	Yes	No	No
Export tabular data to excel	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Internet Based Model	Yes	Yes	No	No	Yes	Yes	No	No
Network/Output Viewer Available								
Single Licenses Cost (2,000 pipe version)	\$5,000	\$7,000	\$7,995	\$12,995	\$2,999 (\$3,999)	\$12,195	Free	n/a
Maintenance and Service (Annual Fee)	\$800	\$1,500	\$1,925	\$3,120	\$999 (\$1,299)	\$1,830	Free	n/a
Water Modeling Software	Yes	Yes	Yes	Yes	No	No	No	No

Notes:

- (1) Costs presented are for the standard fixed seat license. Pricing differs for the floating seat licenses and the suite packages.
(2) SewerCAD evaluation is based on the stand-alone version. SewerCAD with AutoCAD is priced at \$9,995 for 2000 pipe version with \$2,405 annual support and maintenance fee.
(3) Pricing represents a single user license of PCSWMM Standard. Cost in parentheses is for PCSWMM Professional.

3.0 EVALUATION CRITERIA

As a way to evaluate the pros and cons of each software package, several criteria are used for a software evaluation, including:

- Dry and Wet Weather Flow Calculations Methods.
- Hydraulic Flow Routing Calculation Algorithms.
- GIS Interface.
- Scenario Management.
- Customer Service and Support.
- Cost.
- Ease of Use.
- Internet Based Model Network/Output Viewer.

Carollo recommends the City select a model that is easy to operate, compatible with GIS software and data sources, has the ability to analyze several scenarios with multiple facility options, and is cost effective. City staff may also find it necessary to use the software vendor's customer service and support to troubleshoot operating issues associated with model use. Each of the criteria listed above is briefly discussed herein.

3.1 Dry and Wet Weather Flow Calculations

Many of the models listed here were first developed not only for sanitary sewers but also for stormwater sewers. Therefore, these models contain modules for hydrologic (or wet weather flow - WWF) calculations as well as hydraulic calculations. When used as sanitary sewer models, the wet weather flow calculations are used to calibrate the infiltration and inflows (I/I) that enter the system as the result of rainfall events, and then apply these I/I characteristics to other rainfall events. Several of the models also have the ability to project dry weather flows (DWF) based on population, land use data, or parcel level water usage. Estimating accurate DWF and WWF is critical because all hydraulic calculations are based on these flows.

3.1.1 Dry Weather Flows

DWFs can be entered directly into a model, as a series of diurnal flows, or can be generated in the model based on population or land use estimates. Most of the models reviewed can accept a time series of diurnal flows. Certain models also have the ability to generate DWFs based on average dry weather flows (ADWFs) that are generated based on a population in a basin (in gallons per capita per day) or based on land use (in gallons per acre per day). Once the ADWF is estimated, a diurnal pattern can be applied to the ADWF.

3.1.2 Wet Weather Flows

WWFs can be generated using a variety of hydrologic techniques typically applied to stormwater runoff in order to approximate I/I in the collection system. Most models generate an I/I hydrograph by converting rainfall into flow based on the area that contributes flows to the collection system. Unlike stormwater, the area contributing to I/I in a sanitary sewer basin cannot be directly measured. Therefore, the area term is really a percent of the total sewer basin area, or “effective area,” that contributes I/I (e.g., 5 percent).

Simple models usually employ a unit hydrograph type algorithm to generate the WWF hydrograph. This usually includes the use of an “effective area” variable that is sometimes referred to as an R-value. An R-value represents the amount of rainfall that enters a sewer basin as a percent of the total rainfall that fell on the basin (and is usually reported as a percentage). This variable, along with a variable that approximates the time of concentration of the basin is applied to the intensity of rainfall during a storm to calculate the I/I hydrograph. Some models include two or more of these types of hydrographs – one for inflow, and one or more for infiltration. If the system being modeled experiences little I/I, these simplistic routines may be all that is warranted.

Complex models employ a more rigorous estimation of WWFs. These models include more variables to better approximate the peak, volume, and shape of the I/I hydrograph by taking into account soil saturation and near surface groundwater interaction. These routines include linear reservoir, non-linear reservoir, and other combinations of algorithms. The more complex models like PC-SWMM, and XP-SWMM employ these more complex routines to better approximate I/I hydrographs for collection systems that have significant flow contributions from infiltration and inflow.

3.2 Hydraulic Calculations

There are several differences among sewer models in how hydraulic computations are performed. The most important difference is in how the calculations involve time. There are two primary kinds of hydraulic sewer models:

- **Steady State** models do not account for changes in flow over time, and
- **Dynamic** models involve time in their calculations, most notably in being able to vary flow over time and calculate the associated changes in depth and velocity.

Several other refinements may be used to further differentiate sewer hydraulic models, namely in how they handle changes in flow characteristics over the length of the channel, or spatial changes. Differences in the assumptions in the underlying equations may make an important difference in certain situations, while for others the “simpler is better” dictum may prevail. In other words, it is not always true that complex models are always “better,” it depends on the problem to be solved. Common differences in model calculations are demonstrated in Table 2 and Table 3.

3.2.1 Terminology

To simulate the flow of water in sewers, the equations describing the depth and velocity of flow through the sewerage network must be solved. Each sewer simulation model solves some form of these equations, known formally as the “1-dimensional Saint Venant equations of open channel flow”. The St. Venant equations are comprised of two simultaneous equations: a continuity equation that describes the conservation of mass and a momentum equation that describes the conservation of energy. While some models solve the complete equations with all terms included, other models solve simplifications of the equations to facilitate faster run times or to evaluate specific conditions that do not require the full sophistication of the complete equations.

Technical definitions from the field of open channel hydraulics are helpful to better understand the differences between different model solution techniques and to assist in the model selection process. The terms describe how depth and velocity of open channel flow is computed over the length of the channel over the simulation time period.

Temporal Terms:

Steady State: The flow rate is assumed constant in time at any point along the channel. Flow may change along the length of the channel (i.e., a constant tributary flow rate may be added at a point along the channel, or a diversion may reduce the flow by a constant rate at a certain point along the channel). Steady State model assumptions, the formulas used and the software that employ the specified methods are summarized in Table 2.

Table 2 Steady State Assumptions and Models General Sewer Plan City of Bainbridge Island		
	Spatial Assumptions	Model or Equation
Uniform Flow	Water surface is parallel to slope of pipe invert.	Manning Equation
Varied Flow	Water surface may vary in depth along the length of the pipe or channel.	SewerCAD

Dynamic: In dynamic models, also known as “unsteady state” models, the flow rate may change over time. There are four primary solution schemes to the St. Venant equations listed below and the dynamic routing methods, assumptions, and modeling software for each are summarized in Table 3. :

- a. “Kinematic Wave” assumption, the simplest of the dynamic models,
- b. “Diffusion Wave” or “Non inertia” assumption. Both acceleration (inertial) terms are ignored.

- c. “Quasi-Dynamic” - Four of five momentum terms are used. Only the local acceleration term is dropped.
- d. “Dynamic Wave” - all five terms of the momentum equation are used.

In general, the complexity of the routing equation increases from Kinematic Wave to Dynamic Wave, with Dynamic Wave representing the full solution to the 1-Dimensional St. Venant equation. Kinematic Wave simplification allows for faster computational run times, but is not ideal for flat pipeline slopes (<0.002 ft/ft) and cannot calculate backwater effects as accurately as the Dynamic Wave routing equation. In addition to lacking adequate abilities to calculate backwater, the Kinematic Wave equations approximate flow attenuation by mathematical approximations, instead of wave propagation.

The kinematic wave equation was very popular, but with increases in computing power and improvements in the user interface, the use of the dynamic wave routing equations has become a much more user friendly and accessible software option.

Table 3 Dynamic Assumptions and Models General Sewer Plan City of Bainbridge Island		
	Assumptions	Model or Equation
Kinematic Wave	Inertia and pressure are ignored, only gravitational and frictional forces are considered. The most simplified dynamic model.	SWMM 5 Option in InfoSWMM Option in SewerGEMS Option in PCSWMM Option in XP-SWMM Option in Autodesk Storm and Sanitary Analysis
Quasi-Dynamic	One inertial term is included, along with gravity, friction, and pressure. One inertial acceleration term is ignored.	H ₂ OMAP Sewer
Dynamic Wave	All five momentum terms are included: gravity, friction, pressure and two inertial acceleration terms. Computationally time-consuming to solve over large sewer networks.	InfoSWMM, H ₂ OMAP SWMM, SewerGEMS, XP-SWMM, PCSWMM, SWMM 5 Autodesk Storm and Sanitary Analysis

3.3 GIS Interface

Municipalities use GIS software and databases to control, organize, and catalog system data into easy to access and useable formats. For most municipalities, GIS compatibility is an essential element of any infrastructure modeling software. The ability to synchronize system databases with modeling software can result in significant time saving for City Staff.

Software should be able to display GIS data, such as land use, aerial photos, zoning data, parcels, and growth boundaries on the screen in order to allocate flows, and evaluate new facilities based on planning assumptions.

Often, GIS data has topology flaws that need to be corrected before the modeling software can run. Software packages with data diagnostic tools to identify and correct these topology flaws can save time in the model building and updating process.

3.4 Scenario Management

Typically, a planning level hydraulic model serves several purposes. First, the model is used to analyze the existing system and determine where capacity deficiencies and operational problems exist. Second, the model is used to evaluate the system under future flows or land use designations. To be used effectively, the model will need to be able to create and modify multiple scenarios in order to evaluate the effects of infrastructure changes (e.g. new pipelines, pump stations) and increased demands on the collection system. The ability of a model to create and manage what-if scenarios is a necessary component of hydraulic model construction and analysis.

3.5 Customer Service and Support

Operation of a computer model requires a direct relationship with the software vendor in order to troubleshoot any problems that may arise during model operation. Technical service representatives, on-line help, help files and operating manuals all factor into the customer service and support evaluation. Customer support should be fast, responsive and technically qualified to handle the most advanced modeling questions. New and infrequent users usually have many questions regarding the operation of modeling software, and a helpful and responsive customer support department can be an invaluable tool.

An evaluation of customer service and support provided by the software vendors is subjective at best, since the evaluation is influenced by the specific personalities and experiences of both parties. Anecdotal information obtained from other software users is subject to biases as well. However, establishing and maintaining a good working relationship with the vendor can be very helpful to maximize the benefits obtained from the software. Maintaining a good personal relationship with the software vendor is probably the most effective way to obtain extra support and software enhancements when needed.

3.6 Cost

The cost of a software package involves several items. With any software package, the associated costs include a single license or network license fees, support and maintenance fees, and additional add-on modules. The cost for the packages evaluated in this report range from free to \$12,995. Software package costs as of March 2012 are given in the

information matrices (Table 1). The cost of the software should be appropriate for the intended use by the City, and the complexity of the City's collection system.

3.7 Ease of Use

In order for a model to be an effective tool for City Staff in planning and development, it must be user friendly and easy to operate. The operating system must be graphically based and intuitive in its operation. Adding facilities to the existing system and creating scenarios for new improvements should be straightforward and intuitive.

3.8 Internet Based Model Network/Output Viewer

In recent years, some of the software vendors have begun to offer internet based applications where the model network and model simulation results can be accessed without having to actually purchase the software license or be trained on how to use the model. This type of functionality is particularly desirable for clients that do not have the available staff resources and/or need to maintain a hydraulic model, but would still like to be able to view hydraulic model output as the need arises.

4.0 SCREENING LEVEL EVALUATION

Carollo conducted a preliminary evaluation based on the hydraulic calculations, cost, and ease of use criteria. Table 1 displays a comparison between the sanitary sewer modeling software's cost and technical characteristics. Considering the criteria described above, SWMM 5, Autodesk Storm and Sanitary Analysis, PCSWMM, and XP-SWMM are not recommended for the reasons described below.

SWMM 5 is not recommended since the software lacks the enhanced graphical user interface (GUI) and additional features available through the third party vendors. Some examples of this include a lack of GIS compatibility and the inability to create multiple scenarios within a single model. For SWMM 5, a separate model is needed for each scenario that is created, which greatly complicates the model development and hydraulic analysis process.

The Autodesk Storm and Sanitary Analysis add-on is also not recommended because it does not appear to have scenario management capabilities. Like SWMM 5, a separate model must be created to each scenario, complicating the analysis process.

XP-SWMM and PCSWMM are not recommended since the software is much less intuitive when compared to other software packages and requires a good knowledge and frequent use of hydraulic models to operate and maintain. These packages would not be the most logical choice for the City because the new or infrequent user will struggle with the operation, maintenance, and model updates.

5.0 COMPREHENSIVE EVALUATION

After the preliminary evaluation was completed, the remaining software packages, SewerCAD, and SewerGEMS (Bentley); H₂OMAP Sewer/InfoSewer, H₂OMAP SWMM/InfoSWMM (Innovyze) were further evaluated.

5.1 Dry and Wet Weather Flow Calculations

The remaining software packages have varying capabilities of modeling dry and wet weather flows. Both the Innovyze and Bentley programs provide flexibility for developing dry weather flows from a variety of sources, such as geocoded billing records, population, land use, and other GIS based methods. All of the software packages also have the capability to load user-defined hydrographs into the model.

5.2 Hydraulic Calculations

Two of the remaining software applications, SewerCAD and H₂OMAP Sewer/InfoSewer have less robust computational engines. This significantly limits the software's ability to model complex systems with multiple diversion locations.

The software applications that feature fully dynamic flow routing capabilities (H₂OMAP SWMM, InfoSWMM, SewerGEMS) are better suited to simulate backwater conditions, or flow diversions. In addition to the increased accuracy associated with the fully dynamic computational engine, these applications do not require the development of diversion curves, which can be difficult to generate accurately. The drawback of models that feature fully dynamic flow routing capabilities is increased computational time (longer "run" time). However, the City's hydraulic computer model will be small enough that run times should not be a determining factor in model selection.

5.3 GIS Interface

Most of the data in a collection system model comes from Geographic Information Systems (GIS). These information systems are increasingly becoming the primary repository for spatial infrastructure data. Cities that have had these systems in place have usually been successful in significantly increasing the quality of this data.

Software programs such as H₂OMAP Sewer and H₂OMAP SWMM operate in a stand-alone mode that allows these programs to run very efficiently. These programs can easily read, write, and manipulate GIS data.

InfoSewer and InfoSWMM run from within ESRI's ArcGIS software program, so every user of these modeling programs must also have a copy of the GIS software. These modeling programs are able to use additional GIS functionality. The hydraulic calculations are identical to the corresponding H₂OMAP Sewer and H₂OMAP SWMM software. This

software tends to be selected by users who have experience and like working from within the GIS software.

SewerCAD and SewerGEMS users can work in an AutoCAD, MicroStation, or GIS environment when doing model creation and setup tasks. Modeling simulations are often performed in a stand-alone mode. However, these two programs tend to open, load data, and run much slower than the Innovyze programs.

5.4 Scenario Management

H₂OMAP Sewer, H₂OMAP SWMM, InfoSewer, InfoSWMM, SewerGEMS, and SewerCAD offer sophisticated parent child tree scenario creation and management schemes. This feature allows the user to set up multiple what if scenarios based on a variety of model parameters.

The Innovyze software packages also have a facility manager, which enables the model to display only the facilities that are modeled in that simulation. The Innovyze data set manager is very useful in organizing and controlling what facilities and controls are associated with each scenario. In SewerCAD and SewerGEMS, all facilities are displayed for all scenarios. Therefore, facilities that are not present in a particular scenario must be turned off manually.

5.5 Customer Service and Support

Innovyze customer support has been good with timely and supportive response to issues, such as software bugs and technical problems. Innovyze has shown that they are responsive to clients needs and are able to quickly provide enhancements when needed. Instructional manuals are adequate. Help files can be limited, so e-mail and telephone support is the best means of quickly obtaining solutions.

SewerCAD and SewerGEMS offers several support and maintenance options. Users have the option to pay an annual fee or pay a price for each service contract. Anecdotal information obtained from other users was less complimentary on timely responses and personal service.

5.6 Cost

Software costs are a major factor in the selection of a modeling package. Costs discussed here are for a 2,000-pipe version unless otherwise noted. Based on a review of the City's sewer collection system, the City's hydraulic model will consist of roughly 100 links, so the 2,000-pipe versions should be sufficient for the City's current needs. The cost to model collection systems with more pipes will often be higher. The cost for all software packages are summarized in Table 1 and are prices as of March 2012.

Both InfoSewer and H₂OMAP Sewer have a single license fee of \$5,000. Support and maintenance fees cost \$800 annually. Network licenses are available, as well as Pro, Suite, and Pro Suite versions of the software for an additional cost (Pro cost has a \$6,000 single license fee plus \$800 annual maintenance, Suite has a \$6,000 single license fee plus \$1,000 annually, and Pro Suite has a single license fee of \$7,000 plus \$1,000 annually).

InfoSWMM and H₂OMAP SWMM are priced at \$7,000 for a single license. Support and maintenance fees are \$1,200 annually. Network licenses are available, as well as a Suite and Executive Suite version of the software for an additional cost (Suite has an \$8,000 single license plus \$1,500 annual maintenance fee, Executive Suite has a \$9,000 single license fee plus \$2,000 annual maintenance fee).

The stand-alone version of SewerCAD is priced at \$7,995 with a support and maintenance fee of \$1,925. SewerGEMS is priced at \$12,995 with an annual support and maintenance fee \$3,120.

5.7 Ease of Use

The ease of use of each package is an important factor in the software selection.

The user interface for the Innovyze programs has many features that help the user to quickly see and identify associated facility data and controls. The attribute browser allows the user to click on a facility and view or edit information in the database. Another advantage is that output results are viewed in the same window as the model input. This feature is useful for analysis when focusing on specific sections of the system, such as new facilities or system upgrades. The user interface has a control center that displays GIS layer information as well as operational data, annotation, and map display operations that create an easy means to manipulate operational data and view output results for the entire system.

SewerCAD and SewerGEMS have many features that also have the disadvantage of unneeded complexity for the new or infrequent user. One drawback of the SewerCAD and SewerGEMS software is that they use a proprietary database. In doing so, external databases, such as Microsoft Excel, cannot be used to view or edit model data or output results.

5.8 Internet Based Model Network/Output Viewer

Of the software vendors selected for comprehensive evaluation, only the Innovyze software packages offer the ability to export the model network and model analysis results to an internet based viewing application. Innovyze uses its “NetView” add on module to export the model network and output results to a “.kml file,” which can be easily viewed by downloading a free copy of the Google Earth program. NetView is available as part of Innovyze’s Executive Suite license at an additional cost of \$2,000 for a single license fee and an \$800 increase in the annual maintenance fee for the H₂OMAP SWMM/InfoSWMM

software package. Even with the Executive Suite license, the H₂OMAP SWMM/InfoSWMM still costs less than Bentley's comparable program (SewerGEMS)

Depending on the City's intended model usage, however, purchase of the Executive Suite license may or may not be required in order to see the benefits of this feature. For example, if the City does not plan to have one or more of its staff member routinely update and/or use the model, it may be more practical for the City to use the exported NetView .kml file (which would be exported by Carollo) to view model results. If this is the case, the City could opt to purchase the Base package only (if City staff may occasionally want to run a model scenario) or simply not purchase the software at all, while still having the ability to see peak flows and other model output for any given model element.

5.9 Evaluation Results

It is recommended that the City consider software applications that feature fully dynamic flow routing capabilities. Based on these criteria, the City could successfully implement a sanitary sewer-modeling program using either Innovyze (H₂OMAP SWMM, InfoSWMM) or Bentley (SewerGEMS) software programs. In our experience, Innovyze's InfoSWMM software may be the best choice for the following reasons:

- Superior GIS capabilities.
- Superior or comparable ease of use.
- Excellent scenario manager.
- Best value in terms of features/capabilities to cost.
- Available NetView module allows for model network and output results to be viewed for free through Google Earth.

6.0 IN-HOUSE MODELING VS. ON-CALL MODELING SERVICES

In addition to selecting a modeling software, the City must decide whether to have City staff maintain and perform analyses with the sewer model in-house, or hire a consulting firm to perform modeling tasks when needed. Many consulting firms in the wastewater industry maintain licenses to all or most of the software products discussed in this TM. Thus, regardless of which software package is chosen, the City has the option to use on-call modeling services.

If the City decides to maintain and utilize the sewer model in-house, the City will need to buy the software license and pay the annual maintenance fees. However, if the City chooses to enter into an on-call modeling services agreement, the consulting firm buys and maintains the modeling software license. Generally, an on-call modeling contract consists of an hourly fee schedule. If no modeling services are required for the duration of the contract, the City incurs no cost.

Additionally, if the City chooses to maintain the model in-house, City staff members will need to be trained on using the modeling software. The City would probably want more than one person within the department trained at a given time. Vendor trainings typically cost around \$2,000 not including travel expenses. Even with training, it will take a City employee longer to perform modeling tasks than a professional modeler because each time the model is updated and run, which will be infrequently, a City staff member will need to get re-familiarized with the modeling program.

Ultimately, the costs of using and maintaining the sewer model depend on how the City plans to utilize the model in the future. The City may use the model to size developer extensions, consider new service areas, evaluate flooding, and size capital projects. To maintain and update the model and to make model runs to assess the impacts of system changes and growth proposals is estimated to require approximately 120 man-hours per year. The experience in other communities has been that, with this level of required modeling, in-house staff get busy on other projects, need retraining, and do not make modeling a priority. Consultants are easier to hold accountable to make sure the City is getting responsive service from skilled modelers. Furthermore, if modeling needs are less than a few hundred hours per year, it will likely be less expensive for the City to rely on an on-call modeling contract.

7.0 RECOMMENDATION

In our opinion Innovyzes's InfoSWMM software would be the best product for the city to use to develop a sanitary sewer modeling program for the following reasons:

- Superior GIS capabilities.
- Superior or comparable ease of use.
- Excellent scenario manager.
- Best value in terms of features/capabilities to cost.
- Available NetView module allows for model network and output results to be viewed for free through Google Earth.

Additionally, due to the anticipated infrequent utilization of the sewer model in the future, it would likely be most efficient and cost effective for the City to outsource modeling tasks to a consulting firm, rather than maintain the model in-house.

SEWER SYSTEM MODELING PAPER

SELECTING THE RIGHT MODEL TO ANALYZE COLLECTION SYSTEM FLOWS AND HYDRAULICS

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ABSTRACT

There are a wide variety of public domain and commercial sewer system models available today. It can be challenging to select a model that meets the goals of a specific project due to the myriad of features now available in most software packages. The purpose of this paper is to provide a guide for selecting a model to analyze flows and hydraulics within a collection system network. A variety of core model features are detailed including dry and wet weather flow estimation, and hydraulics. The computational algorithms that are used in many models, such as the Saint-Venant equations, are also summarized. Other features are discussed that allow for the efficient management of data and the effective display of results. Various model application levels including gross planning, detailed planning, and design are also addressed.

KEY WORDS

Model, Collection System, Flow Estimation, Hydrology, Hydraulics, Infiltration and Inflow, Commercial Software

INTRODUCTION

The purpose of this paper is to provide a guide for selecting a model to analyze flows and hydraulics within a collection system network. There are a wide variety of public domain and commercial models available; some commercial models were developed by private software companies, while others are simply repackaged versions of public domain models and are sold by software companies with value-added support services. Still others are hybrids, they had their genesis as public domain models but subsequently private software companies have made significant additions and improvements. With the many choices on the market today, it can be challenging to select a model that meets the goals of a specific project and budget.

There are a wide variety of features available in most models today, including sophisticated interfaces, database and Geographic Information Systems (GIS) links and several different computational options. This paper cannot hope to cover details of every model, however the fundamental features in most models can be divided into understandable components. This paper will describe these core components of collection system models, delve into the specifics of generating both dry weather flow (DWF) and wet weather flow (WWF), compare the different hydraulic algorithms used to route flows through a pipe network, and include methods to select the right model for an individual system. This paper identifies specific commercial models, but attempts to compare these models based on only the core hydraulic features without taking into account the myriad of other features that may play into the selection of a specific model.

WHAT IS A MODEL?

A model is a schematic description of a system, theory, or phenomenon that accounts for its known or inferred properties and may be used for further study of its characteristics (dictionary.com). Frequently the most convenient and useful system models are mathematical in nature, and are solved with computer algorithms in software packages. This is what constitutes a “model” for most water resource engineers, and is the working definition for this paper. Every model is a simplification of the real system. The applicability of a given model depends on the degree of simplification that can be applied while still representing the system in a meaningful way to solve a problem. The accuracy and precision required dictates the amount of simplification the model should compromise from reality for a given project (e.g. planning level vs. design level). A model can be as simple as a spreadsheet with calculations for peaking factors of sanitary sewer flows and Manning’s equation for calculations of depth and velocity in a single pipe. Or a model can be a complex, fully dynamic model that accurately simulates a sewer network with thousands of basins and pipes in a sophisticated software suite of programs.

Models can be classified in many different ways. Some of the basic classifications are included as applicable to collection system models. This paper deals strictly with sanitary and combined sewer system models, although many of the model traits are also applicable to storm water models. Some common ways of classifying models include:

- *Hydrologic vs. Hydraulic* – a hydrologic model estimates flow quantity over time, while a hydraulic model estimates properties of flow (typically depth and velocity) as it travels through a channel or a network of pipes. For the purposes of this paper, a hydrologic model will also be referred to as a flow estimation model since sewer modeling usually requires estimates of both DWF and WWF.
- *Deterministic vs. Stochastic* – deterministic models produce identical outputs for a given set of inputs while stochastic models produce different outputs for a given set of inputs (Nix, 1994). Stochastic models contain random variables usually defined by a probability density function, are used for probabilistic hydrologic projections, and are sometimes referred to as statistical models. Stochastic models will not be covered in this paper.
- *Lumped vs. Distributed* – these terms are applied to both hydrologic as well as hydraulic models. A lumped hydrologic model assumes that all characteristics are constant over a watershed or sewer basin, while a distributed hydrologic model accounts for spatial variability as a function of position in a watershed (Nix, 1994). In a lumped hydraulic model, the flow is calculated as a function of time alone at a particular location, while in a distributed hydraulic model, routing of flow is calculated as a function of space and time throughout the system (Chow et al, 1988).
- *Static vs. Dynamic* – a static simulation usually refers to a steady-state analysis of a single flow rate (e.g. a peak flow), while a dynamic simulation refers to time-variable flows typically over at least a day’s period for sewer related analyses.
- *Single-Event vs. Continuous* – both single-event and continuous refer to a dynamic simulation (i.e. variation in flow characteristics are estimated over time). However for single-

event simulations, one event is analyzed based on some “event definition”. This could include an “event” defined as one day of DWF, or a single WWF event based on a minimum dry antecedent period. Continuous simulation refers to an analysis of both wet and dry periods in chronological sequence; the flow response of dry as well as wet periods is simulated. Continuous simulation is commonly used to estimate the probability of peak flows or volumes.

Most modern collection system models are deterministic and contain both hydrologic (or flow estimation) and hydraulic modules. Most models utilize lumped hydrologic processes, while hydraulic calculations can be either lumped or distributed. The majority of models simulate single-event projections, while some are also able to accommodate continuous simulations. For large collection systems, continuous simulation usually requires a more simplified model than single event analyses warrant, in order to reduce model run times.

WHY USE A MODEL?

It is always important to step back and ask if a model is necessary for a specific project. Many times the answer to this question is “yes”, even if that model is a spreadsheet with simple calculations. In fact, deciding on the degree of model sophistication required to solve a problem can be most challenging. All too often it is tempting to use the most sophisticated hydraulic model complete with GIS interfaces and a myriad of other features to model every pipe in a collection system. However the cost of this comprehensive modeling is frequently high, and many problems are more aptly, and cost-effectively accommodated using a more simplified model coupled with decision analysis tools (e.g. cost effectiveness models, uncertainty analysis and multiple objective optimization). This is especially true for planning level analyses. Assuming the project warrants analyses beyond what can be done in a spreadsheet, then some reasons to consider more sophisticated modeling software include:

- *Limitations in flow measurement* – Flow measurements should be included in any collection system modeling effort, but there are two major drawbacks to only using flow measurements for analysis of a collection system. First, you can only measure so much. Accurate flow monitoring is expensive, and unless the smallest project is considered, monitoring cannot fully describe the flows and hydraulics in a system. Second, the sewers and flows change over time. For example, service areas grow, pipes get rerouted, and new pipes age and deteriorate thus causing more infiltration and inflow (I/I) to enter the system. All of these factors could cause measured flows to be out of date within a few years.
- *Ability to predict* – one of the main reasons to model a system is to examine “what-if” scenarios once a model is calibrated and accurately predicting results. A model can provide spatial predictions of future DWF (based on changes in land use or population). A model can predict whether an improvement in a section of pipeline will be adequate. Many of today’s commercial models allow for scenario management to allow the modeler to test an almost unlimited amount of alternatives.
- *Stakeholder education* – many models today include impressive graphical displays of information in a variety of formats (e.g. graphs, dynamic “movies”, maps, etc.). Model output can be directly used to educate stakeholders at all levels within an organization, including board members, managers, engineers, and even operators. It is very useful to verify

model results with field observations from operators. This may also help in the future by demonstrating to operators system performance during unobserved, infrequent events, e.g. where to look for future Sanitary Sewer Overflows (SSOs), effects of major wet weather events on pump station failures, etc.

Assuming a model needs to be used, the real question then is... How detailed should the analysis be to efficiently and accurately solve the problem? To address this issue, the core components of a model will be examined, followed by more detailed descriptions of the flow estimation and hydraulic algorithms of a collection system model.

COMPONENTS OF A MODEL

The basic components of a model include input data, computational algorithms, output data, and a graphical user interface (GUI). Input data are included to describe the physical geometry of the system, define boundary conditions (i.e. at outfalls), and delineate time series that drive the system (e.g. rainfall, flow rates, etc).

The computational algorithms make up the “engine” that drives a model. Unfortunately, like engines in an automobile, model engines can be easily misunderstood and forgotten about when all that is seen is the “shiny exterior.” The computational algorithms will be discussed in detail below in the flow estimation and hydraulics sections. Output are the results of the computational algorithms and may include time series (e.g. flow, velocity, depth for given pipes), scatter graphs (i.e. velocity vs. depth), volumes, hydraulic grade lines (HGL’s), pipes that surcharge, nodes that overflow, depth to diameter (d/D) ratios of flow in pipes, and other statistics. Model output can be voluminous, so it is important that a model utilize some type of GUI that helps the user manage large quantities of information efficiently.

The purpose of a GUI is to facilitate efficient data input, execute the model runs, and present the results. It is easy to become enamored with all the features in today’s models GUI’s, and lose sight of what is happening “inside” the model; the computational algorithms that produce the results. Ultimately the decisions that will be made based on model results are inextricably tied to the features that today’s model GUI’s provide, which makes it is easier than ever to misapply a model to a given project. Typical features that are common to many model GUI’s for management of both input and output are:

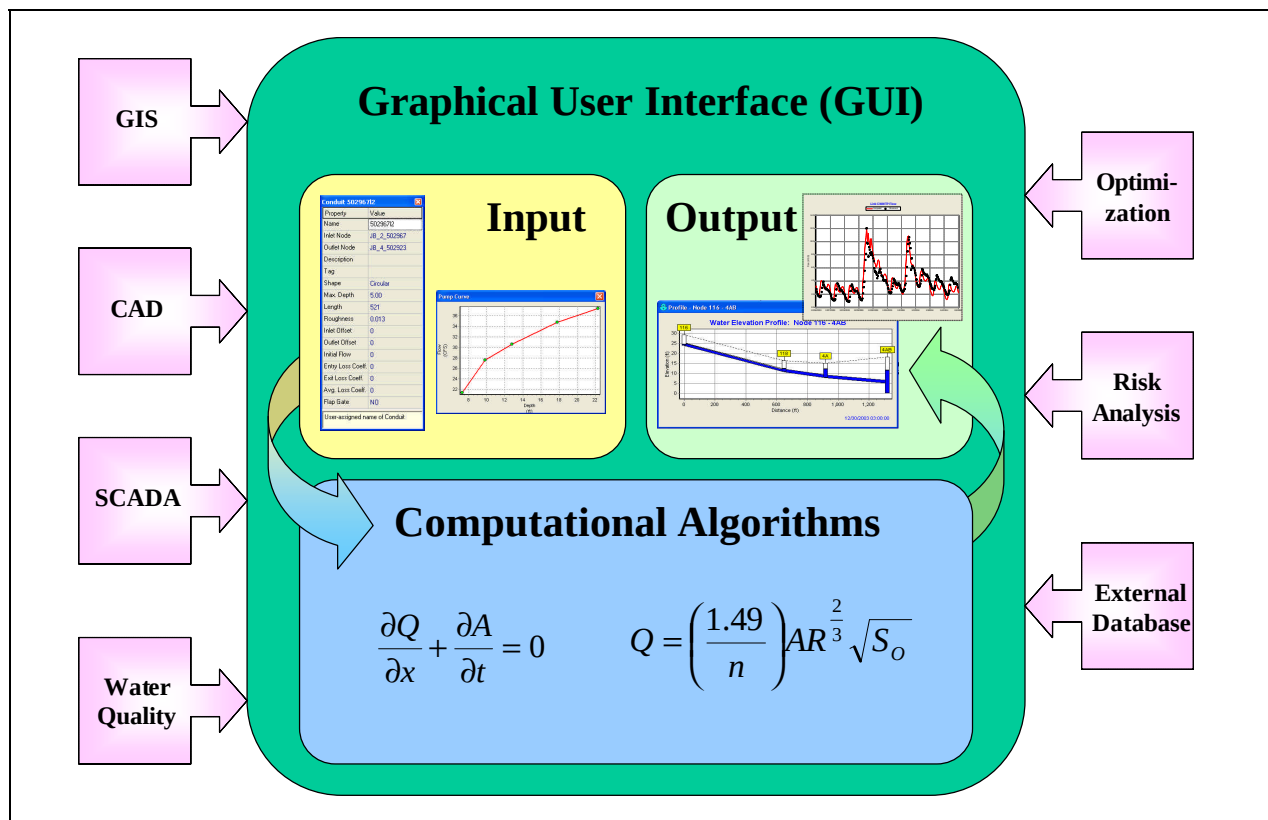
- *Time series database with tabular and graphic capabilities* – used to manage variables (e.g. hydrographs)
- *Spatial database with tabular and mapping capabilities* – used to manage structures and connectivity within the system (e.g. what pipes connect to what junctions)
- *Scenario manager* – manages multiple model runs in a structured format (otherwise model runs need to be managed at a file level by the modeler).
- *Model execution* – allows for starting a run and observing errors.
- *Dynamic displayer* – allows for dynamic display of results in either plan view or profile view. Plan view is typically a map where pipes and nodes change in size or color depending

on certain output variables. A profiler displays a pipeline segment with a varying HGL as it changes throughout the model simulation.

The spatial database feature can either be built into the model, or can be separate Geographic Information System (GIS) software. Many collection system models are moving toward integrating the model with a GIS (e.g. ArcView, ESRI). This provides the advantage of utilizing the graphical and database features of the GIS (without reprogramming them into the model). This structure leverages the many features within GIS and does not require the model to import or export data to a GIS since the data structure is already within the GIS. This feature significantly increases efficiency in inputting data as well as displaying results. The downside of this structure is that the GIS software has to be purchased along with the commercial model.

There are a variety of other model features too numerous to list. However, it's worth noting some linkages that now can be made relatively easily between modeling software and other software to expand the model's capabilities. Certain models now provide linkages to GIS, Computer Aided Design (CAD) software, Supervisory Control And Data Acquisition (SCADA) software, water quality models, optimization and risk analysis software, and external databases. **Figure 1** illustrates a conceptual layout of model components.

Figure 1 – Conceptual Layout of Model Components



FLOW ESTIMATION

Flow estimation is sometimes an overlooked aspect of collection system modeling. However, it is just as important as hydraulics in sizing improvements. If flows are not correctly estimated, the results from the hydraulic calculations will be inappropriate for estimating new or improved pipeline sizes. Flow estimation in a collection system model can be divided into DWF and WWF estimation. DWF is generated by domestic, commercial and industrial wastewater flows throughout a collection system. WWF represents the hydrology of the system and is a factor of the rainfall that enters a collection system either through designed sources, as is the case with combined sewers, or thorough deteriorated facilities or illicit connections, as is the case with sanitary sewers.

Dry Weather Flow

Depending on the complexity of the model, DWF's can either be directly entered into the model or calculated using GIS techniques. A simple approach could consist of calculating an Average Dry Weather Flow (ADWF) for a sewer basin, then applying a peaking factor (typically based on ADWF, sewer basin area, or population) to estimate a peak instantaneous DWF. This single flow value could then be used to calculate the hydraulic capacity required for a pipeline (i.e. steady-state analysis where variability in flow rate is taken into account in the conservativeness of the assumptions underlying ADWF and the peaking factor).

Land use, demographic data (population and employment), and water-use records are typically used to estimate DWF. Population and employment projections may be available as Transportation Analysis Zone (TAZ) data or Census data. Land use information may be available from local planning departments. Water use records may be available from local water agencies (however, water services boundaries may not directly overlap with sewer service boundaries and adjustments must be made). To efficiently utilize this spatial data, especially if it is available at a parcel level, a GIS is a necessity.

Some models, especially those that are integrated with GIS, have the capability of converting this information into Average Dry Weather Flow (ADWF) by applying unit flow factors (e.g. gallons per capita per day, or gallons per acre per day) directly in the model software. This feature can save significant time and effort especially if multiple years need to be analyzed (e.g. current, buildout, etc.). If a model does not have this capability, the calculations can be done externally in a GIS or a spreadsheet, and then imported into the model. If a dynamic model is used, the ADWF then needs to be converted to a diurnal pattern by applying percentages for each time unit (e.g. every hour). Certain models can also use more than one diurnal pattern to account for day-to-day changes in the diurnal pattern (e.g. weekday vs. weekend, month by month variations, etc.). This will facilitate a more accurate simulation of DWF patterns over an extended period of time.

DWF's are usually calibrated by adjusting unit flow factors to match modeled volumes to measured volumes and adjusting the diurnal pattern to match the corresponding DWF model hydrograph (e.g. timing, shape, peak flow and minimum flow). Options exist to compare DWF hydrographs graphically, along with goodness-of-fit statistics (e.g. comparison of minimums,

maximums, averages, R^2 , etc.). Some modeling software packages calculate and graph these statistics directly. If this feature doesn't exist, then it's the responsibility of the modeler to complete these calculations externally. Automated methods for performing the DWF calibration process are not typically available as a built-in feature in most modeling software. However external optimization software can be used to perform the calibration. In cases where collection systems experience very little I/I, calibration of DWF along with the inclusion of some base I/I may be all that is needed for estimation. However, many systems suffer from significant I/I and require explicit modeling of WWF's.

Wet Weather Flow

Combined sewer systems (CSS's) are designed to accommodate WWF's up to the point of discharging out designed overflow points within the system – or Combined Sewer Overflows (CSO's). In this case WWF may include I/I as well as direct, purposeful stormwater connections. I/I is usually defined as extraneous flows that are not desirable in a sanitary collection system, while CSSs were originally designed to accommodate direct storm water drainage. However, the distinction is blurred, as many sanitary sewers also suffer from excessive I/I that result in SSOs that behave similarly to CSSs. In fact, some coastal systems have experienced wet weather peaking factors (peak wet weather flow divided by average dry weather flow) that approach the peaking factor of some CSS's. Therefore, it is extremely important that WWF be estimated as accurately as possible for analyzing and designing improvements for these types of systems.

I/I is a hydrologic component of both combined and separate sanitary systems. Combined systems are generally dominated by storm water that is in effect the same as sanitary inflow. Separate systems can be dominated by either inflow or infiltration. When portions of a combined sewer system are separated, the storm water contribution is greatly diminished, but infiltration may still be a significant component of flow, and may in turn exhibit characteristics of a sanitary system with significant I/I. In either case (a partially separated combined system or a sanitary system with significant I/I), infiltration can be the most difficult portion of the wet weather hydrograph to model, as well as one of the more challenging components of WWF to remove.

Modeling inflow is usually straightforward because the inflow response is a direct result of the rainfall pattern and the amount of impervious area that is tributary to the sewer system (it behaves very similarly to an urban storm water response to rainfall). Most collection system models adequately model inflow. However, infiltration is much more difficult to model than inflow since it can be an indirect response to rainfall and can be heavily influenced by groundwater conditions, which nearly always introduce a tremendous amount of uncertainty into any hydrologic analysis. Infiltration generally can be categorized in two ways:

- Near surface infiltration
- Groundwater infiltration

Near surface infiltration usually starts a few hours after the beginning a rain event and subsides within generally a day or two as the saturated soils return to normal. Groundwater infiltration is caused by groundwater that raises due to saturated soil conditions to a point where the groundwater table elevation exceeds that of the local collection system. This type of infiltration

can be an issue for coastal communities or those located near lakes and rivers where the groundwater table is normally very close to sewer inverts. Groundwater infiltration will not necessarily influence a sewer system until multiple rainfall events saturate the soils and start to increase the groundwater table, but when it does, it can contribute infiltration that last for weeks or months. Also, certain systems directly adjacent to the ocean or estuaries can experience diurnal groundwater infiltration due to tidal fluctuations that directly affect the water table.

Modeling of WWF generally falls into these categories (Wright and Dent, 2001):

- Rational Method - calculation of an individual peak flow or volume using the simplistic equation $Q=CiA$, or R-values (which are calculated the same way, but “C” is replaced by an “R”)
- Unit Hydrograph – includes SCS curve number methods, the RTK method (triple unit triangular hydrographs), and regression analysis (linear or non-linear)
- Physically based - Non-linear reservoir, multiple non-linear reservoirs (when groundwater is included in the model)

The Rational Method should only be used in the case of calculating inflow for small, highly impervious areas. R-values are easy to calculate but can be applied beyond their accurate limits, and should only be used as a first check to see if sanitary sewer basins suffer from significant I/I. To adequately model wet weather flow hydrographs, a unit hydrograph or physically based method should be applied. These methods are more complex and take more time and experience to apply properly. If groundwater is a significant issue, and if there is the possibility that storage facilities are going to be sized to manage excess I/I, a physically based multiple non-linear reservoir method should be applied. For a more in-depth discussion on modeling wet weather flows, refer to Dent et al (2000) and Wright et al (2000).

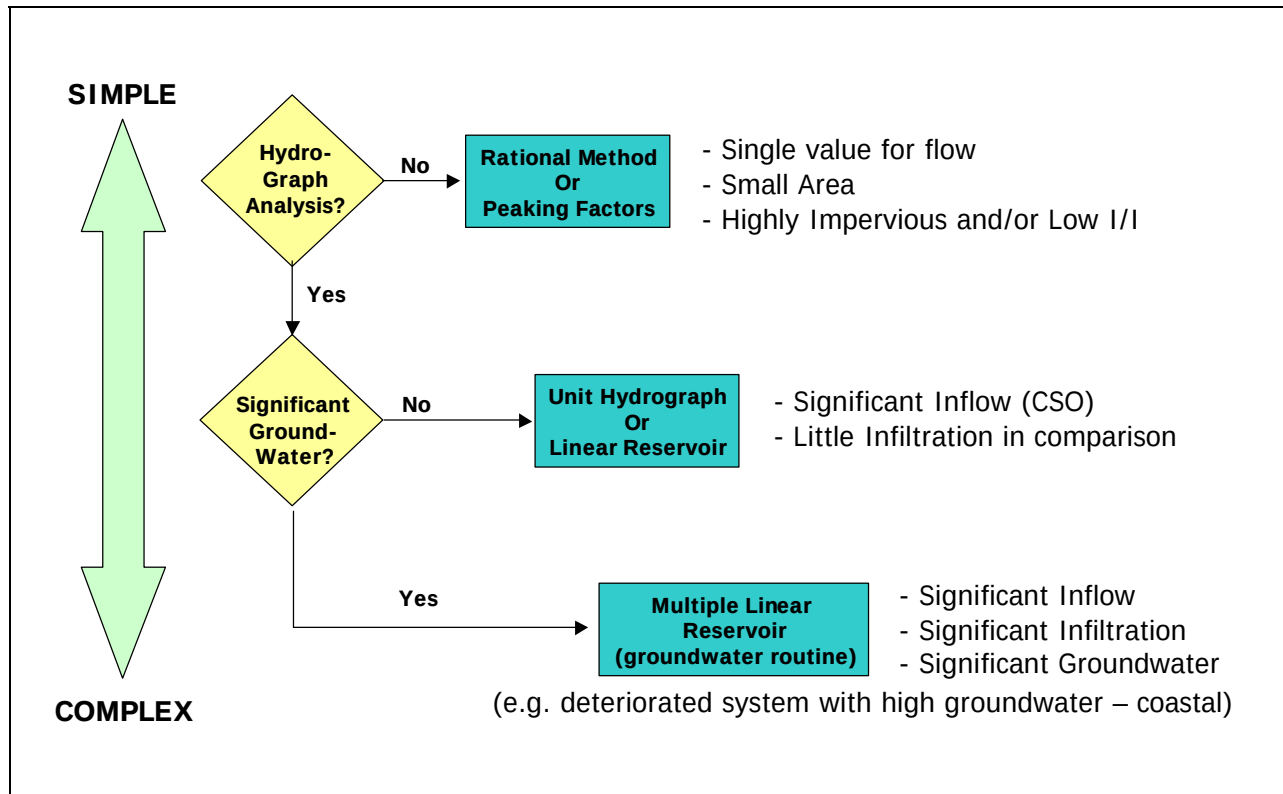
There are usually a variety of wet weather flow estimation options available in most public domain and commercial models, so no specific model or models will be discussed since the topic is too extensive for this paper. However, it is worth noting that automated calibration of WWF's is beginning to be explored in certain commercial collection system models. There also exists the opportunity to link external optimization software to efficiently run iterative calculations for WWF calibration in public domain models (Dent et al, 2004). **Figure 2** illustrates a flowchart to help choose a wet weather flow estimation method.

HYDRAULICS

Hydraulics, and the application of hydraulics, are often misunderstood. Many books are available that explain hydraulic theory and application, but few if any exist that provide a consolidated summary of hydraulic modeling for practical purposes. This explanation of hydraulics hopefully provides this consolidated review.

Due to the wide variety of flow conditions that may exist in an open channel, a complete but sometimes confusing nomenclature has developed to describe the fundamental properties of fluid flow. Yen (2001) provides a simple breakdown of these terms for overland and open-channel flow in terms of variation with time and space.

Figure 2 – Flowchart for Choosing a Wet Weather Flow Estimation Method



Flow variation with time is commonly referred to as either:

- Steady (time invariant), or
- Unsteady (dynamic flow)

A steady state model only uses a single flow within the analysis. A peak flow is a common way to analyze the capacity of a pipe. An unsteady, or dynamic flow model, uses a time series of flows. A hydrograph is commonly used in a dynamic model and can range from several values (e.g. diurnal DWF's over 24 hours) to millions of flow values (e.g. long term continuous simulation). Both steady and unsteady flow will be discussed below as they relate to flow variation in space.

Flow variation in space, or flow along the length of a channel, is referred to as either:

- Uniform, or
- Nonuniform (gradually or rapidly varied)

Uniform flow is the simplest type of open channel flow and the governing equations give unique flow rates as a function of depth. One simple way to envision this type of flow is a pipeline

where the slope of the hydraulic grade line (HGL) is parallel to the slope of the pipe. Under this regime the two forces acting on the flow, gravity and friction, are balanced, and there is no acceleration of the flow in any dimension. Under uniform flow the friction slope is equal to the pipe bed slope (i.e. $S_f = S_o$). By definition, uniform flow must exhibit uniform depth along the length of a pipeline. This depth is commonly referred to as normal depth (Chaudry, 1993).

Steady Flow (Uniform and Nonuniform)

Steady flow models, those where only a single flow is used, are solved for depth and velocity using uniform or nonuniform techniques. When considering flow in time and space, the simplest type of flow is steady uniform flow. The flow rate does not change with time, the depth of flow does not change in space, and the streamlines are all parallel. All acceleration terms are zero, e.g. friction and gravity are in perfect balance. Manning's equation (developed by Robert Manning in 1891) is frequently used to determine the flow rate or velocity for uniform flow because under uniform flow conditions the depth of flow and flow rate are related by a unique rating curve (i.e. the flow rate is a unique function of depth). **Figure 3** illustrates Manning's equation expressed in customary US units.

Figure 3 – Manning's Equation

$$Q = \left(\frac{1.49}{n} \right) A R^{\frac{2}{3}} \sqrt{S_o}$$

where:

- Q = Flow (cfs)
- n = Manning's roughness coefficient (unitless)
- A = Area (ft²)
- R = Hydraulic Radius
- S_o = Pipe Slope

Manning's equation is an empirical equation (i.e. derived from field and laboratory experimental observations) and is appropriate if the conditions mentioned above for uniform flow exist in the pipeline that is being analyzed. If flow in a sewer pipe approaches a steady uniform condition, then Manning's equation may give reasonable results. However, actual sewer pipelines frequently experience a variety of flow conditions where the uniform flow principle is violated and the more complete nonuniform solution techniques are required.

Nonuniform conditions take into account that a single flow will usually exhibit different depths along a length of pipeline. Nonuniform flow is typically categorized as gradually varied and rapidly varied flow. Rapidly varied flow will not be covered in this paper since sewer flows rarely exhibit this flow condition, and no models covered in this paper solve for this condition. Therefore, from now on, this paper will refer to nonuniform flow only in terms of gradually varied flow.

Gradually varied flow can be either steady or unsteady in time. Steady, gradually varied flow, requires calculations beyond Manning's equation to solve for depth and velocity in a open channel (unsteady gradually varied flow will be addressed in detail later in this paper). The Step Method has been developed to solve the gradually varied flow equation. Numerical integration is necessary because the equations are not generally explicitly soluble (Henderson, 1966). Two common solutions of this method include the Standard and Direct Step Method. These methods can be used to solve for changing depths and velocities for a given flow along the length of an open channel (or pipeline if the flow does not surcharge beyond the crown of the pipe). Two commercial models that utilize the Direct Step Method include SewerCAD and StormCAD both by Haestad Solutions (Bentley Systems).

Unsteady Gradually Varied Flow

The most computationally complex type of one-dimensional open channel flow is unsteady flow, which is, for practical purposes, also nonuniform (Chaudry 1993). Unsteady gradually varied flow can be solved using distributed flow routing models where flow rate and water level are computed as functions of space and time, rather than space alone (such as the Standard Step Method discussed above) or time alone (such as spatially lumped models which are not covered in this paper) – (Chow et al, 1988). Most of the unsteady sewer models on the market today utilize distributed flow routing and solve a form of the Saint-Venant equations. These equations are covered in detail in many publications including, but not limited to, Chow et al (1988), Bedient and Huber (1992), Chaudry (1993), Yen (2001), and Henderson (1966).

The Saint-Venant equations, first developed by Barre de Saint-Venant in 1871, describe one-dimensional unsteady open channel flow where depth and velocity only vary in the longitudinal direction of the channel, the bottom slope of the channel is small, and Manning's equation can be used to describe resistance effects (Chow et al, 1988). So why are these equations so important in distributed flow routing models? One primary reason why these equations are needed are because a wave (a variation in energy in time and space) can be propagated upstream and downstream in unsteady gradually varied flow. Waves cannot be accounted for in the simplified forms of the St. Venant equations that do not consider changes in acceleration over time and space. The Saint-Venant equations generally consist of equations of continuity and momentum and are able to estimate wave celerity (the velocity of a wave along the channel). These partial differential equations are summarized in **Figure 4** (adapted from Chow et al, 1988).

The kinematic wave solution, as shown in Figure 4, balances the gravity and frictional forces and assumes the flow does not accelerate appreciably. The diffusion wave solution is the kinematic solution with the pressure term included which takes into account the change in water pressure with depth along the channel. The Quasi-Dynamic wave solution is the diffusion wave solution with the inclusion of the convective acceleration term which describes the change in momentum due to the change in velocity along the channel. The Fully Dynamic solution includes all terms in the momentum equation including the local acceleration term, which describes the change in momentum due to the change in velocity over time.

Figure 4 – Saint-Venant Equations

Continuity Equation: $\frac{\partial Q}{\partial x} + \frac{\partial A}{\partial t} = 0$

Momentum Equation:

$$\frac{1}{A} \frac{\partial Q}{\partial t} + \frac{1}{A} \frac{\partial}{\partial x} \left(\frac{Q^2}{A} \right) + g \frac{\partial y}{\partial x} - g(S_o - S_f) = 0$$

$\frac{1}{A} \frac{\partial Q}{\partial t}$
 Local
Acceleration

$\frac{1}{A} \frac{\partial}{\partial x} \left(\frac{Q^2}{A} \right)$
 Convective
Acceleration

$g \frac{\partial y}{\partial x}$
 Pressure
Force

$- g(S_o - S_f)$
 Gravity & Friction
Force

← **Kinematic Wave**

← **Diffusion Wave**

← **Quasi-Dynamic Wave**

← **Fully Dynamic Wave**

where:

- Q = Flow
- A = Area
- t = Time
- x = Distance
- y = Depth
- S_o = Pipe Slope
- S_f = Friction Slope (slope of hydraulic grade line)

The Saint Venant equations are partial differential equations that describe one dimensional, unsteady, gradually varied flow. Unfortunately they are not amenable to analytical solution methods and therefore must be solved using numerical approximations. A common method for approximating the solution of these equations, although not covered in detail here, is the finite-difference method. This method can employ either an explicit scheme (where unknown values are solved for sequentially) or implicit scheme (where unknowns are solved for simultaneously). The explicit method is iterative and somewhat simpler to implement in a computer program, but can produce unstable results. The implicit method is more complicated from a programming perspective, but generally provides a more stable solution and can provide faster simulation times than the explicit method. Explicit solutions were applied in the past, but implicit methods are more commonly used in today's distributed flow models.

Another mathematical solution issue, which may seem somewhat esoteric, but is necessary to understand because of how certain sewer models are marketed, include the way the equations are

applied to solve for surcharge flow (when flows exceed the crown of a pipe and transition into pressure flow). There are two ways to simulate unsteady surcharged flow in sewer models and include the standard transient flow approach and the hypothetical piezometric open slot approach. The hypothetical piezometric open slot approach, is also known as the Priessmann slot approach. According to Yen (2001), both solution techniques have their own pros and cons and it is not clear whether one method is superior in all cases, regardless of how some commercial software is marketed.

Generally, the more terms of the Saint-Venant equations that are included in the solution, the more computational intensive the model can become and the slower the simulation times become. Excessive run times can still be a problem (even with the computational power of today's computers) if the sewer network becomes large enough. Therefore, some models standard solution routine applies the kinematic wave solution, such as the Hydra software by Pizer, or provides this solution technique as an option, as is the case with the US EPA Storm Water Management Model - SWMM5. This simplification of the Saint-Venant equations will provide very efficient simulation run times. However, the kinematic wave routine does have some significant limitations in that flow is routed only in a downstream direction, only open channel flow (or gravity flow as it is sometimes called) can be simulated (no surcharge), and flow in looped pipes (e.g. cross connections) cannot be directly calculated.

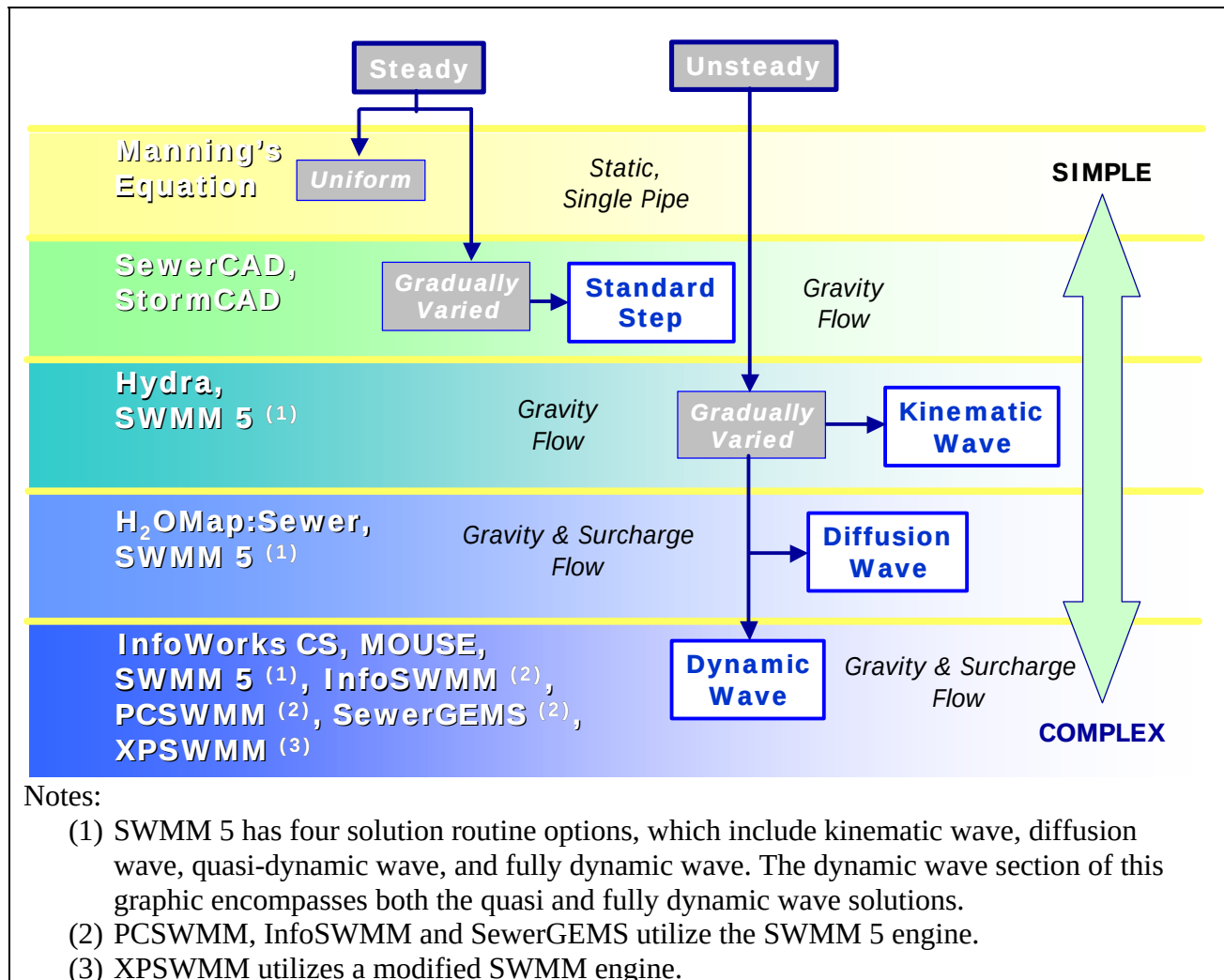
Many distributed flow routing models on the market today include fully dynamic wave solutions as well as options to model only quasi-dynamic or diffusion wave solutions for sewer networks. H2Omap:Sewer (MWH Soft) includes a diffusion wave solution routine. Other models such as SWMM5, MOUSE (Danish Hydraulic Institute – DHI), InfoWorks CS (Wallingford Software), and XPSWMM (XP Software) include fully dynamic wave solutions and may offer options for diffusion and quasi-dynamic wave solutions. PCSWMM (Computational Hydraulic Institute – CHI), InfoSWMM (MWH Soft), and SewerGEMS (Haestad Methods/Bentley Solutions) utilize the SWMM5 engine but provide a more comprehensive GUI than the standard SWMM5 package. **Figure 5** provides a graphical characterization of hydraulic solution methods along with a summary of which models apply which routines.

OTHER MODEL FEATURES

What about the other features that are available in today's public domain or commercial models? The core features of today's models are described above, but it is also necessary to investigate other model features that may influence the choice of selecting one model over another. The following list is by no means comprehensive, but hopefully provides some features that should be investigated before an individual model is chosen or upgraded:

- Who will be the model users (consultant vs. client, full-time vs. part time, experienced with hydrology and hydraulics)
- Cost (both initial purchase as well as yearly service contracts for technical support and upgrades)

Figure 5 – Characterization of Hydraulic Solution Methods



- Database and Engine structure (ability to work with 3rd party software, ability to easily extract model input/output from model)
- Estimate DWF from population or landuse
- Utilize monitored data for calibration
- Perform automated calibration
- Efficiently complete continuous simulation modeling
- Perform automated pipe sizing (upgrades or parallel pipelines under open channel and surcharge conditions)
- Water quality (i.e. hydrogen sulfide) and sediment transport modeling
- Simulate Real Time Controls (RTC) at pumps, weirs, orifices, etc.
- Link with SCADA software to provide real time modeling capabilities

Many of the options mentioned in the above list can be found in some of the models listed previously in this paper. However, two features that would be extremely helpful in sewer system model, but aren't available (to the authors knowledge) include:

- (1) Ability to directly distribute WWF's into unmonitored areas of the system
- (2) Ability to analyze capacity of sewer pipes based on a comparison of the HGL to the slope of the sewer pipe

Feature (1) addresses the need to provide a modeler with a mechanism to distribute WWF's throughout sewer basins even when basins are not monitored for flow (which is typically the case). Statistical methods do exist (see Wright et al, 2005) but could be included as an option in software packages.

Feature (2) is related to automated pipe sizing, but seems to be feature that has been overlooked. If a model could illustrate, during a dynamic simulation, which pipes in a network have an HGL equal to, greater than, or less than the slope of the pipe, the modeler would be able to easily identify which pipes need to be upgraded. This is especially true when pipes become surcharged. For example, if a pipe has an HGL slope greater than the slope of the pipe, and portion of the pipe is surcharged, then that pipe has a capacity restriction for the modeled flow and needs be upgraded (e.g. larger diameter or parallel pipeline). Likewise, if a pipe has an HGL slope less than the slope of the pipe, and the pipe is surcharged, the pipe does not represent a restriction (and the restriction is somewhere downstream). This relatively simple feature would provide the modeler with invaluable information to identify deficiencies within a sewer network and help focus capacity improvements.

MODEL APPLICATION

Selection of any model always comes back to what type of project the model is being used for, and what accuracy is needed in the results. Three examples, or levels of sewer system modeling include:

- Gross Planning Level
- Detailed Planning Level
- Design Level

Gross planning level modeling can be accomplished in several ways. One example of gross planning level modeling is the use of hydrologic routines to simulate the overall WWF response of a sewer system. For example, if a municipality wants to identify the I/I response of a sewer system upstream of some critical point (e.g. a pump station or wastewater treatment plant), a model could be constructed by simplifying the entire sewer network upstream of that point into one or more sewer basins. Measured WWF can then be used to calibrate the models I/I response and design flow events can be projected (either using design storms or continuous simulation techniques). This simplified technique, although it does not provide information on the detailed hydraulics of the upstream sewer system, can provide invaluable information regarding the

management of WWF at a pump station or wastewater treatment plant. If a sophisticated model is used to perform this simplified effort (such as SWMM), the model can always be expanded at a later time to include the detailed upstream sewer hydraulics.

Detailed planning level modeling would be considered for existing systems when the flows (both DWF and WWF) are estimated throughout a sewer network, and the flows are routed through the sewer network to a downstream point. This type of modeling is typically performed during master planning projects. In selecting a model for detailed planning level investigations, it is necessary to not only identify the core hydrologic and hydraulic features of a model, but also all the options that might be necessary to provide an efficient analysis of a complex system (see the Other Model Features above). When selecting a model based on core features, the model should simulate what the system is experiencing (i.e. surcharge, looped connections, complex pump stations and forcemains, etc). Also, many times the optional features tend to be the discriminating factors in selecting a model when the core features are very similar (e.g. PCSWMM, InfoSWMM, and SewerGEMS – which all have the same SWMM5 engine, but different GUI's).

Design level models are used to design new facilities, but may not need to be as sophisticated as models used for detailed planning. If new pipes are being designed that do not surcharge, then less sophisticated hydraulic routines may be adequate (e.g. models that utilize the Step Method or the Kinematic wave method). These models are very useful for designing sewers for new developments or even completing detailed planning level modeling if an existing system is not hydraulically complex and any surcharging will be relieved with upsized or paralleled pipelines. However, the results from these types of models are not typically satisfactory for combined sewer systems or sanitary sewer systems that experience extensive I/I (i.e. if surcharging could occur).

CONCLUSIONS

Too simple of a model does not adequately represent reality and can lead to inappropriate decisions. Too complex of a model may be difficult to use (including interpretation of results) and may lead to abandonment. Modeling software packages have a variety of strengths and weaknesses. Each software company has developed its own software package based on its vision, experience, and client base. Therefore, a software package may be stronger for some applications than for others. A model should only be used to assist in informed decision-making. Since all models include some simplification of the actual system, the engineer or operator should make the final decision, not the model.

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DETAILED CALIBRATION RESULTS

Table 1 Dry Weather Flow Calibration Results
General Sewer Plan
City of Bainbridge Island

		Weekday Dry Weather Flow												Weekend Dry Weather Flow											
		Measured Data ⁽¹⁾				Modeled Data ⁽²⁾				Percent Error ⁽³⁾				Measured Data ⁽¹⁾				Modeled Data ⁽²⁾				Percent Error ⁽³⁾			
Pipe Meter Number	Diameter (in)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)	Avg. (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)
Meter 01	10	0.060	0.109	1.83	1.5	0.060	0.108	1.96	1.4	-0.6%	-1.2%	7.3%	-5.4%	0.061	0.114	1.87	1.5	0.061	0.111	1.96	1.4	-0.7%	-2.3%	4.8%	-7.4%
Meter 02	10	0.078	0.121	0.71	3.2	0.078	0.116	0.76	3.2	-0.4%	-4.1%	6.7%	-0.3%	0.063	0.105	0.64	3.0	0.064	0.096	0.71	2.9	1.3%	-8.9%	9.7%	-1.8%
Meter 03	12	0.207	0.304	6.72	1.2	0.219	0.363	6.86	1.2	5.6%	19.4%	2.0%	1.5%	0.204	0.337	6.73	1.2	0.212	0.415	6.77	1.2	4.0%	23.1%	0.7%	-0.1%
Meter 04	12	0.165	0.259	2.59	1.9	0.165	0.281	2.77	2.0	0.0%	8.5%	7.0%	3.9%	0.150	0.272	2.49	1.8	0.139	0.239	2.63	1.8	-7.1%	-12.2%	5.3%	-0.3%
		Average Dry Weather Flow ⁽⁴⁾																							
		Measured	Modeled	Percent Error	Measured	Modeled	Percent Error	Measured	Modeled	Percent Error															
Pipe Meter Number	Diameter (in)	Avg. Flow (mgd)	Avg. Flow (mgd)	Avg. Flow (%)	Avg. Level (mgd)	Avg. Level (mgd)	Avg. Level (%)	Avg. Velocity (mgd)	Avg. Velocity (mgd)	Avg. Velocity (%)															
Meter 01	10	0.061	0.060	-0.7%	1.467	1.380	-6.0%	1.840	1.961	6.6%															
Meter 02	10	0.074	0.074	0.0%	3.163	3.140	-0.7%	0.693	0.745	7.5%															
Meter 03	12	0.206	0.217	5.2%	1.209	1.221	1.0%	6.722	6.833	1.6%															
Meter 04	12	0.161	0.158	-1.9%	1.889	1.941	2.7%	2.564	2.732	6.5%															

Notes:

1. Source: ADS Flow Monitoring Data Report
2. Average flow is calculated from weekday/weekend dry weather flow monitoring data. Maximum flow values are hourly peaks corresponding to either weekend or weekday conditions, as appropriate.
3. Percent Difference = (Modeled - Measured)/Measured*100.
4. Average Dry Weather Flow = (5*Weekday Dry Weather Flow + 2*Weekend Dry Weather Flow)/7



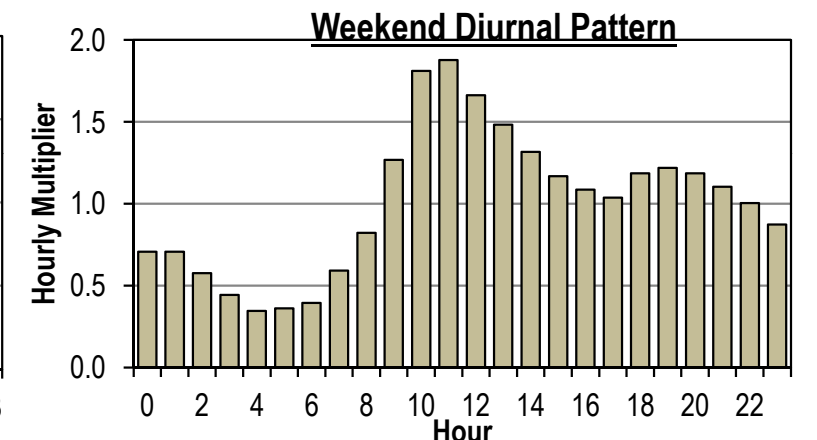
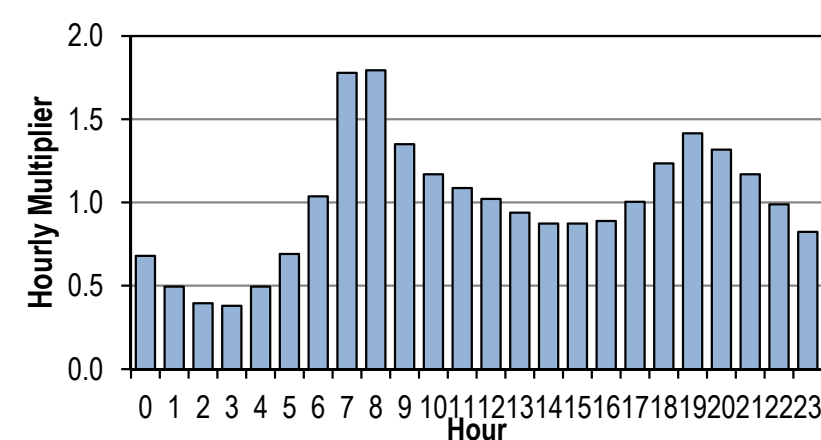
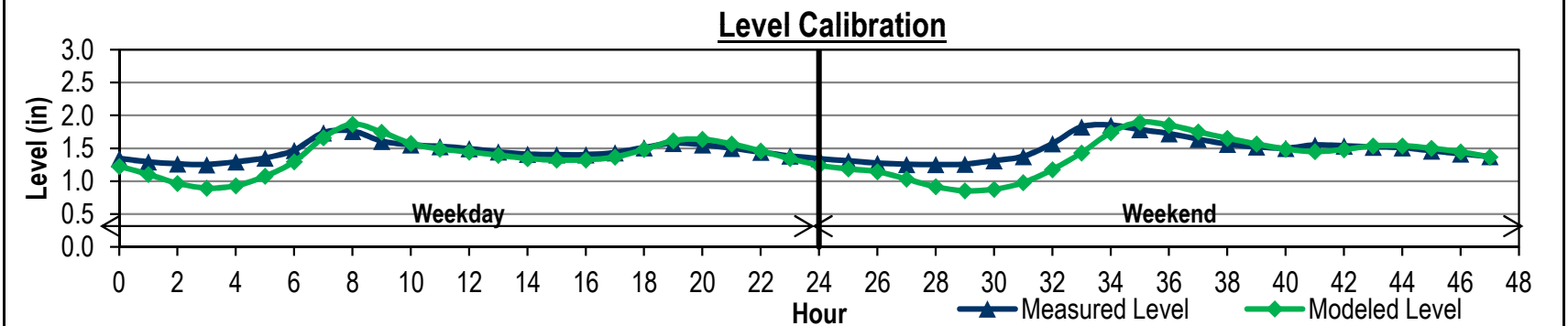
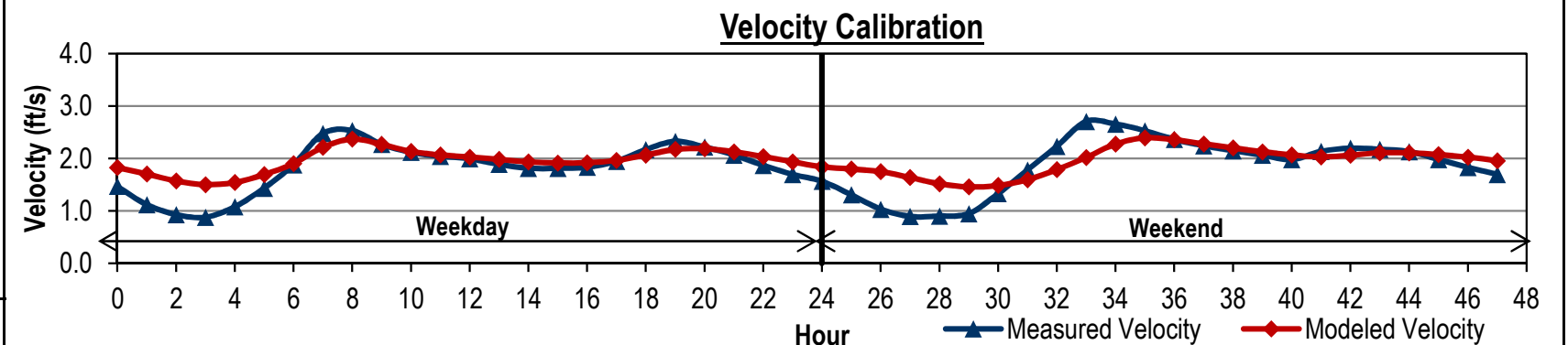
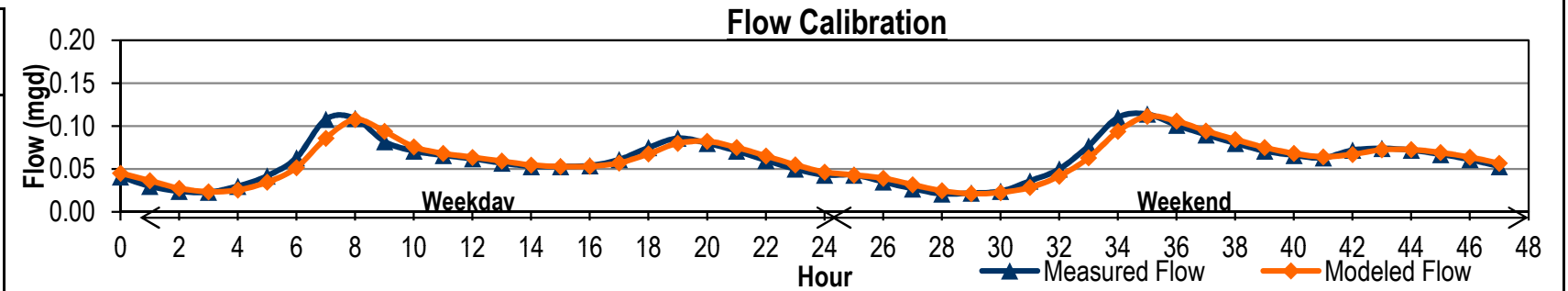
City of Bainbridge Island

General Sewer Plan

FLOW MONITORING SITE Meter 01 DRY WEATHER FLOW CALIBRATION



	Hour	Measured	Level	Velocity	Modeled	Level	Velocity	Calibrated
		Flow (mgd)	(in)	(ft/s)	Flow (mgd)	(in)	(ft/s)	Diurnal
Weekday	0	0.041	1.346	1.469	0.045	1.226	1.829	0.68
	1	0.030	1.294	1.120	0.036	1.102	1.706	0.49
	2	0.024	1.263	0.930	0.028	0.968	1.573	0.40
	3	0.023	1.252	0.879	0.024	0.896	1.502	0.38
	4	0.030	1.293	1.078	0.026	0.932	1.544	0.49
	5	0.042	1.352	1.434	0.035	1.075	1.693	0.69
	6	0.063	1.470	1.881	0.052	1.297	1.905	1.04
	7	0.108	1.735	2.475	0.086	1.660	2.214	1.78
	8	0.109	1.760	2.534	0.108	1.866	2.372	1.80
	9	0.082	1.608	2.271	0.094	1.744	2.270	1.35
	10	0.071	1.552	2.121	0.076	1.574	2.135	1.17
	11	0.066	1.528	2.040	0.068	1.489	2.068	1.09
	12	0.062	1.494	1.998	0.064	1.443	2.027	1.02
	13	0.057	1.445	1.890	0.059	1.394	1.984	0.94
	14	0.053	1.409	1.814	0.055	1.344	1.937	0.87
	15	0.053	1.403	1.814	0.053	1.320	1.916	0.87
	16	0.054	1.403	1.835	0.053	1.324	1.921	0.89
	17	0.061	1.434	1.948	0.057	1.368	1.965	1.00
	18	0.075	1.511	2.169	0.068	1.483	2.067	1.24
	19	0.086	1.576	2.329	0.080	1.614	2.174	1.42
	20	0.080	1.553	2.220	0.082	1.636	2.189	1.32
	21	0.071	1.502	2.066	0.075	1.565	2.128	1.17
	22	0.060	1.440	1.871	0.065	1.459	2.038	0.99
Weekend	23	0.050	1.383	1.696	0.055	1.345	1.937	0.82
	24	0.043	1.343	1.565	0.047	1.241	1.843	0.71
	25	0.043	1.308	1.307	0.043	1.188	1.800	0.71
	26	0.035	1.274	1.033	0.039	1.144	1.750	0.58
	27	0.027	1.256	0.895	0.032	1.033	1.638	0.44
	28	0.021	1.253	0.901	0.025	0.917	1.519	0.35
	29	0.022	1.258	0.948	0.021	0.855	1.459	0.36
	30	0.024	1.313	1.329	0.023	0.877	1.486	0.40
	31	0.036	1.376	1.780	0.029	0.978	1.596	0.59
	32	0.050	1.570	2.234	0.042	1.177	1.790	0.82
	33	0.077	1.824	2.708	0.063	1.430	2.022	1.27
	34	0.110	1.851	2.657	0.094	1.737	2.277	1.81
	35	0.114	1.784	2.531	0.111	1.896	2.396	1.88
	36	0.101	1.723	2.365	0.106	1.851	2.359	1.66
	37	0.090	1.638	2.244	0.094	1.750	2.279	1.48
	38	0.080	1.563	2.149	0.084	1.652	2.203	1.32
	39	0.071	1.521	2.063	0.075	1.565	2.128	1.17
	40	0.066	1.500	1.982	0.068	1.489	2.067	1.09
	41	0.063	1.551	2.137	0.064	1.449	2.032	1.04
	42	0.072	1.535	2.196	0.067	1.480	2.062	1.19
	43	0.074	1.520	2.177	0.073	1.536	2.110	1.22
	44	0.072	1.511	2.133	0.073	1.537	2.109	1.19
	45	0.067	1.461	1.981	0.069	1.501	2.077	1.10
	46	0.061	1.417	1.831	0.064	1.445	2.027	1.00
	47	0.053	1.374	1.697	0.057	1.367	1.958	0.87
Average								
Weekday		0.06	1.46	1.83	0.06	1.38	1.96	1.00
Weekend		0.06	1.49	1.87	0.06	1.38	1.96	1.01
ADWF ⁽¹⁾		0.06	1.47	1.84	0.06	1.38	1.96	1.00
% Error								
Weekday					-0.6%	-5.4%	7.3%	
Weekend					-0.7%	-7.4%	4.8%	
Note: 1. ADWF = (5xWeekday Average + 2xWeekend Average)/7								





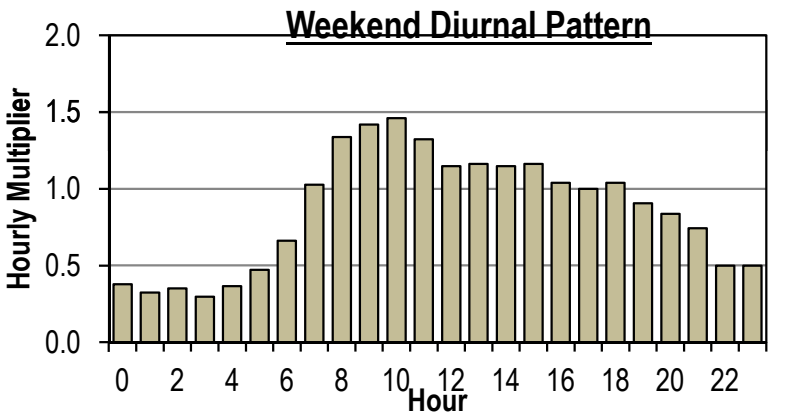
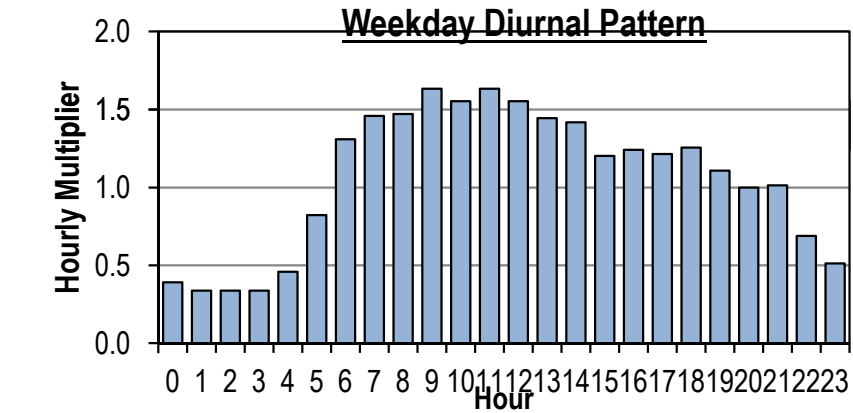
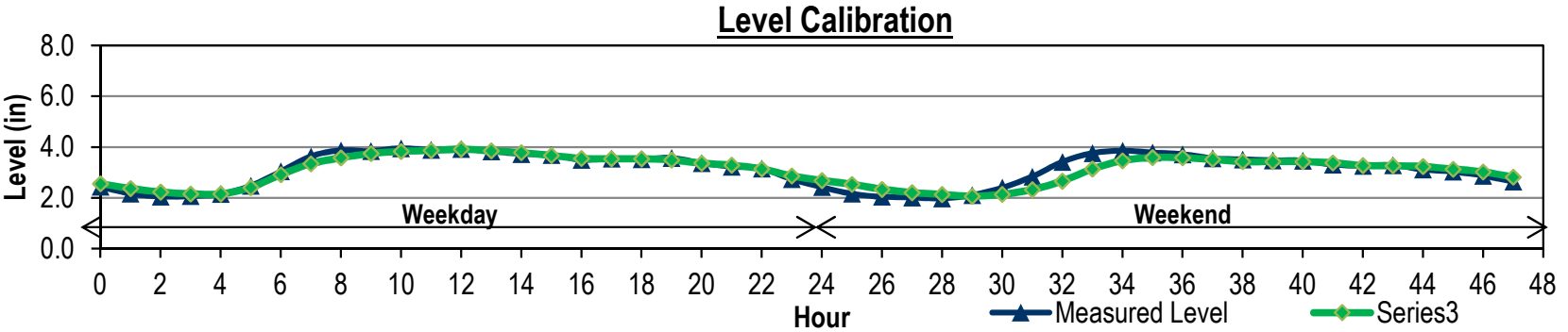
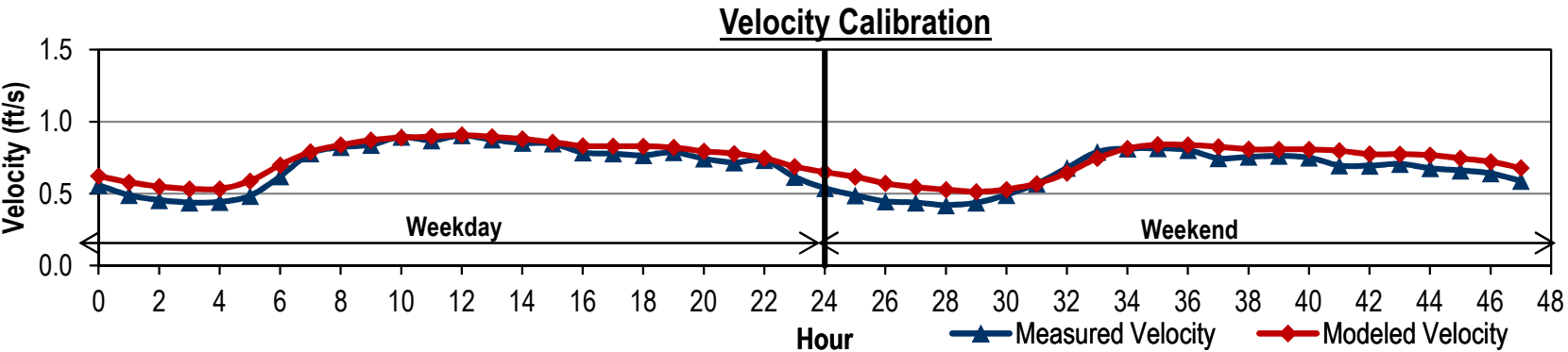
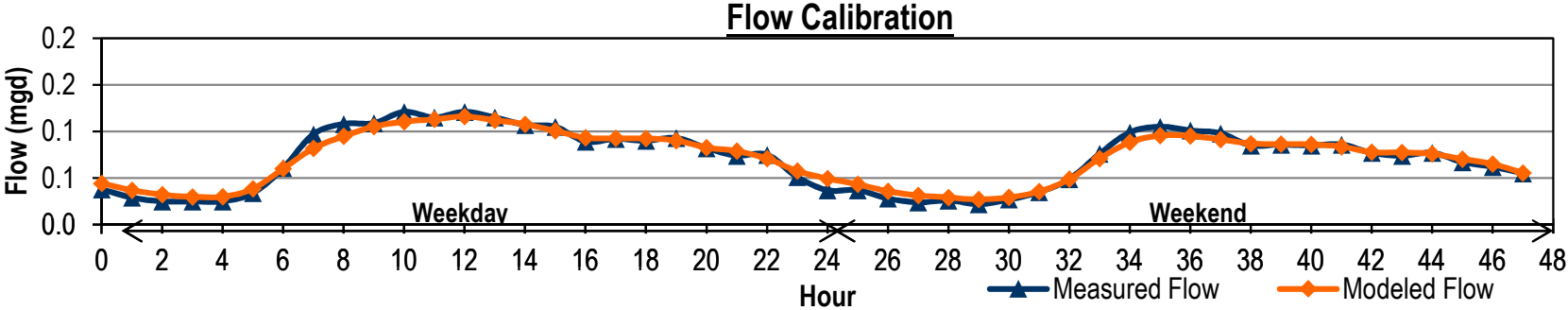
City of Bainbridge Island

General Sewer Plan

FLOW MONITORING SITE Meter 02 DRY WEATHER FLOW CALIBRATION



	Hour	Measured Flow	Level	Velocity	Modeled Flow	Level	Velocity	Calibrated
		(mgd)	(in)	(ft/s)	(mgd)	(in)	(ft/s)	Diurnal
Weekday	0	0.038	2.441	0.560	0.044	2.557	0.623	0.39
	1	0.029	2.167	0.490	0.037	2.370	0.580	0.34
	2	0.025	2.058	0.456	0.032	2.231	0.550	0.34
	3	0.025	2.078	0.439	0.030	2.155	0.533	0.34
	4	0.025	2.155	0.443	0.030	2.159	0.534	0.46
	5	0.034	2.486	0.485	0.039	2.409	0.588	0.82
	6	0.061	3.045	0.621	0.060	2.917	0.699	1.31
	7	0.097	3.636	0.780	0.082	3.345	0.791	1.46
	8	0.108	3.873	0.824	0.095	3.578	0.838	1.47
	9	0.109	3.843	0.840	0.105	3.747	0.872	1.63
	10	0.121	3.951	0.896	0.111	3.830	0.890	1.55
	11	0.115	3.894	0.871	0.113	3.867	0.897	1.63
	12	0.121	3.931	0.905	0.116	3.917	0.907	1.55
	13	0.115	3.829	0.876	0.112	3.853	0.895	1.44
	14	0.107	3.733	0.853	0.108	3.784	0.881	1.42
	15	0.105	3.687	0.849	0.101	3.672	0.858	1.20
	16	0.089	3.503	0.787	0.093	3.553	0.833	1.24
	17	0.092	3.545	0.780	0.093	3.540	0.831	1.22
	18	0.090	3.522	0.767	0.093	3.538	0.830	1.26
	19	0.093	3.572	0.788	0.090	3.494	0.821	1.11
	20	0.082	3.370	0.744	0.083	3.365	0.795	1.00
	21	0.074	3.228	0.717	0.079	3.289	0.779	1.01
	22	0.075	3.156	0.734	0.071	3.139	0.747	0.69
	23	0.051	2.738	0.617	0.058	2.865	0.689	0.51
Weekend	24	0.037	2.429	0.539	0.050	2.682	0.650	0.38
	25	0.037	2.167	0.489	0.043	2.534	0.618	0.32
	26	0.028	2.050	0.447	0.036	2.335	0.572	0.35
	27	0.024	2.022	0.439	0.032	2.207	0.545	0.30
	28	0.026	1.985	0.421	0.029	2.135	0.529	0.36
	29	0.022	2.117	0.438	0.027	2.064	0.513	0.47
	30	0.027	2.406	0.492	0.029	2.139	0.530	0.66
	31	0.035	2.842	0.571	0.036	2.325	0.570	1.03
	32	0.049	3.415	0.680	0.049	2.661	0.644	1.34
	33	0.076	3.761	0.790	0.071	3.140	0.747	1.42
	34	0.099	3.855	0.815	0.088	3.464	0.815	1.46
	35	0.105	3.787	0.815	0.096	3.591	0.841	1.32
	36	0.101	3.719	0.804	0.095	3.581	0.839	1.15
	37	0.098	3.557	0.747	0.091	3.517	0.826	1.16
	38	0.085	3.519	0.757	0.087	3.432	0.809	1.15
	39	0.086	3.481	0.763	0.087	3.429	0.809	1.16
	40	0.085	3.468	0.751	0.086	3.426	0.808	1.04
	41	0.086	3.312	0.697	0.084	3.380	0.799	1.00
	42	0.077	3.265	0.695	0.078	3.274	0.776	1.04
	43	0.074	3.289	0.708	0.078	3.268	0.775	0.90
	44	0.077	3.116	0.677	0.076	3.236	0.769	0.84
	45	0.067	3.038	0.662	0.070	3.131	0.746	0.74
	46	0.062	2.875	0.642	0.065	3.023	0.722	0.50
	47	0.055	2.648	0.589	0.055	2.819	0.679	0.50
Average								
Weekday		0.08	3.23	0.71	0.08	3.22	0.76	1.06
Weekend		0.06	3.01	0.64	0.06	2.95	0.71	0.86
ADWF ⁽¹⁾		0.07	3.16	0.69	0.07	3.14	0.75	1.00
% Error								
Weekday					-0.4%	-0.3%	6.7%	
Weekend					1.3%	-1.8%	9.7%	
Note: 1. ADWF = (5xWeekday Average + 2xWeekend Average)/7								



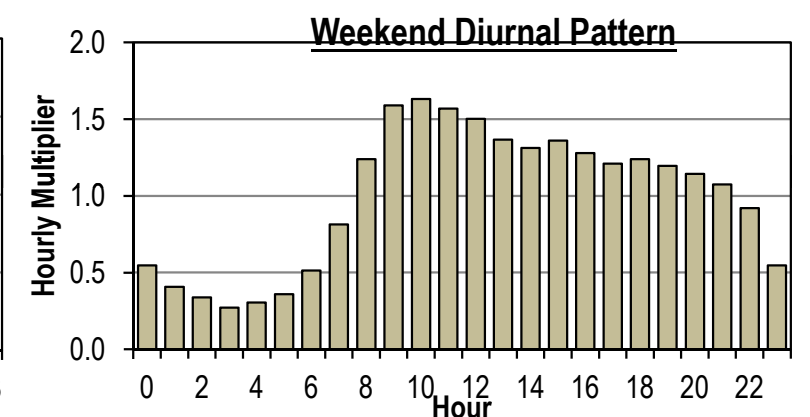
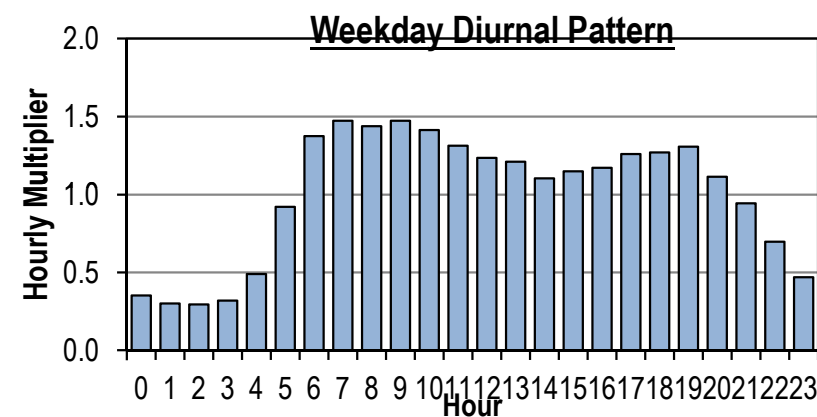
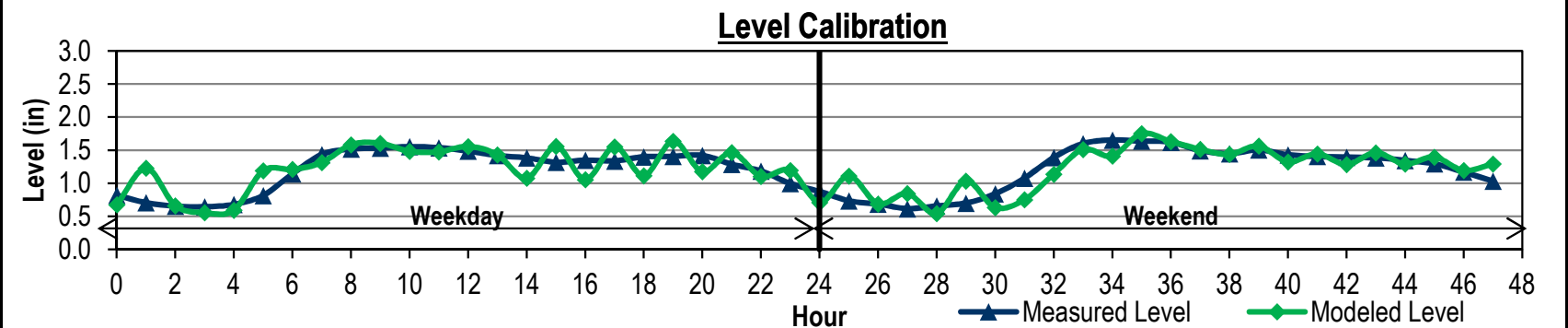
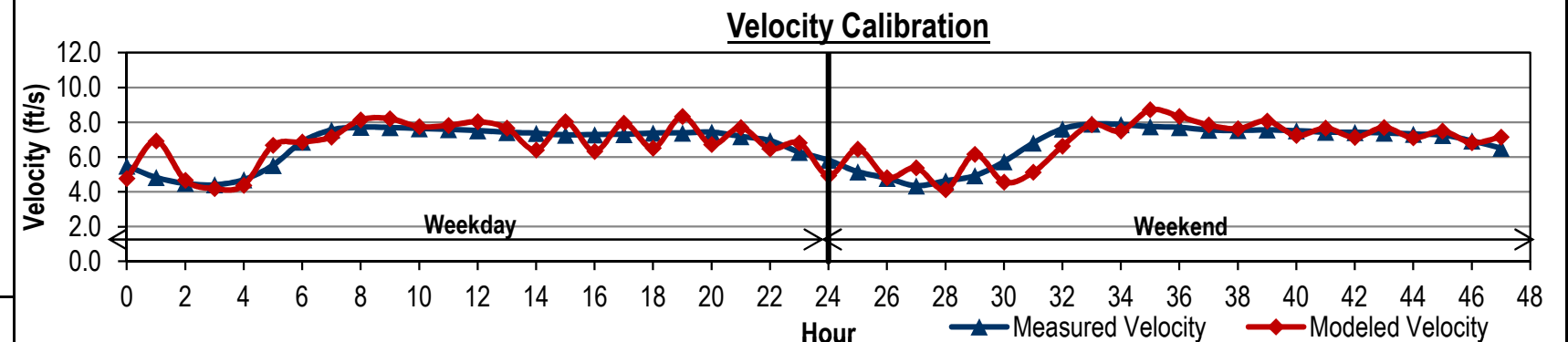
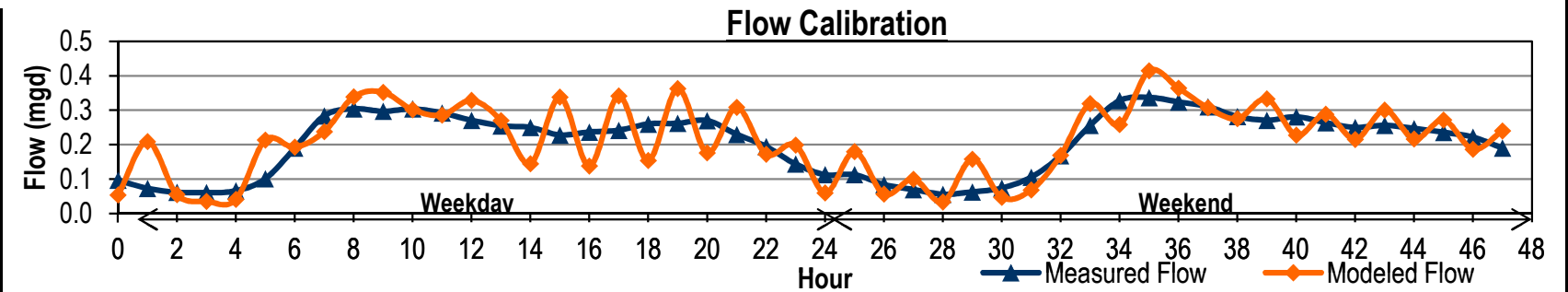


City of Bainbridge Island
General Sewer Plan

FLOW MONITORING SITE Meter 03 DRY WEATHER FLOW CALIBRATION



	Hour	Measured Flow	Level	Velocity	Modeled Flow	Level	Velocity	Calibrated
		(mgd)	(in)	(ft/s)	(mgd)	(in)	(ft/s)	Diurnal
Weekday	0	0.097	0.819	5.494	0.054	0.675	4.770	0.35
	1	0.073	0.707	4.833	0.209	1.227	6.928	0.30
	2	0.062	0.654	4.491	0.055	0.660	4.672	0.30
	3	0.061	0.645	4.412	0.036	0.554	4.190	0.32
	4	0.066	0.680	4.706	0.041	0.592	4.375	0.49
	5	0.101	0.816	5.529	0.214	1.190	6.681	0.92
	6	0.190	1.143	6.870	0.193	1.209	6.866	1.38
	7	0.284	1.435	7.552	0.238	1.311	7.156	1.47
	8	0.304	1.516	7.711	0.339	1.582	8.145	1.44
	9	0.297	1.530	7.695	0.352	1.602	8.206	1.47
	10	0.304	1.553	7.643	0.302	1.481	7.755	1.41
	11	0.292	1.537	7.586	0.286	1.474	7.824	1.31
	12	0.271	1.486	7.515	0.329	1.555	8.031	1.24
	13	0.255	1.420	7.422	0.270	1.429	7.667	1.21
	14	0.250	1.383	7.364	0.145	1.076	6.409	1.10
	15	0.228	1.317	7.265	0.338	1.557	8.039	1.15
	16	0.237	1.348	7.290	0.138	1.053	6.333	1.17
	17	0.242	1.338	7.308	0.342	1.551	7.952	1.26
	18	0.260	1.400	7.376	0.154	1.114	6.518	1.27
	19	0.262	1.405	7.387	0.363	1.635	8.336	1.31
	20	0.270	1.420	7.426	0.176	1.176	6.724	1.11
	21	0.230	1.287	7.183	0.309	1.463	7.699	0.94
	22	0.195	1.185	6.942	0.173	1.103	6.471	0.70
	23	0.144	0.996	6.282	0.199	1.194	6.818	0.47
Weekend	24	0.113	0.875	5.819	0.060	0.709	4.943	0.55
	25	0.113	0.734	5.155	0.180	1.110	6.459	0.41
	26	0.084	0.686	4.791	0.057	0.687	4.825	0.34
	27	0.070	0.616	4.354	0.100	0.844	5.387	0.27
	28	0.056	0.657	4.635	0.034	0.542	4.127	0.31
	29	0.063	0.700	4.933	0.158	1.034	6.162	0.36
	30	0.074	0.840	5.736	0.047	0.632	4.566	0.51
	31	0.106	1.076	6.809	0.069	0.752	5.130	0.81
	32	0.168	1.389	7.619	0.169	1.137	6.633	1.24
	33	0.256	1.599	7.898	0.320	1.511	7.871	1.59
	34	0.328	1.652	7.866	0.259	1.411	7.508	1.63
	35	0.337	1.636	7.747	0.415	1.750	8.719	1.57
	36	0.324	1.620	7.698	0.364	1.630	8.334	1.50
	37	0.310	1.493	7.552	0.307	1.512	7.847	1.37
	38	0.282	1.445	7.528	0.276	1.436	7.633	1.31
	39	0.271	1.504	7.561	0.333	1.561	8.079	1.36
	40	0.281	1.431	7.513	0.228	1.323	7.241	1.28
	41	0.264	1.404	7.427	0.289	1.443	7.662	1.21
	42	0.250	1.395	7.425	0.216	1.283	7.134	1.24
	43	0.256	1.383	7.382	0.301	1.460	7.700	1.20
	44	0.247	1.346	7.320	0.217	1.290	7.110	1.14
	45	0.236	1.294	7.255	0.272	1.394	7.494	1.08
	46	0.222	1.170	6.930	0.187	1.193	6.825	0.92
	47	0.190	1.032	6.515	0.240	1.292	7.153	0.55
Average								
Weekday		0.21	1.21	6.72	0.22	1.23	6.86	1.00
Weekend		0.20	1.21	6.73	0.21	1.21	6.77	0.99
ADWF ⁽¹⁾		0.21	1.21	6.72	0.22	1.22	6.83	1.00
% Error								
Weekday					5.6%	1.5%	2.0%	
Weekend					4.0%	-0.1%	0.7%	
Note: 1. ADWF = (5xWeekday Average + 2xWeekend Average)/7								



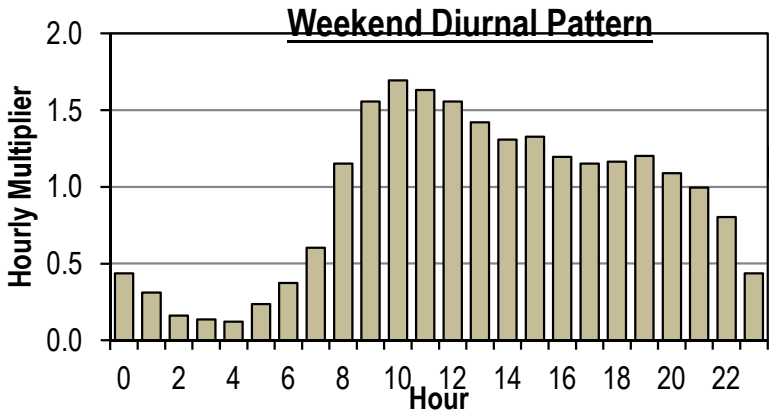
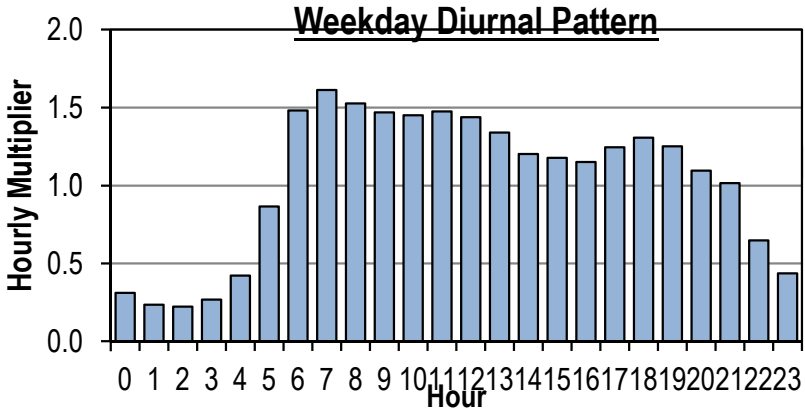
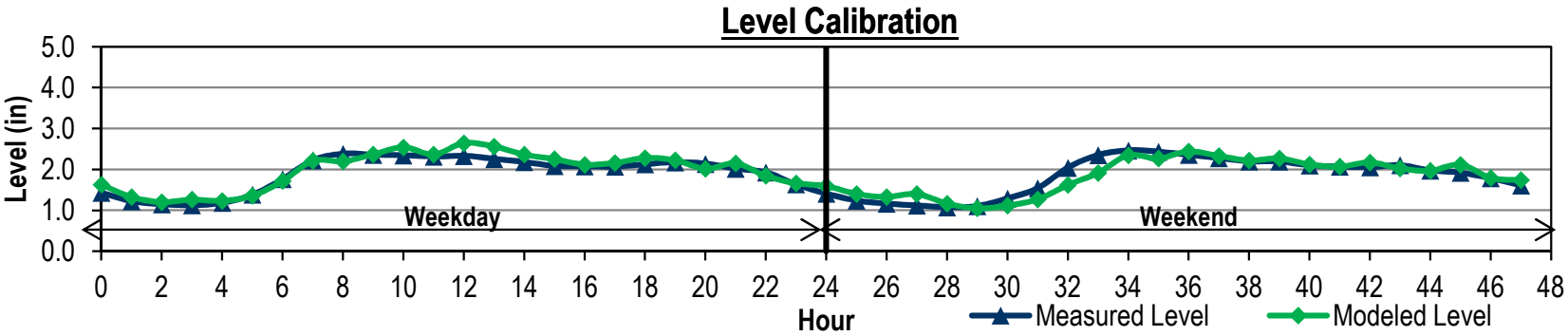
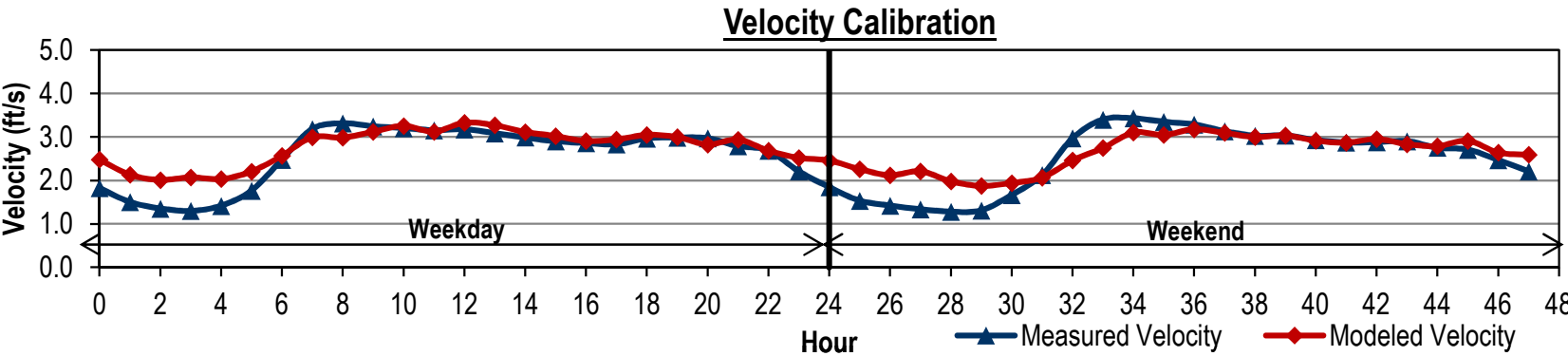
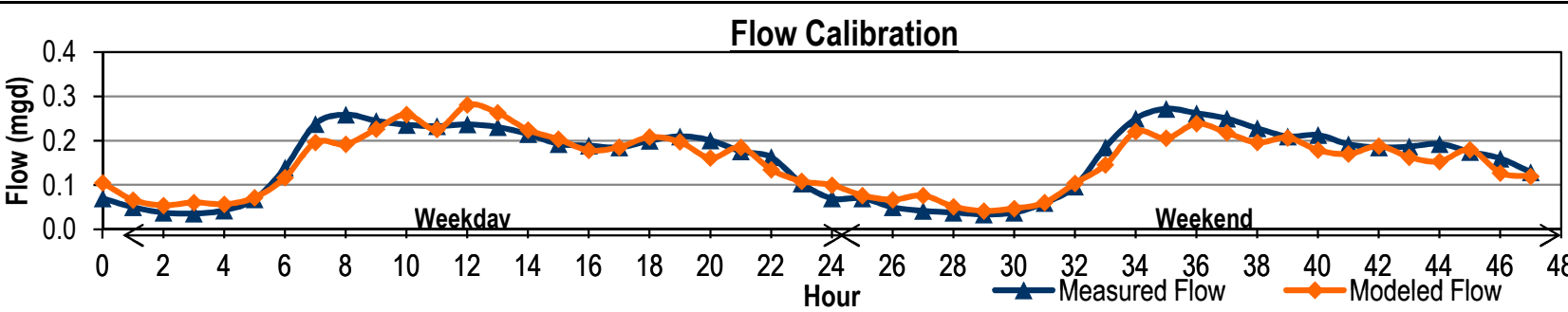


City of Bainbridge Island
General Sewer Plan

FLOW MONITORING SITE Meter 04 DRY WEATHER FLOW CALIBRATION



	Hour	Measured Flow	Level	Velocity	Modeled Flow	Level	Velocity	Calibrated
		(mgd)	(in)	(ft/s)	(mgd)	(in)	(ft/s)	Diurnal
Weekday	0	0.070	1.429	1.823	0.105	1.629	2.480	0.311
	1	0.050	1.227	1.505	0.066	1.325	2.133	0.237
	2	0.038	1.150	1.353	0.054	1.204	2.010	0.224
	3	0.036	1.125	1.298	0.061	1.267	2.070	0.268
	4	0.043	1.185	1.415	0.057	1.234	2.032	0.424
	5	0.068	1.385	1.766	0.072	1.360	2.204	0.866
	6	0.139	1.765	2.475	0.117	1.718	2.568	1.482
	7	0.238	2.223	3.184	0.196	2.212	2.994	1.613
	8	0.259	2.383	3.313	0.192	2.197	2.985	1.526
	9	0.245	2.360	3.247	0.226	2.368	3.119	1.470
	10	0.236	2.346	3.204	0.259	2.541	3.254	1.451
	11	0.233	2.316	3.152	0.226	2.369	3.122	1.476
	12	0.237	2.331	3.177	0.281	2.643	3.327	1.439
	13	0.231	2.258	3.086	0.263	2.562	3.271	1.339
	14	0.215	2.180	2.990	0.224	2.364	3.113	1.202
	15	0.193	2.085	2.900	0.204	2.254	3.019	1.177
	16	0.189	2.077	2.863	0.178	2.118	2.907	1.152
	17	0.185	2.069	2.830	0.186	2.161	2.941	1.246
	18	0.200	2.126	2.968	0.208	2.281	3.047	1.308
	19	0.210	2.177	2.988	0.197	2.226	2.997	1.252
	20	0.201	2.140	2.971	0.161	2.015	2.827	1.096
	21	0.176	2.020	2.792	0.185	2.149	2.939	1.015
	22	0.163	1.928	2.689	0.135	1.844	2.683	0.648
	23	0.104	1.636	2.208	0.109	1.663	2.519	0.436
Weekend	24	0.070	1.408	1.846	0.100	1.596	2.455	0.436
	25	0.070	1.240	1.533	0.076	1.403	2.259	0.311
	26	0.050	1.164	1.420	0.067	1.330	2.119	0.162
	27	0.042	1.121	1.337	0.076	1.402	2.208	0.137
	28	0.038	1.078	1.278	0.051	1.167	1.977	0.121
	29	0.034	1.107	1.311	0.042	1.052	1.876	0.237
	30	0.038	1.294	1.666	0.047	1.117	1.939	0.374
	31	0.060	1.540	2.125	0.060	1.272	2.064	0.604
	32	0.097	2.042	2.971	0.104	1.622	2.462	1.152
	33	0.185	2.350	3.401	0.146	1.916	2.745	1.557
	34	0.250	2.465	3.432	0.221	2.346	3.102	1.694
	35	0.272	2.432	3.349	0.206	2.270	3.045	1.632
	36	0.262	2.356	3.288	0.239	2.441	3.178	1.557
	37	0.250	2.281	3.131	0.218	2.333	3.095	1.420
	38	0.228	2.197	3.028	0.196	2.219	2.998	1.308
	39	0.210	2.192	3.037	0.207	2.272	3.035	1.327
	40	0.213	2.098	2.931	0.179	2.123	2.913	1.196
	41	0.192	2.070	2.873	0.170	2.070	2.869	1.152
	42	0.185	2.056	2.880	0.188	2.171	2.952	1.165
	43	0.187	2.103	2.902	0.163	2.028	2.835	1.202
	44	0.193	1.977	2.753	0.153	1.968	2.790	1.090
	45	0.175	1.918	2.709	0.180	2.118	2.912	0.996
	46	0.160	1.786	2.467	0.127	1.795	2.642	0.803
	47	0.129	1.613	2.208	0.120	1.742	2.592	0.436
Average								
Weekday		0.16	1.91	2.59	0.17	1.99	2.77	1.03
Weekend		0.15	1.83	2.49	0.14	1.82	2.63	0.92
ADWF ⁽¹⁾		0.16	1.89	2.56	0.16	1.94	2.73	1.00
% Error								
Weekday					0.0%	3.9%	7.0%	
Weekend					-7.1%	-0.3%	5.3%	
Note: 1. ADWF = (5xWeekday Average + 2xWeekend Average)/7								





City of Bainbridge Island
General Sewer Plan

FLOW MONITORING SITE WWTP DRY WEATHER FLOW CALIBRATION



	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Calibrated Diurnal
Weekday	0	0.321	0.247	0.653
	1	0.243	0.238	0.493
	2	0.210	0.222	0.428
	3	0.204	0.121	0.415
	4	0.217	0.139	0.442
	5	0.299	0.225	0.608
	6	0.408	0.358	0.830
	7	0.606	0.430	1.233
	8	0.696	0.662	1.415
	9	0.663	0.629	1.348
	10	0.700	0.623	1.422
	11	0.690	0.673	1.403
	12	0.623	0.646	1.267
	13	0.596	0.696	1.212
	14	0.571	0.467	1.160
	15	0.559	0.620	1.138
	16	0.557	0.375	1.133
	17	0.600	0.603	1.221
	18	0.573	0.461	1.166
	19	0.602	0.626	1.225
	20	0.538	0.410	1.095
	21	0.498	0.610	1.012
	22	0.465	0.330	0.945
	23	0.363	0.431	0.738
Weekend	24	0.330	0.235	0.508
	25	0.250	0.252	0.437
	26	0.233	0.213	0.487
	27	0.200	0.184	0.482
	28	0.223	0.175	0.598
	29	0.221	0.186	0.803
	30	0.274	0.293	1.234
	31	0.368	0.521	1.456
	32	0.565	0.604	1.604
	33	0.667	0.684	1.487
	34	0.735	0.709	1.432
	35	0.681	0.606	1.258
	36	0.656	0.592	1.213
	37	0.576	0.594	1.207
	38	0.555	0.505	1.099
	39	0.553	0.535	1.165
	40	0.503	0.517	1.141
	41	0.534	0.493	1.172
	42	0.523	0.504	1.132
	43	0.537	0.508	1.093
	44	0.518	0.502	0.935
	45	0.501	0.497	0.791
	46	0.428	0.412	0.720
	47	0.362	0.381	0.547
Average				
Weekday		0.49	0.45	1.00
Weekend		0.46	0.44	1.00
ADWF ⁽¹⁾		0.48	0.45	1.00
% Error				
Weekday			-8.3%	
Weekend			-3.0%	
Note:				
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7				

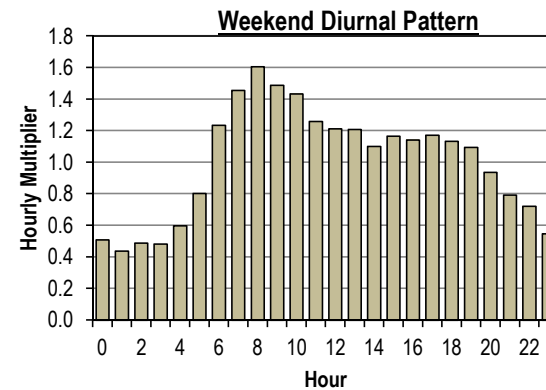
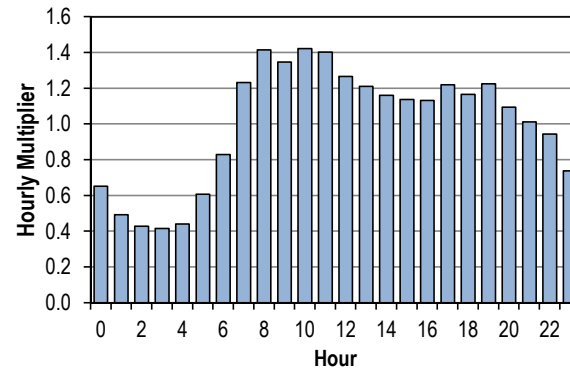
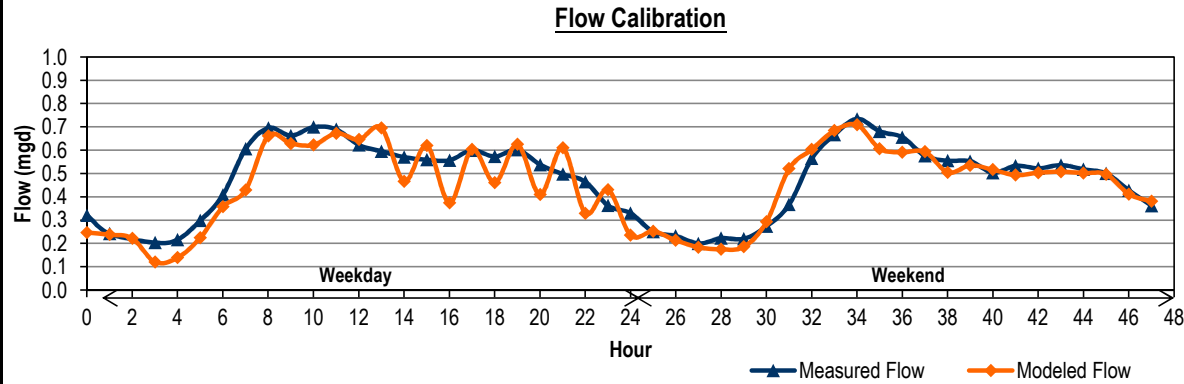


Table 2	Wet Weather Flow Calibration Results
	General Sewer Plan
	City of Bainbridge Island

Meter Number		Pipe Diameter (in)		Storm 1 (11/18/2013-11/20/2013)												Storm 2 (1/5/2014-1/15/2014)												Storm 3 (1/27/2014-1/31/2014)											
				Measured Data ⁽¹⁾				Modeled Data ⁽²⁾				Percent Error ⁽³⁾				Measured Data ⁽¹⁾				Modeled Data ⁽²⁾				Percent Error ⁽³⁾				Measured Data ⁽¹⁾				Modeled Data ⁽²⁾				Percent Error ⁽³⁾			
				Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)
Meter 01	0	0.065	0.117	1.87	1.5	0.074	0.145	2.09	1.5	15.0%	23.2%	11.7%	1.4%	0.070	0.189	2.00	1.5	0.077	0.196	2.11	1.6	10.0%	3.7%	5.5%	2.9%	0.066	0.139	1.95	1.5	0.071	0.133	2.06	1.5	8.1%	-3.7%	5.7%	1.0%		
Meter 02	0	0.089	0.169	0.76	3.5	0.102	0.191	0.83	3.7	14.6%	12.9%	9.8%	6.1%	0.098	0.250	0.83	3.5	0.105	0.249	0.84	3.7	7.2%	-0.1%	1.7%	7.2%	0.092	0.186	0.81	3.4	0.098	0.173	0.82	3.6	5.6%	-7.1%	1.2%	5.2%		
Meter 03	0	0.243	0.374	7.00	1.3	0.234	0.397	7.00	1.3	-3.9%	6.2%	0.0%	-4.5%	0.223	0.451	6.98	1.3	0.236	0.472	7.01	1.3	6.1%	4.8%	0.5%	-0.2%	0.214	0.354	6.75	1.3	0.230	0.412	6.96	1.3	7.2%	16.2%	3.2%	-0.4%		
Meter 04	0	0.176	0.329	2.48	2.1	0.231	0.387	3.08	2.3	30.9%	17.4%	24.0%	11.2%	0.208	0.470	2.95	2.1	0.237	0.559	3.09	2.4	14.1%	19.1%	4.8%	13.1%	0.192	0.346	2.84	2.0	0.221	0.370	3.03	2.3	14.9%	6.9%	6.8%	12.0%		

Notes:

1. Source: City of Bainbridge Island, ADS Report

2. Average flows are calculated from flow monitoring data. Maximum flow values are hourly peaks.

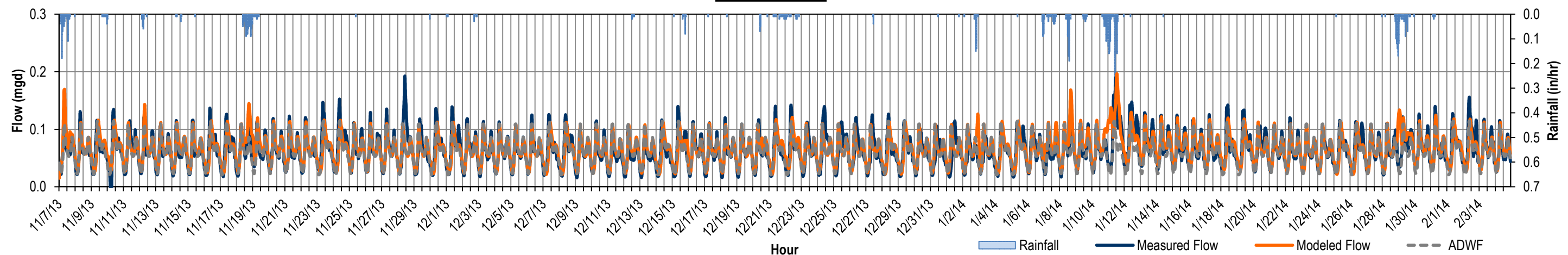
3. Percent Difference = (Modeled - Measured)/Measured*100.



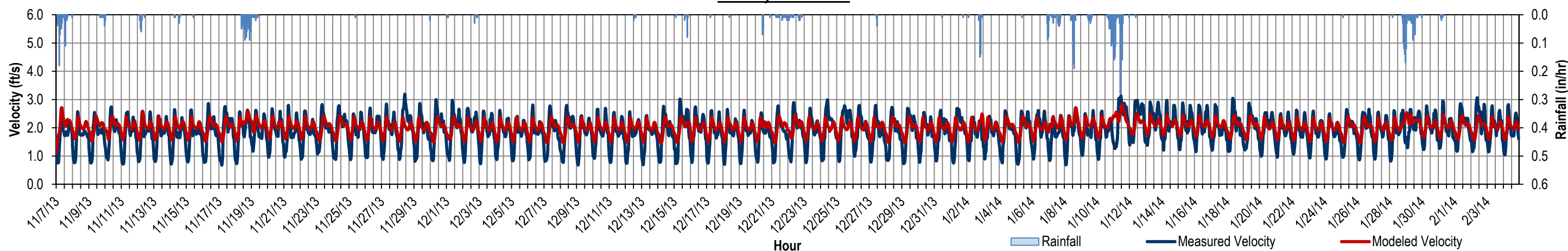
City of Bainbridge Island
General Sewer Plan
FLOW MONITORING SITE Meter 01 WET WEATHER FLOW CALIBRATION



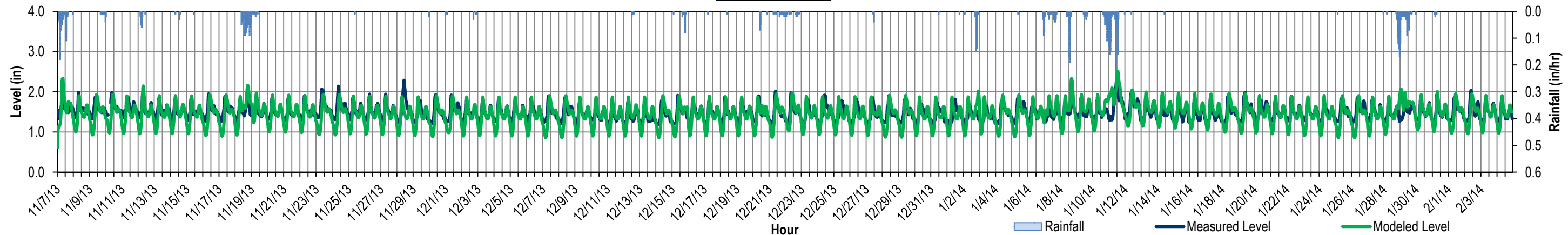
Flow Calibration



Velocity Calibration



Level Calibration

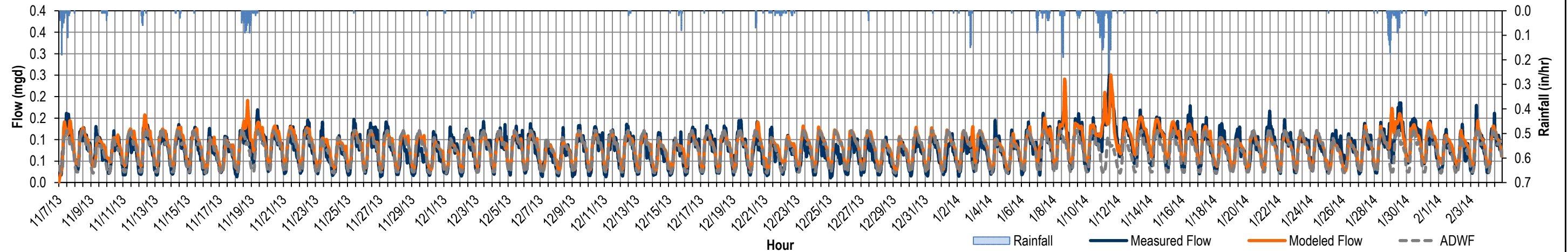




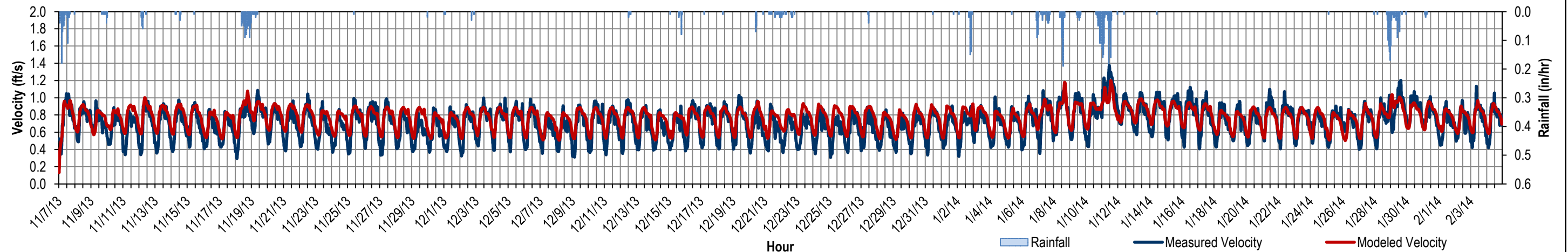
City of Bainbridge Island
General Sewer Plan
FLOW MONITORING SITE Meter 02 WET WEATHER FLOW CALIBRATION



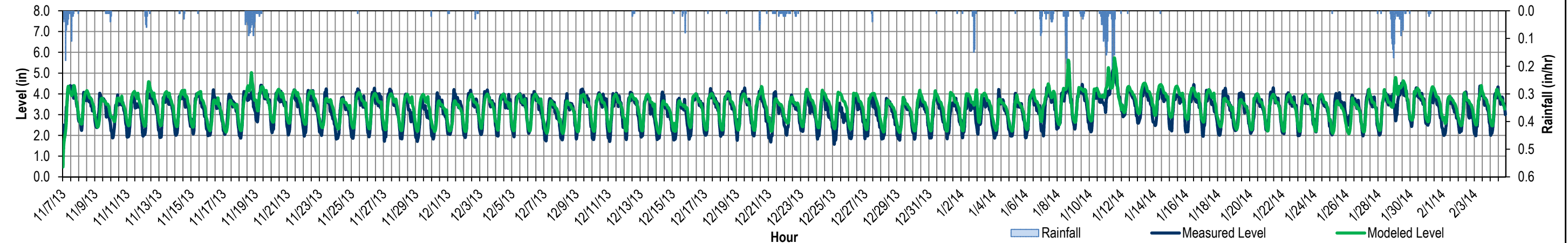
Flow Calibration



Velocity Calibration



Level Calibration

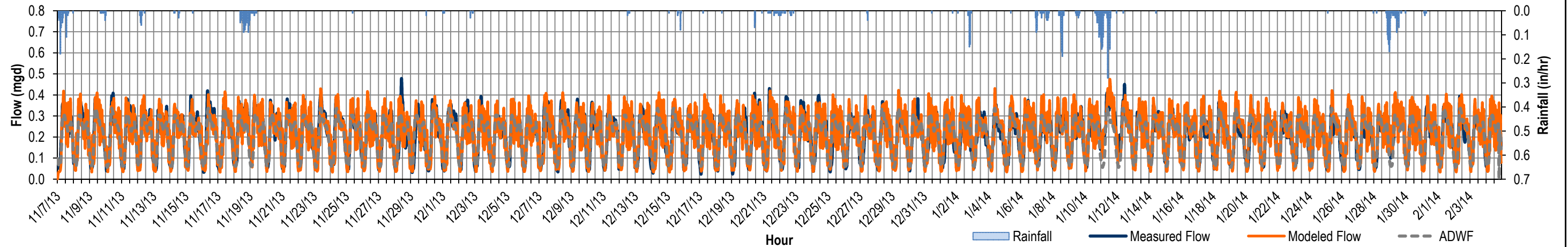




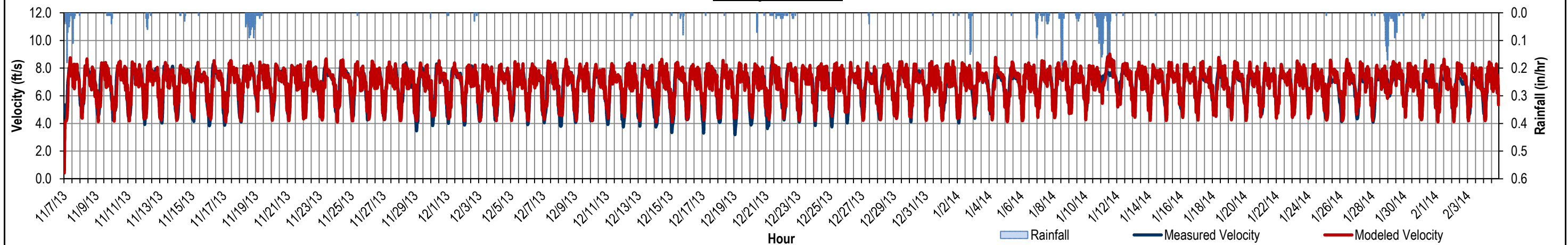
City of Bainbridge Island
General Sewer Plan
FLOW MONITORING SITE Meter 03 WET WEATHER FLOW CALIBRATION



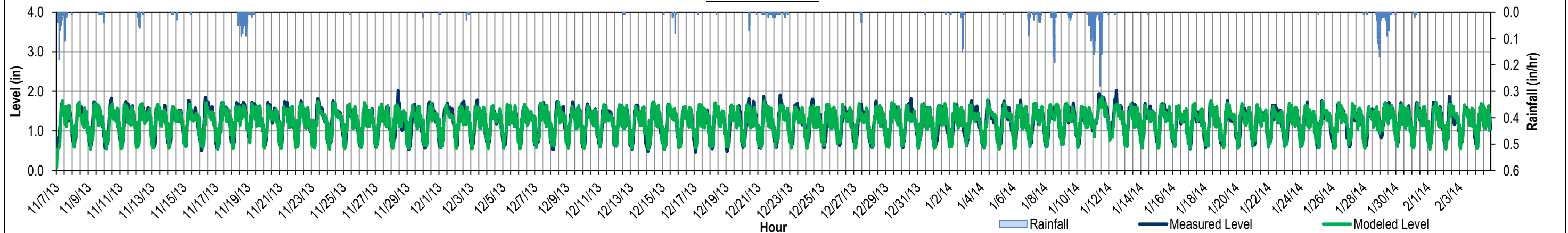
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Velocity Calibration



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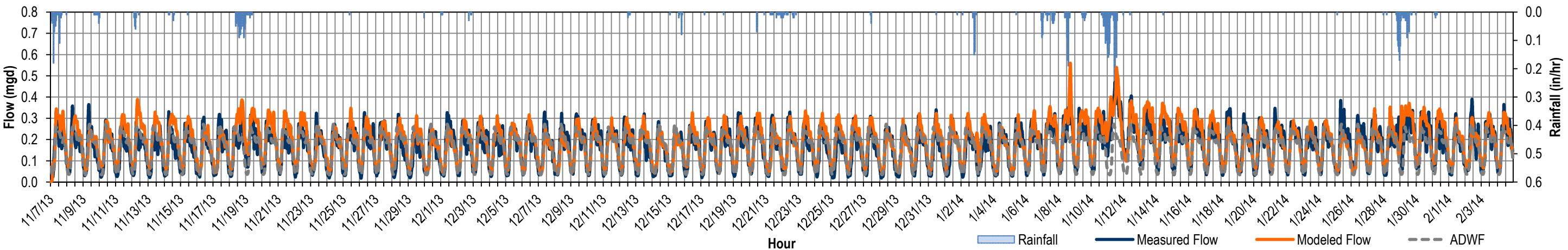




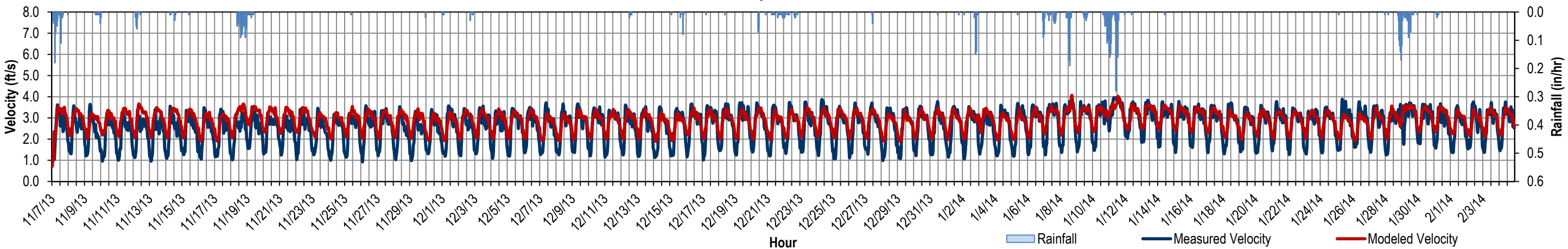
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General Sewer Plan
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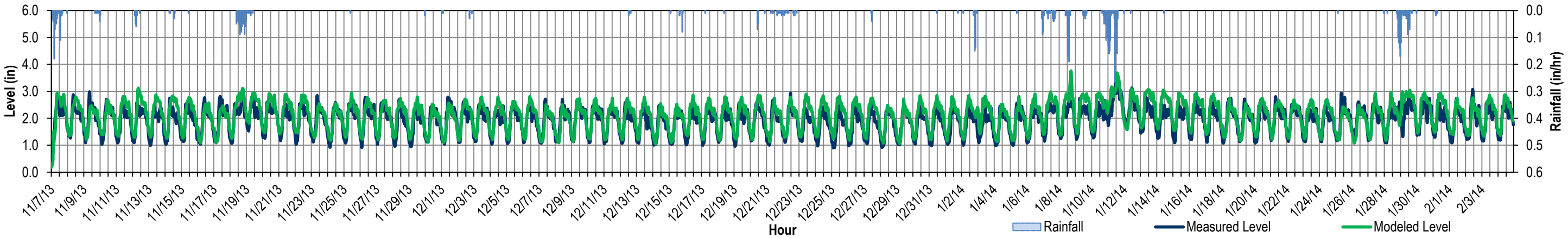
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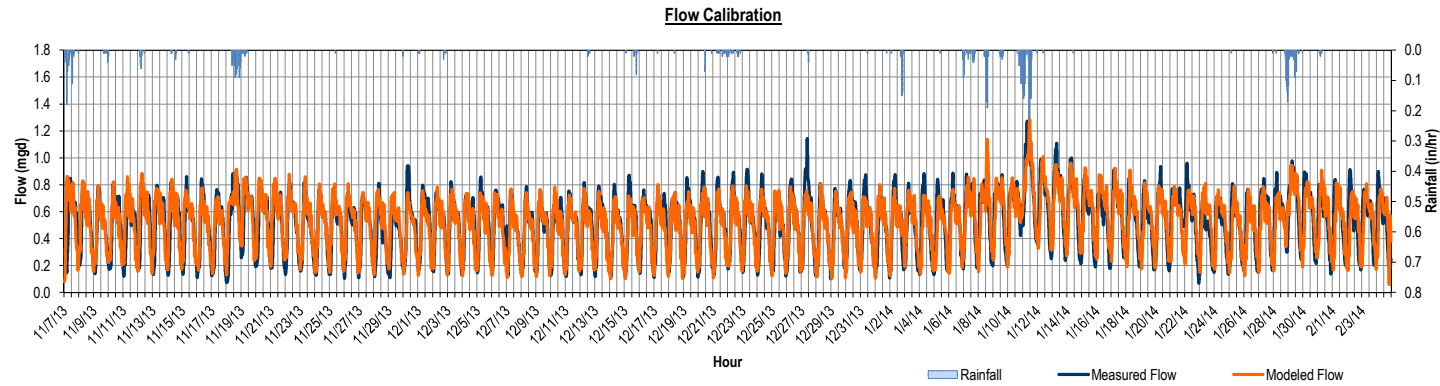


Level Calibration





City of Bainbridge Island
General Sewer Plan
FLOW MONITORING SITE WWTP WET WEATHER FLOW CALIBRATION



Storm	Measured Data		Modeled Data		% Error	
	Average Flow	Peak Flow	Average Flow	Peak Flow	Average Flow	Peak Flow
Storm 1	0.567	0.881	0.601	0.916	6.1%	3.9%
Storm 2	0.619	1.271	0.626	1.282	1.2%	0.9%
Storm 3	0.593	0.978	0.580	0.943	-2.2%	-3.6%

**SOUTH ISLAND SEWER FACILITIES GENERAL PLAN
AND ENGINEERING REPORT**

SOUTH ISLAND

SEWER FACILITIES GENERAL PLAN AND ENGINEERING REPORT



280 Madison Avenue North
Bainbridge Island, WA 98110

Approved By City of Bainbridge Island City Council, December 12, 2001
Approved By Washington State Department of Ecology, March 7, 2002

CITY OF BAINBRIDGE ISLAND

280 Madison Avenue North
Bainbridge Island, WA 98110

SOUTH ISLAND SEWER SERVICE

GENERAL PLAN & ENGINEERING REPORT



EXPIRES 9/5/2003

10/15/01

H. Richard Esvelt, P.E.
H. R. Esvelt Engineering



EXPIRES 04-05-2003

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HSW
EXECUTIVE



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21197

Mayor
City Administrator
Y. MYERS
Caret

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

Northwest Regional Office, 3190 - 160th Ave S.E. • Bellevue, Washington 98008-5452 • (425) 649-7000

March 7, 2002

Mr. Lynn Nordby
City Administrator
City of Bainbridge Island
280 Madison Ave North
Bainbridge Island, WA 98110-1812

Dear Mr. Nordby:

Re: Approval of South Island Sewer Facilities General Plan
and Engineering Report

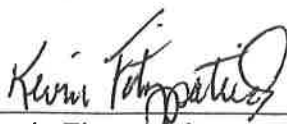
In accordance with RCW 90.48.110 and WAC 173-240-010 through 180 of the Department of Ecology, the General sewer/comprehensive plan and Engineering Report for this project has been reviewed and is hereby approved.

The sewerage projects identified in this plan are not eligible for State Revolving Fund (SRF) loans or Centennial Clean Water Fund (CCWF) grants, as the document does not meet the requirements of a facility plan.

Nothing in this approval shall be construed as satisfying other applicable federal, state or local statutes, ordinances or regulations. This review and approval is limited to assuring compliance with the State water quality laws and regulations listed above.

For additional information, please contact Mr. David Nunnallee, Municipal Unit Supervisor, at the address above or telephone (425) 649-7050.

Sincerely,



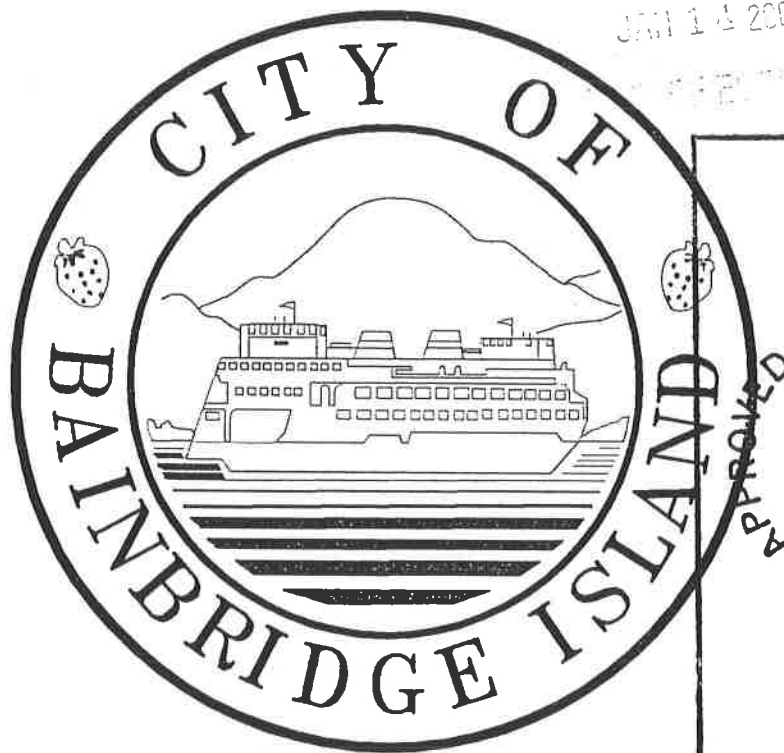
Kevin Fitzpatrick
Water Quality Section Manager

KF:DN:dh

cc: Mr. Rick Esvelt, H.R. Esvelt Engineering



SOUTH ISLAND
SEWER FACILITIES
GENERAL PLAN AND
ENGINEERING REPORT



JAN 14 2002

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MAR 12 2002

H&W
EXECUTIVE

DEPARTMENT OF ECOLOGY

SIGNATURE

David J. Jannal

DATE

Mar 7, 2002

280 Madison Ave. North
Bainbridge Island, WA
98110

CITY OF BAINBRIDGE ISLAND
280 Madison Avenue North
Bainbridge Island, WA 98110

SOUTH ISLAND SEWER FACILITIES
GENERAL PLAN & ENGINEERING REPORT

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CITY OF BAINBRIDGE ISLAND

**280 Madison Avenue North
Bainbridge Island, WA 98110**

SOUTH ISLAND SEWER FACILITIES GENERAL PLAN & ENGINEERING REPORT

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- Bainbridge Island School District, Stephen R. Rowley, Ph.D, Superintendent, 2/5/01 letter requesting sewer service for Blakely Elementary School
- City Council Resolution No. 99-17 authorizing general sewer planning and calling for a public process
- Proposed Process for South Bainbridge General Sewer Plan and LID's
- Public Meeting Notice for October 12, 1999 Comment Meeting
- October 21, 1999 memo to City Council: Summary of October 12 Public Meeting on South-end Sewer Planning and Request for Policy Direction from Council
- Fact sheet prepared for the three neighborhoods: Basic Information on Sewers and Local Improvement District, January 2, 2000
- January 25, 2000 update memo to the City Council: South End Sewer Planning Status Report (subsequently distributed to citizens on project mailing list)
- KCSD7 resolution setting criteria (98-4, Sept. 25, 1998)
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- Minutes of Recessed Regular Council Meeting, January 9, 2001 - Workshop

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**City of Bainbridge Island
South Island Sewer Service
General Sewer Plan and Engineering Report**

EXECUTIVE SUMMARY

INTRODUCTION AND BACKGROUND

Work on a General Sewer Plan for the South End of Bainbridge Island was initiated by the City Council on October 21, 1999 in response to a public process, which had pointed out drainfield failures and associated health and environmental concerns.

A preliminary Sewer Service Study prepared by Esvelt/Isley in May 1999 provided the initial problem statement and a preliminary list of neighborhoods, organizations and individuals indicating a need for sewer service.

At its Oct. 21, 1999 meeting the City Council also approved work on (see resolution in Appendix A):

- negotiating an interlocal agreement with Kitsap County Sewer District No 7 (KCSD7), which owns and operates the Fort Ward wastewater treatment plant, and
- preliminary investigations on forming Local Improvement Districts (LID's) in three neighborhoods demonstrating the highest apparent levels of consensus and need for sewers: Emerald Heights, Pleasant Beach and Rockaway Beach

Purpose of the plan

The General Sewer Plan provides planning for both near and long term sewer needs for the south end of Bainbridge Island, in accordance with the requirements in WAC 173-240. It also provides the basis for regulatory approval for sewer service extension (Washington State Department of Ecology, WDOE) and for the interlocal agreement with KCSD7 to provide treatment of the sewage.

Beyond the contents of this plan, expansion of sewer service areas must be governed by the City of Bainbridge Island's Comprehensive Plan and current zoning. Both the City and KCSD7 have adopted policies guiding provision of sewers, which prohibit increases beyond zoned density limits as a result of sewer service, emphasize locations where on-site septic systems are or will be failing and neighborhoods request sewers, emphasize locations where public benefit can be obtained through more

creative development site planning, and emphasize locations where provision of sewers will protect environmentally sensitive areas.

Ownership, Operation and Maintenance

The plan assumes the sewer district (KCSD7) will continue to own and operate their wastewater treatment plant. The City will contract and pay for wastewater treatment and disposal through an Interlocal Agreement with KCSD7. User charges will be billed by and paid to the City.

The collection system, including the main pump station at Lynwood Center and the recommended Halls Hill Pump Station to serve Rockaway Beach neighborhood, will be owned, operated and maintained by the City of Bainbridge Island.

Community Interest in Sewers

Drainfield failures have been documented (Bremerton-Kitsap County Health District records) and reported by residents, particularly along the waterfront and in older small lot subdivisions. In response to citizen concerns and in an effort to understand the magnitude of the problem, the City Council commissioned a limited preliminary study by Esvelt/Isley, which was completed in the summer of 1999. The study identified problem areas and the potential for serving these areas.

In a March 26, 1999 letter to the City Council supporting the study, KCSD7 noted that providing sewer service in certain south-end areas could mean:

- preserving part of historic Blakely Harbor
- saving open space which would otherwise be lost to development;
- making low income housing available;
- allowing clustered development resulting in open space and trails;
- solving health and environmental emergencies in an affordable manner.

Also during the summer of 1999, KCSD7 Commissioners held a District public meeting where they reiterated their September, 1998 policies guiding provision of sewer service to areas outside its borders. These included not increasing density beyond established zoning, the City operating and maintaining delivery systems, correcting existing or future water pollution problems or creating community benefit, and not putting any of the financial burden on District customers.

4700-18-5102-112

Following these discussions, in September 1999 the City Council authorized a public outreach effort to determine what issues needed to be addressed before a final decision to proceed with south-end sewer planning. Questions included:

- Which neighborhoods most (or least) want and need sewers?
- Are there situations which should require provision of sewer service on an emergency basis?
- What issues are of most critical concern to homeowners as sewer planning proceeds?

Based on the results of the public outreach, at its October 21, 1999 meeting the City Council authorized work on:

- A General Sewer Plan for the South end of Bainbridge Island,
- Negotiating an interlocal agreement with Kitsap County Sewer District No 7 (KCSD7), and
- Preliminary investigations on forming Local Improvement Districts (LID's) in three neighborhoods demonstrating the highest apparent levels of consensus and need for sewers: Emerald Heights, Pleasant Beach and Rockaway Beach.

Neighborhood meetings were held with each of these neighborhoods to disseminate and gather information on septic system failures and the process of obtaining sewer service. All three neighborhoods decided to proceed with formation of LIDs for construction of sewers to serve their neighborhoods. Rockaway Beach was the first neighborhood to present the petition with signatures for LID formation; Emerald Heights and Pleasant Beach North submitted subsequent petitions. Point White residents have subsequently begun organizing and have requested sewer service.

POPULATION AND LAND USE

The existing land use of South Bainbridge Island is predominately single family detached homes on 1.0 and 2.5 acre/house lots. The waterfront is zoned for 1/2 acre lots. However, historical waterfront development patterns are in many cases smaller than the current requirements for septic systems. Substandard lots are considered legal lots if they were platted prior to the new zoning regulations.

The Comprehensive Plan for Bainbridge Island was adopted in 1994 and stands as the public policy document guiding future development on the Island. In addition, both the City Council and KCSD7 have adopted policies guiding provision of sewer for existing and new development.

In City Resolution 99-17 (June 23, 1999), the following policies relate to the extension of sewer service in South Bainbridge Island:

- In return for sewer service, the City of Bainbridge Island will require binding covenants for density reductions or public benefits, such as trails and open space.
- The City will follow KCSD7 policies regarding extension of sewer service outside their boundaries.

In KCSD7 Resolution 98-4 (September 25, 1998) the following policies relate to the extension of sewer service outside district borders:

The proposal may not be used for the purpose of increasing density above the previously established zoning and must correct or prevent a water pollution problem and/or present a clear benefit to the general community.

Waterfront and Upland Development

While there are larger areas of undeveloped wooded uplands, there are only a few undeveloped waterfront properties remaining today. The higher value of waterfront property has created a trend of replacing or remodeling older structures with larger homes, requiring upgrades to on-site septic systems. Because of the poor soil conditions and the set back requirements, some of these homes must seek formal Bremerton-Kitsap County Health District (Health District) waivers from standards. Further, some residents reported that the Health District is unaware that some marginal or failing systems at waterfront homes are not being improved.

In most upland areas, with larger lots and more acceptable soil conditions, on-site septic systems are the preferable means of disposal. Some upland areas were also examined for reasons listed here and in Chapter 3. However, most of these areas with significant development have not expressed an interest in sewer and are not included in the recommended sewer plan. The following are typical of the areas examined:

- Lynwood Center is in the Comprehensive Plan for sewer service.
- Blakely Elementary School has had multiple on-site septic system failures over the years and sewer service has been requested by the school district.
- Much of the Emerald Heights subdivision is small lots and very poor soils resulting in many septic failures. The neighborhood also lies near the head waters to a wetland and stream corridor and has been requesting help from the city since 1998.

- The Blakely Heights subdivision lies upland of the South Bainbridge Water Company wells and was included in the preliminary evaluation, but is not included in the recommended sewer plan.
- Per City and KCSD7 policy, some undeveloped upland parcels may petition the City for extension of sewer service in exchange for creative site design and/or other public benefits guaranteed in perpetuity.

Comprehensive Plan and Growth Management Act

Bainbridge Island is unique in that the entire island is an incorporated city with both rural low density zoning and clearly defined higher density activity centers. Availability of sewers would not change any existing zoning to higher density; however in some cases lots which are legally sub-dividable but currently include only one dwelling, using the other half of the lot for the drainfield, might be able to subdivide. It should be noted, however, that the availability of newer, high-tech septic systems which require minimal drainfield space has essentially the same effect (e.g. allowing subdivision of previously intact lots where zoning allows).

The City Council has determined that the Comprehensive Plan needs to be amended for expansion of sewer service outside existing sewer service areas and has requested a review and recommendations by the Planning Commission.

DEVELOPMENT OF SEWER SERVICE AREAS

Basis of Need and Public Participation

For several years, residents of two south island neighborhoods (Emerald Heights and Pleasant Beach) had been in contact with city officials seeking relief from failing septic systems and the resulting concerns about environmental and public health.

On June 23, 1999 the City Council directed development of a general sewer plan for the south part of the island, including the need for a public process.

A public meeting was held on Oct. 12, 1999 to provide background on the purpose and content of the current sewer planning for the south-end and hear residents' comments and statements of need. Emerald Heights residents described failing drainfields and sewage running in ditches during the rainy season. They expressed a high level of consensus about the need for sewers. Similarly, Pleasant Beach residents expressed concerns about

estuary pollution and described situations where sewage ran across the lawn despite careful septic system upkeep. Rockaway Beach residents cited failing systems on their and/or neighbors' property, characterized their situation as 'critical', and requested high priority consideration for sewers. Residents from other neighborhoods, including Point White, South Beach and Oddfellows, also forwarded concerns about failing septic systems.

In the months since the October, 1999 meeting four neighborhoods have worked actively to petition the city to proceed with sewers to serve their areas to rectify failing systems. Most neighborhoods circulated Septic Survey Questionnaires asking residents to describe the condition of their septic systems and any problems or concerns they have experienced. Each neighborhood tallied their own questionnaires and used the results in determining the extent of the need and the number of houses which would most benefit from provision of sewers.

Existing On-Site Sewer Systems

The traditional on-site system consisting of a septic tank and drainfield has commonly been used in Kitsap County and still is a viable option where a public sewer hook-up is unavailable, soil percolation rates are acceptable, and water tables are not shallow. With the exception of KCSD7 and Lynwood Center, South Bainbridge Island is dominated by on-site systems for treatment and disposal of domestic wastewater.

According to Bremerton/Kitsap County Health District records, during the past two years approximately 70 south island septic systems have reported failures requiring repairs. The Health District indicates the following issues are considerations when weighing septic system repair/replacement vs. provision of sewer service:

- Sometimes the repairs are very expensive, more so than it would be to connect to the sewer.
- Often the repairs do not last over the long term given the poor soil conditions.
- Sewers give a permanent solution and may allow for expansion of the home whereas a small lot would limit the installation of enough drainfield to allow for a home expansion, i.e. adding more bedrooms.
- There are cases where repairs meeting the code cannot be made due to small lots. These homes are listed as 'Substandard'.

Identification of Sewer Service Areas

The majority of the study area should continue to be served by on-site septic systems. The areas identified (as directed by the

1999 City Council) for preliminary evaluation for near- and longer-term future sewer service include sites which meet these criteria:

- In the higher density areas along the waterfront,
- In the uplands areas where poor soils for drainfields (as defined by Health District) make it undesirable or impractical to build and/or maintain on-site systems,
- Where on site septic systems may jeopardize water sources or degrade environments such as streams, wetlands and waterfronts, and
- In certain undeveloped lands where public benefit can be gained through more creative subdivision design.

COLLECTION SYSTEM ALTERNATIVES

A number of alternatives for collection systems were considered in the planning process, but only two were considered viable for use in the study area, as follows:

Conventional gravity sewers use gravity to transport wastewater to the WWTP

Advantages:

- Low maintenance and no energy consumption when intermediate lift stations are not required
- Low operation and maintenance (O&M) costs
- Can easily accommodate full-buildout/ultimate development

Disadvantages:

- Relatively high construction costs
- Favorable topography required.
- Infiltration/Inflow may be excessive, increasing treatment plant size and cost.
- Customer is responsible for maintenance of on-property systems components.
- High potential environmental impact during construction.

Grinder pump low pressure sewer service conveys sewage through small diameter, low pressure piping to the treatment facility.

Advantages:

- May be the only appropriate sewer when gravity flow is not possible and septic tanks have a high failure rate and/or short design life
- Low installation costs and low environmental impact during construction
- Reduced infiltration/inflow

Disadvantages:

- Higher operation and maintenance costs

- Permanent maintenance easements for access to the customer's property
- Increased inflow may result.
- Wastewater delivered to the treatment plant may be more concentrated, which could result in higher treatment costs

WASTEWATER FACILITIES

Kitsap County Sewer District 7 Wastewater Treatment Facility

The existing wastewater treatment plant (WWTP) was completed and operational in 1998, designed to produce effluent treated to better than secondary treatment levels with ammonia reduction. The plant currently has excess capacity, and KCSD7 has offered to make connections available to customers outside the district.

The treatment plant and the site were designed to allow expansion and with existing available capacity and the capability for expansion of components in the plant, there will be adequate capacity to serve the sewer hookups recommended for sewer service in Chapter 8.

RECOMMENDED PLAN

Recommended Service Areas

The neighborhoods listed below meet the established criteria for sewers and are recommended in Chapter 8 of this Plan for sewer service:

Emerald Heights
 Rockaway Beach
 Lynwood Center/Schel-Chelb Estuary
 Point White Drive WF
 Pleasant Beach North
 Fort Street
 Blakely Elementary School

Operations and Maintenance

Collection system operation and maintenance will be done by the City of Bainbridge Island and billed as part of the monthly sewer fees. A maintenance program for the on site grinder pumps will have to be established by the City to assure that all connections are reliably served.

CHAPTER 5

DESIGN CRITERIA

5.1 BASIS FOR WASTEWATER FLOW PROJECTIONS

Kitsap County Sewer District No. 7 (KCSD7), Fort Ward, Bainbridge Island, currently uses an average of 259 gallons per day (gpd) to calculate an equivalent residential unit (ERU) ("Kitsap County Sewer District No. 7 Comprehensive Plan & Engineering Report", July 5, 1990, called Sewer Plan). This ERU flow was based upon population equivalents per household in the Fort Ward area and the high infiltration and inflow (I/I) found in the old sections of sewers that date back to World War I.

Most Western Washington communities with average I/I, use 200 to 240 gpd/ERU, depending upon persons per average household (see Chapter 2).

Since completion of the wastewater treatment plant (WWTP), KCSD7 has replaced all the old sewers in the sewage collection system with new sewers. The flows at the WWTP have been monitored to establish the I/I remaining in the system. The I/I continues to be within acceptable ranges (personal communication with Mike Yuhl, KCSD7 manager).

The unit flows could be adjusted downward for the existing KCSD7 sewer service area (Average persons per household on Bainbridge Island was established in Chapter 2 and 3 as 2.39 persons per household average, at WDOE criteria of 100 gpd/person is 240 gpd/ERU). A preliminary evaluation by KCSD7 estimated that there is capacity in the WWTP for 200 more connections (see letter in Appendix A). Since there is an anticipated need of 50 additional connections within their service area, KCSD7 offered 150 connections outside of the district for initial connections. Unit flows will be based upon historic flows into the existing plant and existing plant capacity will be established in the KCSD7 engineering report for plant expansion.

All sewers within the South Bainbridge Island City collection system will be new (or close to new in the existing Lynwood Center service area). As noted above, most Western Washington communities are using lower per capita flows for new service areas, due to low flow fixtures, emphasis on water conservation and new sewers with lower infiltration. Therefore, unit flow of

220 gpd/ERU is recommended for the sewer collection system outside of the KCSD7/Fort Ward service area.

A peaking factor (average flow to peak flow) of 3.0 (as per Washington State Department of Ecology, WDOE, design standards for sewers and pump stations) will be used with the 220 gpd/ERU for sizing sewers and pump stations. This unit flow was also used to establish the capacity of the existing Lynwood Center Pump Station (see Section 4.4).

5.2 FLOW PROJECTIONS

Table 5-1 lists the areas to be provided sewer service in the Recommended Plan (Chapter 8).

TABLE 5-1 THEORETICAL FACILITY CAPACITY PLANNING -
recommended service areas, only

Existing Neighborhoods	ERU ⁴ Possible Totals
<u>To Lynwood Cntr Pump Station:</u>	
Lynwood Center/Schel-Chelb Estuary	120 ³
Emerald Heights	60
Pleasant Beach North	40
Blakely School	15
Point White Drive	65
Total to Lynwood Center Pump Station	300
Rockaway Beach	90
Total to Hall's Hill Pump Station	90
Other possible areas outside of KCSD7 boundaries:	
Fort Street	6
Theoretical Facility Capacity (outside of KCSD7) (includes 80 existing connections)	396

NOTES:

1. Total ERU's to the Lynwood Center Pump Station (existing capacity 480 ERU).
2. Total ERU's to Hall's Hill Pump Station, which is proposed to pump directly to the treatment plant.

3. 80 of these connections are existing Lynwood Center connections, included in KCSD7 wastewater treatment plant current committed connections.
 4. ERU = equivalent residential unit = connection or hookup
-

2007 WINSLOW WWTP UPGRADES PROJECT DRAWINGS

