



April 11, 2019

To:	Town of Falmouth, MA	Ref. No.:	11153041
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CC:	File; Project Team		
Subject:	South Coast Embayments – Preliminary Evaluations and Notice of Project Change Project Teaticket / Acapesket Study Area Discharge Technologies Evaluation – Technical Memorandum No. 3 (TASA TM-3)		

1. Purpose of Memo

The purpose of TASA Technical Memorandum 3 (TASA TM-3) is to summarize the updated discharge technologies evaluation that was conducted for the Teaticket/Acapesket Study Area (TASA), which includes portions of the Great and Green Pond watersheds.

1.1 References, Regulations, and Design Guidelines

The references, regulations, and design guidelines listed below were used to develop this memorandum. Documents are referred to by the abbreviation indicated in parenthesis for the remainder of the memorandum.

References:

- TASA TM No. 6 – South Coast Embayments Preliminary Evaluations and Notice of Project Change Project – Draft Outfall Conceptual Cost Evaluation, prepared by GHD, dated November 2018 (TASA TM-6)
- TASA TM No. 5 – South Coast Embayments Preliminary Evaluations and Notice of Project Change Project – Draft Hydraulic Load Tests at the Augusta Parcel an Allen Parcel, prepared by GHD, dated November 2018 (TASA TM-5)
- TASA TM No. 4 – South Coast Embayments Preliminary Evaluations and Notice of Project Change Project – Draft WWTF Evaluation, prepared by GHD, dated October 2018 (TASA TM-4)
- TASA TM No. 1 – South Coast Embayments Preliminary Evaluations and Notice of Project Change Project – Draft Service Area, Flow and N Load Evaluation, prepared by GHD, dated May 2018 (TASA TM-1)



- Shared Wastewater Management Study – Towns of Bourne, Falmouth, Mashpee, Sandwich and Joint Base Cape Cod, prepared by Wright Pierce, dated November 2017 (2017 Wright Pierce JBCC Study)
- Recharge Beds 14 and 15 Operations and Maintenance Manual, prepared by GHD, dated June 2017
- Modified Individual Groundwater Discharge Permit No. 168-5, effective date December 22, 2015 (2015 Permit)
- Comprehensive Wastewater Management Plan and Final Environmental Impact Report and Targeted Watershed Management Plan – Little Pond, Great Pond, Green Pond, Bournes Pond, Eel Pond, and Waquoit Bay Watersheds and Recommendations for West Falmouth Harbor Watershed, prepared by GHD, dated September 2013. (2013 CWMP/FEIR/TWMP)
- Technical Memorandum No. 7 – Evaluation and Summary of Committee’s Preferred Option, prepared by Stearns & Wheler, dated October 20, 2010 (2010 TM-7)
- Technical Memorandum No. 1 – Cost Summaries for Alternative Wastewater Management Scenarios, prepared by Stearns & Wheler, dated October 7, 2010 (2010 TM-1)
- Comprehensive Wastewater Management Plan Review Committee Findings (revised 8/31/10, 9/7/10) Part 1: Design and Technical Principles (2010 CWMP Committee Findings)
- Groundwater Modeling to Support Comprehensive Wastewater Management Planning Guidance Document and Case Study Report, prepared by Stearns & Wheler GHD and Watershed Hydrogeologic Inc., dated June 2009 (2009 GW Modeling Report)
- Little Pond, Great Pond, Green Pond, Bournes Pond, Eel Pond, and Waquoit Bay Watersheds Alternatives Screening Analysis Report, prepared by GHD (formally Stearns & Wheler, LLC), dated November 2007 (2007 ASAR)
- Little Pond, Great Pond, Green Pond, Bournes Pond, Eel Pond and Waquoit Bay Watersheds Needs Assessment Report, prepared by Stearns & Wheler, dated October 2007 (2007 NAR)
- Falmouth Wastewater Treatment Facility Operation & Maintenance Manual – Draft, prepared by MaGuire Group Inc., dated 2007 (2007 Draft WWTF O&M Manual)
- Falmouth Country Club Conservation Restriction’, dated 2007 (FCC Restriction)
- Plan of Land Prepared for Town of Falmouth in Falmouth, MA Being a Subdivision of Lot 1 as Shown on L.C. Plan 39540-A, prepared by Holmes and McGrath, Inc., dated May 25, 2005 (2005 Allen Parcel Plan of Land)
- Article 5 and the Vote Thereon at the Special Town Meeting Held in Falmouth April 13, 2004
- Quitclaim Deed for the Augusta Parcel, dated August 2003
- Cape Cod Commission Modification of Development of Regional Impact Decision for the Falmouth Country Club – TR96021, dated 1999 Article 20 and the Vote Thereon at the Annual Town Meeting Convened at Falmouth, Massachusetts April 7, 2003
- Falmouth Conservation Commission Order of Conditions, dated 1997



- Plan of Land in Falmouth, drawing, prepared by Philip D. Holmes, dated December 1976
- Plan of Land for the Northern Trust Company in East Falmouth, Mass drawing, prepared by Philip D. Holmes, dated December 1976
- Sewage Disposal in Falmouth Massachusetts – III. Predicted Effects of Inland Disposal and sea Outfall on Groundwater, Robert Meade and Ralph Vaccaro, published in the Boston Society of Civil Engineers October 1971 (Meade & Vaccaro, 1971)
- Sewage Disposal in Falmouth Massachusetts – II. Predicted Effect of the Proposed Outfall, W. Redwood Wright, Dean F. Bumpus and Ralph Vaccaro, published in the Boston Society of Civil Engineers October 1971 (Bumpus, Wright & Vaccaro, 1971)
- Sewage Disposal in Falmouth Massachusetts – I. “Expert” Opinion and Public Policy, W. Redwood Wright, Dean F. Bumpus and Ralph Vaccaro, published in the Boston Society of Civil Engineers October 1971 (Bumpus & Vaccaro, 1971)
- Cape & Vineyard Electric Company Right of Way for Falmouth – Hatchville 23 k.v. Electric Line Through the Town of Falmouth drawing, prepared by Walter E Howlet B. Associates, revised March 19, 1965

Regulations:

- 314 CMR 5.00 – Groundwater Discharge Permits, effective December 2, 2016 (314 CMR 5.00)
- 310 CMR 27.00 – Underground Injection Control Regulations, dated September 23, 2016 (310 CMR 27.00)
- 314 CMR 4.00 – Massachusetts Surface Water Quality Standards, effective December 6, 2013 (314 CMR 4.00)
- 314 CMR 20.00 – Reclaimed Water Permit Program and Standards, effective March 20, 2009 (314 CMR 20.00)
- Massachusetts Ocean Sanctuaries Act (M.G.L. c132A) (Massachusetts Ocean Sanctuaries Act)
- 40 CFR Part 147 - State, Tribal and EPA-Administered Underground Injection Control Programs (40 CFR Part 147)

Design Guidelines:

- Guidelines for the Design, Construction, Operation, and Maintenance of Small Wastewater Treatment Facilities with Land Disposal, prepared by MassDEP, as revised in July 2018. (2018 MassDEP Small WWTF Design Guidelines)
- Massachusetts Department of Environmental Protection (MassDEP) Standard Design Guidelines for Shallow UIC Class V Injection Wells' <https://www.mass.gov/service-details/standard-design-guidelines-for-shallow-uic-class-v-injection-wells>, 2018 (MassDEP Shallow Injection Well Guidelines)
- New England Interstate Water Pollution Control Commission, TR-16: Guides for the Design of Wastewater Treatment Works, 2011 Edition as revised in 2016. (TR-16)



- 'Title 5 Pressure Distribution Design Guidance', prepared by MassDEP, dated 2002

2. Discharge Technology Evaluation Update

Effluent discharge technology options were initially evaluated as part of the 2007 Alternatives Screening Analysis Report (ASAR). This section documents the updated discharge technology evaluation that was conducted based on a review of regulations and industry design guidelines (as of August 2018). To maintain consistency throughout the document each discharge technology is referred to by the name used in the 2018 MassDEP Small WWTF Design Guidelines.

2.1 Land Application

The 2018 MassDEP Small WWTF Design Guidelines list the following technologies as approved methods of effluent land disposal:

- Open sand beds
- Leaching facilities (leaching pits, leaching trenches, leaching chambers)
- Drip dispersal or other approved subsurface methods
- Reclaimed water uses consistent with MassDEP policies (including spray irrigation)

Alternative methods of effluent disposal through land application, including well injection and wick wells, are allowable on a case-by-case basis provided that adequate pilot test results at the proposed discharge site (performed with MassDEP approval) are provided or adequate experience at similar locations exists. Discharge sites within a Zone II need to meet a higher effluent standard than a site outside of a Zone II. All discharge sites currently under consideration are outside of a Zone II.

2.1.1 Open Sand Beds

Open sand beds—also known as sand infiltration beds, surface infiltration beds, recharge beds, or rapid infiltration beds—are open basins designed to allow treated effluent to flow across the bottom of the basin and infiltrate through the sand bed and the unsaturated zone to the groundwater. Open sand beds are typically operated year-round. Bed operation and maintenance (O&M) is relatively simple because the bed is exposed at the surface and the sand surface can be raked or replaced if the sand becomes plugged with effluent solids, debris, or vegetative growth. The Town currently has 15 open sand beds at the Falmouth WWTF.

A hydraulic loading rate of 5 gallons per day per square foot (gpd/sf) of bed area is typically allowed by MassDEP unless hydrogeologic tests demonstrate a greater infiltration loading capacity at the specific site. Advantages and disadvantages of open sand beds are summarized below in the following table.



Table 2.1 Open Sand Beds Summary

Discharge Technology	Advantages	Disadvantages
Open Sand Beds	<ul style="list-style-type: none"> • Relatively high hydraulic loading rates on sites with good permeability and sufficient depth to groundwater. • Town of Falmouth currently uses these at the WWTF and is familiar with the technology. 	<ul style="list-style-type: none"> • Large surface footprint requirements, which may have a visual and environmental impact. • No secondary uses of the land. • Effluent disinfection required. • If the discharge site is located in a nitrogen-sensitive watershed, effluent will likely need to be treated to a very low effluent nitrogen limit. • If discharge site is located in a Zone II protection area, effluent filtration is required per 314 CMR 5.00. An effluent Total Organic Carbon (TOC) limit will also need to be met.

2.1.2 Spray Irrigation

A spray irrigation system is comprised of effluent pumps, distribution piping, and a spray system consisting of risers and spray nozzles. Treated effluent is pumped through distribution lines and discharged via spray nozzles to the surrounding surface area. Spray irrigation systems may be suitable for golf courses and in large remote fields during the growing season. During the winter (non-growing season) effluent would need to be stored or discharged at a different location through an alternate technology.

314 CMR 20.00 – Reclaimed Water Program and Standards, which was most recently updated in 2009, classifies irrigation uses into three categories:

- Class A – Locations where individual members of the public are likely to come into contact with the reclaimed water.
- Class B – Locations where individual members of the public are not likely to come into contact with the reclaimed water.
- Class C – Agricultural irrigation with restrictions and silviculture (growing and cultivation of trees).

Spray irrigation was utilized at the Falmouth WWTF for a period of time starting in 1988 and has been discontinued. The spray irrigation system had a design average annual capacity of 0.5 mgd and was designed to be used from March to November. Two storage ponds at the WWTF were intended to provide storage capacity for effluent during winter when the system was not in use. It should be noted that if spray irrigation was reinstated at a new location, an additional disinfection process would be required to meet the fecal coliform requirement for Class A or Class B reclaimed water.

The Application rate for non-golf course areas is typically 2 inches per acre per week. Application rates for golf courses are typically based on turf management needs. Effluent disposal through spray irrigation is limited to the growing season.

Advantages and disadvantages of spray irrigation systems are summarized in the following table.



Table 2.2 Spray Irrigation Summary

Discharge Technology	Advantages	Disadvantages
Spray Irrigation	<ul style="list-style-type: none"> • Land can be utilized for secondary uses such as golf courses. • Reduces potable water demands. • Provides nitrogen uptake by plant life and reduces need for fertilizers at golf courses. • Falmouth has past experience with this type of system. 	<ul style="list-style-type: none"> • Difficult to secure suitable and authorized locations for spray irrigation. • Limited cold weather use due to potential freezing. • Limited use during site’s secondary use (for example spray irrigation on a golf course fairway likely cannot be operating when people are golfing). • Spray nozzles subject to clogging. • Requires secondary method of discharge or storage during winter months or during the site’s secondary use. • If discharge site is located in a nutrient-sensitive watershed, effluent will likely need to be treated to a very low effluent nitrogen limit. • If discharge site is located in a Zone II protection area, effluent filtration and disinfection are required per 314 CMR 05. An effluent TOC limit will also need to be met. • Discharge needs to meet reclaimed water effluent limits. • Pressurized systems often require more complex system balancing, and equalization/storage may be necessary to provide equal distribution throughout the system.

2.1.3 Leaching Facilities

Leaching facilities—also known as subsurface infiltration—typically utilize pump and piping systems to pressure dose sub-surface infiltration areas (trenches, chambers, or pits) which percolate to groundwater. Maintenance and cleaning of these systems is more difficult than surface systems because the infiltration area is below-grade and effluent solids cannot be easily removed. Leaching facilities can have secondary uses, such as parking lots, lawns, playing fields, and recreational areas.

The Town currently operates this type of facility at the New Silver Beach WWTF, which has leaching trenches installed below a school youth soccer field.

Hydraulic loading rates of 2½ to 3 gallons per day per square foot (gpd/sf) of bed area are typically allowed by MassDEP (depending on the configuration of the system), unless hydrogeologic tests demonstrate a greater infiltration loading rate at the specific site.

Advantages and disadvantages of leaching facilities are summarized in the following table.



Table 2.3 Leaching Facilities Summary

Discharge Technology	Advantages	Disadvantages
Leaching Facilities	<ul style="list-style-type: none"> • Located below-grade allowing for secondary uses, such as parking lots or municipal recreational areas. • Disinfection is typically not required prior to discharge unless the discharge site is within a water supply area. • Town currently operates this type of system at New Silver Beach WWTF. 	<ul style="list-style-type: none"> • Larger land areas are required due to lower hydraulic loading rates than open sand beds. • Effluent filtration is typically required to minimize bed clogging over time. • If discharge site is located in a nutrient-sensitive watershed, effluent will likely need to be treated to a very low effluent nitrogen limit. • If discharge site is located in a Zone II protection area, effluent filtration and disinfection are required per 314 CMR 05. An effluent TOC limit will also need to be met. • Pressurized systems often require more complex system balancing, and equalization/storage may be necessary to provide equal distribution throughout the system.

2.1.4 Drip Dispersal

Drip dispersal systems—also known as subsurface dispersal systems or drip irrigation systems—consist of shallow subsurface perforated tubing. These types of systems were developed based on drip irrigation systems typically utilized to irrigate agricultural areas or plants. The systems can also be potentially used in lawns and wooded areas, if sited properly, or installed below the root zone (similar to a leaching facility). Treated effluent is pumped through the tubes under pressure and discharged slowly through the emitters into the ground (either within the root zone or below the root zone). Tubing is typically installed with a vibratory plow or trencher, and requires minimal disturbance to the surface.

A hydraulic loading rate of 1.5 gallons per day per square foot (gpd/sf) of drip dispersal area is typically allowed by MassDEP unless hydrogeologic tests demonstrate a greater infiltration loading capacity at the specific site. The hydraulic loading rate assumes that the system is installed in a rectangular configuration with emitters evenly spaced at 2 feet on center and tubing 4 feet on center with the area between the tubing used as reserve area. Effluent typically needs to be filtered to avoid clogging the drip emitters. MassDEP does not require disinfection for drip dispersal systems outside of a Zone II or Interim Wellhead Protection Area.

Advantages and disadvantages of drip dispersal are summarized in the following table.

Table 2.4 Drip Dispersal Summary

Discharge Technology	Advantages	Disadvantages
Drip Dispersal	<ul style="list-style-type: none"> • Can be utilized in various terrain conditions and land uses. • Tubing is typically installed at a shallow depth using relatively simple construction techniques. • Low delivery rate minimizes water table impacts. • Located below-grade allowing for secondary uses such as municipal recreational areas, or below parking areas (although not as common). 	<ul style="list-style-type: none"> • Large area required due to low hydraulic loading rate. • Effluent filtration is typically required to minimize clogging. • Periodic back-flushing required. • Limited cold weather use due to potential freezing (if located within the root zone). • Tubing is typically installed at a shallow depth and the above-grade surface needs to be protected from heavy loading. • If discharge site is located in a nutrient-sensitive watershed, effluent will likely need to be treated to a very low effluent nitrogen limit. • If discharge site is located in a Zone II protection area, effluent filtration and disinfection are required per 314 CMR 05. An effluent TOC limit will also need to be met. • Pressurized systems often require more complex system balancing, and equalization/storage may be necessary to provide equal distribution throughout the system.

2.1.5 Well Injection

A well injection system pumps treated effluent through wells that extend into permeable and saturated geologic strata. When discharged into saturated strata, the discharge process is the reverse of extracting water from a well. Well injection systems are regulated under the Underground Injection Control (UIC) Program, which is administered by MassDEP.

The well injection rate depends on site conditions such as the groundwater depth, geologic conditions, and effluent characteristics. Potential concerns of well injection include the mounding of groundwater at low elevations. Extensive hydrogeologic testing is necessary to confirm the suitability of this technology for an application.

Well injection of treated municipal wastewater effluent has been implemented on a limited basis throughout the United States; and limited information exists on the proper siting, design, construction, and operation of the wells. Pilot tests at the Hyannis Water Pollution Control Facility (WPCF) in 2003 indicated that injection wells can become plugged with biological growth if the effluent is not properly chlorinated. Discussions with MassDEP identified minimal support for the development of this technology because it utilizes chlorination. Chlorination can create secondary impacts to the groundwater through the formation of disinfection byproducts—such as total organic halide (TOX) and trihalomethanes (THMs)—that can pose potential health risks. If the effluent is discharged directly to the groundwater, 314 CMR 5.10.4C requires that the effluent



meet the same requirements as a discharge to a Zone II or Interim Wellhead Protection Area with a two-year groundwater travel time to the source.

Advantages and disadvantages of well injection systems are summarized in the following table.

Table 2.5 Well Injection Summary

Discharge Technology	Advantages	Disadvantages
Well Injection	<ul style="list-style-type: none"> • Small surface footprint with minimal surface disturbance. • Wells could be installed in several discrete locations to minimize groundwater mounding. 	<ul style="list-style-type: none"> • Effluent filtration and chlorination is typically required to minimize clogging/biofouling. • Formation of disinfection byproducts after chlorination can pose potential health risks. • Effluent needs to meet very stringent discharge requirements for deep well systems (equivalent to a Zone II with a two-year ground water travel time). • Limited successful installations in the United States and limited performance data available. • Extensive hydrogeologic testing required. • Pressurized systems often require more complex system balancing and equalization/storage may be necessary.

2.1.6 Wick Wells

Wick wells typically utilize large diameter (3 to 6 feet) well casings filled with stone. Treated effluent is discharged into the unsaturated zone and infiltrates into the underlying aquifer. Wick wells have been implemented on a limited basis in the United States, with three permitted locations in Massachusetts. Extensive hydrogeologic testing is necessary to confirm the suitability of this technology for an application.

Advantages and disadvantages of wick wells are summarized in the following table.

Table 2.6 Wick Wells Summary

Discharge Technology	Advantages	Disadvantages
Wick Wells	<ul style="list-style-type: none"> • Small surface footprint with minimal surface disturbance. • Wells could be installed in several discrete locations to minimize groundwater mounding. 	<ul style="list-style-type: none"> • Effluent filtration is typically required to minimize clogging. • Limited successful installations in the United States and limited performance data available. • Extensive hydrogeologic testing required. • Depending on well spacing, may require a more complex system for flow distribution and system balancing.

2.2 Outfall

The Massachusetts Oceans Sanctuary Act (M.G.L. c132A) regulations establish state environmental policy to be enforced in the five Massachusetts Ocean Sanctuary areas (consisting of the Cape Cod Ocean Sanctuary, the Cape Cod Bay Ocean Sanctuary, the Cape and Islands Ocean Sanctuary, the North Shore



Ocean Sanctuary, and the South Essex Ocean Sanctuary). Historically, municipal wastewater discharges into ocean sanctuaries were specifically precluded under these regulations, unless the discharge was approved and licensed prior to December 1971. In 2014, the Massachusetts Oceans Sanctuary Act was amended to outline prerequisites that must be met for new or modified discharges into ocean sanctuaries. An extensive permitting process is anticipated for the approval of a new municipal wastewater discharge into an ocean sanctuary.

Advantages and disadvantages of outfalls are summarized in the following table.

Table 2.7 Outfall

Discharge Technology	Advantages	Disadvantages
Outfall	<ul style="list-style-type: none">• Relatively small land area required.• Effluent discharge occurs outside of a watershed, greatly reducing nitrogen loading impacts to coastal embayments.• Greater dilution provided by discharging into a large surface water body.	<ul style="list-style-type: none">• Extensive permitting process anticipated.• Potential reduction in aquifer recharge.• Public perception.

2.3 Anticipated Effluent Limits for Discharge Technology Options

Future effluent permit requirements are anticipated to be dictated by the location of the effluent discharge sites and the type of technology implemented for discharge. Anticipated effluent permit requirements for the discharge technologies outlined in this memo are outlined in the following table.



Table 2.8 Anticipated WWTF Effluent Discharge Limits

Parameter	Open Sand Beds – Outside of a Zone II ⁽¹⁾	Subsurface Effluent Disposal – Outside of a Zone II ⁽¹⁾⁽²⁾	Spray Irrigation – Class A, Outside of a Zone II ⁽³⁾	Deep Well Injection ⁽⁴⁾	Outfall – Class SA ⁽⁵⁾
BOD (mg/L)	30	30	10	10	30
TSS (mg/L)	30	30	5	5	30
TN (mg/L) ⁽⁶⁾	3	3	3	3 – 5 ⁸	3
TP (mg/L)	TBD ⁷	TBD ⁷	TBD ⁷	TBD ⁷	TBD ⁷
Fecal Coliform (#/100 mL)	200	N/A	14	14	TBD
Enterococci (#/100 mL)	N/A	N/A	N/A	N/A	TBD
Total Organic Carbon, mg/L	N/A	N/A	N/A	1	N/A

Notes:

1. Source: Guidelines for the Design, Construction, Operation and Maintenance of Small Wastewater Treatment Facilities with Land Disposal, prepared by MassDEP, revised July 2018.
2. Category includes leaching facilities, drip dispersal, shallow well injection, and wick wells.
3. Source: 314 CMR 20 – Reclaimed Water Permit Program and Standards, effective March 2009.
4. Source: 314 CMR 5.00 – Groundwater Discharge Permits, effective December 2, 2016.
5. Ocean outfall discharge pre-requisites are outlined in Part I Title XIX Chapter 132A Section 16. New ocean outfall discharges are required to receive advanced treatment and disinfection. Effluent parameters are not specified in the regulations. Anticipated requirements are assumed for this project. Class SA, High Quality Waters are designated per 314 CMR 4.00.
6. Anticipated effluent TN limit of 3 mg/L is anticipated for a discharge into a nutrient impaired watershed. Per the Shared Wastewater Management Study Towns of Bourne, Falmouth, Mashpee, Sandwich and Joint Base Cape Cod report prepared by Wright-Pierce and dated November 2017, anticipated effluent TN limit for Joint Base Cape Cod discharge is 10 mg/L for open sand beds and wick wells and 5 mg/L for deep well injection and outfall (Class SB).
7. A TP effluent limit may be required depending on discharge site location.
8. Effluent limit of 5 mg/L assumes that deep well injection discharge is deep enough to emerge beyond all nitrogen sensitive embayments/watersheds.

2.4 Technologies Recommended for Conceptual Layout Development

Based on the evaluation summarized in Section 2, the following discharge technologies are recommended for incorporation into the conceptual layouts developed as part of this project:

1. Open sand beds are recommended for conceptual layout development due to their relatively high hydraulic loading capacity, which requires less land area than other land-based options. Additionally, the Town of Falmouth currently uses this technology at the Falmouth WWTF and is familiar with the technology.
2. Leaching facilities are recommended for conceptual layout development in areas with a potential secondary use (for example under fairways in a golf course or under public parks/ballfields) due to their minimal visual impact. Additionally, the Town of Falmouth currently uses this technology at the New Silver Beach WWTF and is familiar with the technology.
3. Ocean outfalls are recommended for conceptual layout development due to the relatively small land area required for this technology, relatively high disposal capacity, and the ability to discharge



outside a nutrient impacted watershed, reducing the nitrogen loading impacts to coastal embayments.

3. Discharge Site Evaluation

This section summarizes the discharge site evaluation that was conducted for the following eight sites:

- Falmouth WWTF – existing WWTF open sand beds
- Joint Base Cape Cod (JBCC)
- Allen Parcel (previously identified as “Site 4” in 2013 CWMP/FEIR/TWMP)
- Augusta Parcel (previously identified as “Site Z” in the 2007 ASAR)
- Buzzards Bay Outfall
- Falmouth Country Club (previously identified as Sites A, B, and 2B in the 2013 CWMP/FEIR/TWMP)
- Nobska Point Outfall
- Land and property adjacent to Recharge Beds 14 and 15

A general description of each site is provided in this section.

3.1 Existing WWTF Open Sand Beds (With Enhanced Nitrogen Removal)

The Falmouth WWTF currently operates under Modified Groundwater Discharge Permit No. 168-5, effective date December 12, 2015 (2015 Permit). The WWTF has 15 effluent disposal open sand beds. Open sand beds 1 through 13 are located within the West Falmouth Harbor watershed. Recharge Beds 14 and 15 are located outside of the West Falmouth Harbor watershed. The 2015 Permit allocates effluent flow limits by watershed.

The following table compares the permitted flow that can be discharged to the existing open sand beds with their design flow. As shown in the table, the overall permitted flow is less than the design flow of the open sand beds. It should be noted that the actual infiltration capacity of existing open sand beds 9 through 15 is substantially greater than design and permitted capacity, based on operational experience since bed startup.



Table 3.1 Open Sand Bed Design Flow vs. Permitted Flow

	Annual Average Design Capacity – All Beds Operating (mgd)	Annual Average Permitted Capacity ² (mgd)	Un-utilized Design Capacity Due to Permit Nitrogen Load Limit (mgd)
Open Sand Beds 1 through 13	0.75 ³	0.45	0.3
Recharge Beds 14 and 15	0.26 ¹	0.26	0
Total	1.01¹	0.71	0.3

Notes:

1. Source: Recharge Beds 14 and 15 Operations and Maintenance Manual, prepared by GHD, dated June 2017.
2. Source: Modified Individual Groundwater Discharge Permit No. 168-5, effective date 12/22/15.
3. Design hydraulic capacity for Sand Beds 1 through 13 = 1.1 gpd/sf per the 'Falmouth Wastewater Treatment Facility Operation & Maintenance Manual – Draft', prepared by Maguire Group Inc., dated February 2007.

The 2015 WWTF permit limits the cumulative nitrogen annual load that can be discharged within the West Falmouth Harbor watershed to 4,109 pounds per calendar year (assuming that sewer is not extended within the West Falmouth Harbor watershed and no other nitrogen reductions are credited within this watershed). This load limit is based on an average annual flow of 450,000 gpd of flow discharged to sand beds 1 through 13 at a concentration of 3 mg/L. To maintain the existing load limit, the effluent nitrogen concentration would need to be reduced if additional flow was discharged to sand beds 1 through 13. The relationship between decreasing nitrogen concentration and additional flow is linear. If the effluent nitrogen concentration was consistently reduced to 2.5 mg/L, then the flow to the beds could potentially be increased to 0.54 mgd; if it were reduced to 2 mg/L, then the flow to the beds could potentially be increased to 0.68 mgd. The WWTF would need to consistently meet an effluent limit of less than 1.8 mg/L in order to utilize the design capacity of Discharge Beds 1 through 13 (0.75 mgd) and meet the existing load limit of 4,109 lb/yr without any additional nitrogen removal from the West Falmouth Harbor watershed. Options for enhanced nitrogen removal (less than 3 mg/L) are discussed in TASA TM-4.

3.2 Joint Base Cape Cod (JBCC)

The WWTF is located at the southeast corner of the JBCC and provides wastewater treatment for the existing five military branch's joint-use facilities. The WWTF is currently owned by the United States Air Force, and operated and maintained by the Massachusetts Air National Guard.

The 2017 Wright Pierce JBCC Study provides an engineering assessment for a potential partnership for shared wastewater management options at JBCC between the four towns of Bourne, Falmouth, Mashpee, and Sandwich. As part of the study, each of the four participating towns provided capacity requests by wastewater type. The Town of Falmouth requested the following capacity allocations for its study basis:

- Mid-term allocation – 490,000 gpd (annual average) of effluent is treated at the Falmouth WWTF and sent to the JBCC disposal system
- Long-term allocation – 1,490,000 gpd (annual average) of effluent is treated at the Falmouth WWTF and sent to the JBCC disposal system

Both the mid-term and long-term allocations represent un-allocated flows since the location within the Town that the flow is derived from is not specified.



The 2017 Wright Pierce JBCC study assumed that a new 18-inch force main would be constructed in Route 28, Route 151, and Turpentine Road with a connection to the existing JBCC collection system, a total new force main distance of 6.7 miles. The evaluation also provided preliminary cost estimates for the infrastructure that would be required to allow JBCC to function as a regional facility—including expansion of the existing WWTF, development of collection system infrastructure from each community to JBCC, and development of additional effluent disposal capacity. The mid-term allocation requested by the Town of Falmouth for JBCC (490,000 gpd annual average flow) would provide adequate effluent disposal capacity for TASA (330,000 gpd estimated annual average flow) if regionalization of the facility proceeds. An agreement with JBCC and the participating Towns would be required for this option.

3.3 Allen Parcel (Site 4)

The Allen Parcel is approximately 70 acres and is Town-owned. Fourteen acres in the southwest corner of the parcel—labeled as ‘Lot 3’ on the ‘2005 Allen Parcel Plan of Land’—has been identified for general municipal use and is located in the Great Pond watershed. The property has a 100-foot wide utility easement along the western boundary of the property.

Subsurface investigation by means of a test pit in 2010 indicated that this site is in the outwash plain with sandy soils. A percolation test conducted in 2010 indicated that the underlying soils have a percolation rate of less than 2 minutes per inch. Based on the results of the percolation test, a design loading rate of 7 gpd/sf for open sand beds was assumed in the Falmouth 2013 CWMP/TWMP/FEIR. As summarized in TASA TM-5, subsurface field investigations conducted in Fall of 2018 confirmed that a design hydraulic loading rate of 7 gpd/sf is appropriate for this site. A layer of unsuitable material was discovered during the 2018 field investigation, approximately 10-inches thick at approximately 28-inches to 38-inches below grade. This layer would need to be excavated and removed if the site were developed for effluent disposal.

JBCC maintains several monitoring wells on the Allen Parcel due to its proximity to the Ashumet Valley Plume. Coordination with Air Force Civil Engineer Center at JBCC will be required if this site is pursued as a proposed effluent disposal location.

3.4 Augusta Parcel

The Augusta Parcel is approximately 20 acres and is Town-owned. It is surrounded by residential and commercial properties and is located in the Great Pond watershed. There is a topographic drop-off on the southeast portion of this property that would need to be taken into account in recharge area design. The site was previously identified as a potential site for a new WWTF. The site was also designated for a proposed booster station in the TASA collection system conceptual layout which will collect untreated wastewater from the area and pump it to the Falmouth WWTF on Blacksmith Shop Road.

The deed to the Augusta Parcel limits the sewer service area of future wastewater treatment and disposal on the property to the Teaticket Water Quality Improvement District (TWQID). The TWQID is generally defined as the Maravista area between Little Pond and Green Pond, generally bounded by Sandwich Road on the west, Brick Kiln Road on the north, and Acapesket Road on the east. The deed map showing the TWQID is provided in Attachment 1. TWQID encompasses the majority of TASA, as well as an area north of Route 28 which is not currently under consideration for sewerage, and the Maravista peninsula, most of which was connected to the sewer system under the Little Pond Sewer Service Area Project. Hydraulic load testing,



conducted in Fall of 2018, indicated that a design hydraulic loading rate of 7 gpd/sf was appropriate for open sand beds on this parcel. Soil borings indicated that soils at this location are generally homogenous and comprised of sand with traces of gravel and finer grained materials.

3.5 Buzzards Bay Outfall

Construction of an ocean outfall in Buzzards Bay, extending approximately 4,400 feet into Buzzards Bay and sized for 4 mgd, was evaluated as part of this project. The proposed outfall was modeled using high-resolution ocean model data for the greater Buzzards Bay area and a plume tracking model to simulate plume dispersion at the potential discharge location. A year-long simulation of effluent transport indicated that the potential outfall is anticipated to have a negligible effect on the TN concentrations in Buzzards Bay and West Falmouth Harbor. The Buzzards Bay modeling, conceptual layout, and conceptual level cost estimate are discussed in further detail in the Buzzards Bay Outfall Technical Memorandum (TASA TM-6).

3.6 Falmouth Country Club (FCC)

The FCC site is comprised of multiple parcels with a combined area of approximately 150 acres. The site is Town-owned and a portion of the site is presently utilized as a municipal golf course. The FCC Conservation Restriction (FCC Restriction), dated November 2007, notes that portions of the property may be used for effluent disposal.

In 2009, the Town was awarded a grant from the Cape Cod Water Protection Collaborative to complete groundwater modeling for a proposed recharge at the Falmouth Country Club site using a calibrated sub-regional model based on the USGS regional model of the Sagamore Lens. The study included particle tracking and groundwater mounding analysis for recharge at the FCC site. Particle tracking indicated that recharge at the FCC could flow to the Bourne Pond, Green Pond, Eel Pond, and Waquoit watersheds, depending on location and volume of discharge on the site.

Field investigations indicated that subsurface conditions were generally homogenous and comprised of sand and gravel with lenses of finer grained materials. The predominance of sand suggests suitable conditions for infiltration of treated wastewater. Depth to groundwater at the site is approximately 35 feet below ground surface (approximately 16 feet above mean sea level).

The investigations indicated that a design loading rate of 11 gpd/sf for open sand beds could be used for this site, with the understanding that additional hydrogeological investigations may be needed once the open sand basin locations are identified at the site and a full environmental impact analysis is completed. The conservative design loading rate was derived using the lowest average infiltration rate observed during the investigations and EPA's recommended design factor (10 percent of the infiltration test rate). The loading rate of 11 gpd/sf is over two times the loading rate typically allowable by MassDEP (5 gpd/sf), and MassDEP has indicated they would allow a design loading rate of 7 gpd/sf until performance testing (after WWTF implementation with actual treated water from a WWTF) proved that a higher rate was warranted.

Effluent disposal at the Falmouth Country Club was included in the Preferred Option (Scenario 1E) outlined in the 2013 CWMP/FEIR/TWMP. The Preferred Option, shown in Figure 1, included areas designated for subsurface leaching trenches on the western portion of the FCC (Site 2B) and open sand beds on the eastern portion of the property (Sites A1 and B).



A portion of the FCC is located over the Ashumet Valley plume, which is being managed by JBCC. Coordination with the Air Force Civil Engineer Center at JBCC will be required if this site is pursued as a proposed effluent disposal location.

3.7 Nobska Point Outfall

Construction of an ocean outfall at Nobska Point in Woods Hole, extending approximately 2,000 feet into Vineyard Sound and sized for 4 mgd, was first evaluated as part of wastewater planning efforts in the 1970's. Nobska Point was selected as the proposed outfall location due to its high dilution and mixing potential, and proximity to a WWTF to be built on Fay Road.

Data collected through drifter buoys, drift bottles, and seabed drifters was used to determine flushing and tidal characteristics of the site. The evaluation, summarized in a series of articles published in the Journal of Boston Society of Civil Engineers in 1971 (Bumpus & Vaccaro, 1971; Bumpus, Wright & Vaccaro, 1971; Meade & Vaccaro, 1971), indicated that the outfall should extend more than a quarter mile off of Nobska Point to avoid flow towards the beaches or into Woods Hole Passage. The evaluation concluded that *“the minimum return to shores, harbors and estuaries, coupled with maximum dilution and minimum length of outfall pipe, could be achieved at a distance of 0.375 miles south of Nobska Point (700 yards 141 deg T) from Nobska Lighthouse.”*

As part of the original evaluation, a treatment facility was proposed in Woods Hole, near Nobska Point, on land owned by the Marine Biological Laboratory.

A potential ocean outfall at Nobska Point was reexamined as part of the CWMP process in 2011. Conceptual costs for this 2011 analysis were prepared assuming the use of a 3-foot diameter HDPE force main, installed from the existing Falmouth WWTF at Blacksmith Shop Road to Nobska Point. Costs were based on construction unit costs for the 1,300-foot long outfall constructed at the Seabrook, NH WWTF in 1994.

The conceptual route to Nobska Point as part of the 2011 evaluation followed the same route as the force main from the Woods Hole Lift Station to the WWTF. However, the Town has expressed concerns about the high coastal erosion vulnerability of this route. As part of TASA TM-3, it is recommended that further discussion be held on an alternate route for the force main, if this is to be further evaluated.

3.8 Land and Property Adjacent Recharge Beds 14 and 15 to the North

A currently privately-owned parcel that is adjacent to the existing WWTF property, combined with available area adjacent to Recharge Beds 14 and 15, was identified as a potential recharge location. The privately-owned parcel is approximately 4.7 acres. This parcel abuts Town-owned property, Recharge Beds 14 and 15 (Recharge Beds 14 and 15 are located on a parcel previously identified at “Site 7” in the 2013 CWMP/FEIR/TWMP), and the Falmouth WWTF. These beds, constructed on the eastern portion of the Site 7 property in 2015, have a rated maximum month capacity of 0.47 mgd. If the site containing Recharge Beds 14 and 15 is expanded through purchase or acquisition, the location has the potential to add additional sand beds on the expanded property.

Groundwater modeling and particle tracking of treated water recharge at the Recharge Beds 14 and 15 site, conducted in 2011, indicated that effluent is anticipated to recharge into Buzzards Bay. The model indicated that a portion of the treated effluent would pass through Crocker Pond, a small freshwater kettle pond to the



west of Recharge Beds 14 and 15, which is phosphorus limited. An evaluation, conducted by EcoLogic in 2013, indicated that the aquifer soils downstream of Recharge Beds 14 and 15 have a large capacity to sequester phosphorus from the groundwater and significantly retard migration of phosphorus downstream to the kettle pond. The absorptive capacity of the soil was estimated as 100 to 1,400 years of phosphorus discharge, depending on the level of effluent treatment. Additionally, the University of Massachusetts Dartmouth School of Marine Science and Technology (SMAST) conducted an evaluation assessing coastal down-gradient impacts of Recharge Beds 14 and 15 wastewater effluent discharge. The study concluded that, based on the amount of nitrogen entering Buzzards Bay and its low nitrogen levels in the study region, it is unlikely that the anticipated maximum nitrogen load from Recharge Beds 14 and 15 will be detectable.

Additional modeling would be required to determine the impact of additional flow if new beds were developed adjacent to Recharge Beds 14 and 15. The privately-owned property (if purchased) would also need to be rezoned to Public Use and would require a site hearing to be conducted by MassDEP in accordance with M.G.L. c 83 s6.

A second option for this site is to expand Recharge Beds 14 and 15 to the North within the boundaries of the existing Town-owned parcel. Performance testing could also be conducted at existing Recharge Beds 14 and 15 to evaluate the ability to request an increase in the rated capacity of the open sand beds.

4. Discharge Capacity Evaluation

This section summarizes the discharge capacity evaluation that was developed to establish the maximum capacity of each site. Maximum capacities were established based on estimated available area and discharge method. The following basis of design was used to estimate discharge capacity for each site:

- Disposal area divided into four areas.
- Disposal system sized to handle maximum month flow with one area out of service.
- 100 percent redundancy provided for average annual flow.
- 100 foot buffer maintained from property boundaries.

The discharge capacity for each site is outlined in the following table.



Table 4.1 Estimated Maximum Month Discharge Capacity of Discharge Technologies¹

Discharge Site	Estimated Available Area (acres)	Open Sand Beds (mgd) / Estimated Footprint (acres) ⁷	Drip Dispersal (mgd)/ Estimated Footprint (acres) ⁸	Leaching Trenches (mgd) / Estimated Footprint (acres) ⁹	Spray Irrigation (mgd) / Estimated Footprint (acres) ¹⁰
New Site Abutting Recharge Beds 14 and 15	1.7 ²	0.27 MGD (1.7 acres)	0.09 MGD (1.7 acres)	0.17 MGD (1.7 acres)	0.01 MGD (1.7 acres)
Allen Parcel	12.6 ³	2.88 MGD (12.6 acres)	0.62 MGD (12.6 acres)	1.23 MGD (12.6 acres)	0.07 MGD (12.6 acres)
Augusta Parcel	19.4 ⁴	0.67 MGD (2.9 acres)	0.67 MGD (13.7 acres)	0.67 MGD (6.8 acres)	0.11 MGD (19.4 acres)
Falmouth Country Club – A1	6.6 ⁵	1.51 MGD (6.6 acres)	0.32 MGD (6.6 acres)	0.65 MGD (6.6 acres)	0.04 MGD (6.6 acres)
Falmouth Country Club - B	4.9 ⁵	1.12 MGD (4.9 acres)	0.24 MGD (4.9 acres)	0.48 MGD (4.9 acres)	0.03 MGD (4.9 acres)
Falmouth Country Club – 2B	22.0 ^{5,6}	N/A	1.08 MGD (22 acres)	2.16 MGD (22 acres)	0.13 MGD (22 acres)

Notes:

1. All discharge sites designed to handle maximum month conditions with one bed out of service.
2. Acreage for New Site Abutting Recharge Beds 14 and 15 includes development of available space on the existing WWTF site (immediately north of the existing open sand beds) and the New Site Abutting Recharge Beds 14 and 15 (immediately north of the existing open sand beds). Per discussions with the WQMC working group portions of both properties west of the existing open sand beds are not included in the estimated available area.
3. Allen Parcel estimated available area per Table 4-3 of the 2013 CWMP/TWMP/FEIR. Discharge capacity based on available land area.
4. Potential available area of Assessor’s Map 34-04-036-000C1. A deed restriction on the property limits the disposal capacity to flow from the Teaticket Water Quality Improvement District (TWQID). The estimated acreage required to provide recharge capacity for the estimated TWQID maximum month flow (0.67 mgd) is outlined for each type of technology.
5. Potential available area per 2013 CWMP/FEIR/TWMP Table 4.3 and Figure 4-6.
6. Available area based on estimation of surface area under fairways not including the greens.
7. Estimated Hydraulic loading rate = 7 gpd/sf.
8. Hydraulic loading rate per MassDEP 2018 guidelines = 1.5 gpd/sf. Calculations assume that drip tubing is placed 4-feet on center.
9. Hydraulic loading rate per MassDEP 2018 guidelines = 3 gpd/sf.
10. Hydraulic loading rate per MassDEP 2018 guidelines = 2 inches/acre/week when system is in use. It is assumed that spray dispersal can only be utilized for nine months of the year.

All of the discharge sites have adequate effluent disposal capacity for TASA if they are developed with open sand beds.



5. Conceptual Layout Development

Six site/technology combinations were selected by the Town and the Water Quality Management Committee Working Group (WQMC) for conceptual layout development (a combination is defined as a single technology used on a single site):

- Allen Parcel with open sand beds.
- Augusta Parcel with open sand beds.¹
- Falmouth Country Club with leaching trenches on the western portion of the property.
- Site abutting Recharge Beds 14 and 15 (Site 7) to the north with open sand beds.
- Nobska Point ocean outfall.
- Buzzards Bay ocean outfall.

Although a conceptual layout was not developed for effluent recharge at JBCC to serve TASA, JBCC was evaluated as part of another study and the Town continues to consider it as a future long-term option for effluent disposal.

5.1 Conceptual Layout – Sizing Criteria

All of the conceptual layouts were sized to recharge the anticipated maximum month flow from TASA with one disposal “area” out of service (0.53 mgd). Anticipated TASA flows are outlined in the following table. Additionally, each conceptual layout was also developed for a future condition, which maximized the recharge capacity of the site.

Table 5.1 Anticipated Flow from TASA

Parameter	TASA Flow (mgd) ¹	TASA Flow + I/I (mgd) ²
Average Annual	0.25	0.33
Maximum Month	0.46	0.53
Maximum Day	0.48	0.56
Peak Instantaneous	0.86	0.94

Notes:

1. Source: TASA TM-1 – South Coast Embayments Preliminary Evaluations and Notice of Project Change Update Project – Draft Service Area, Flow and N Load Evaluation prepared by GHD, dated May 2018.
2. I/I allocation based on estimated TASA gravity sewer length and an infiltration rate of 500 gpd/sf. I/I allocation will need to be re-calculated once the TASA collection system conceptual layout has been finalized.

5.2 Conceptual Force Main Routing

Conceptual force main routing for the layouts is shown in Figure 2 and Figure 3. The distance from the WWTF to each discharge location along the conceptual force main routes is summarized in the following table.

¹ One additional conceptual layout was developed for sub-surface leaching trenches at the Augusta Parcel.



Table 5.2 Distance from Falmouth WWTF to Proposed Discharge Site Locations

Conceptual Force Main Route	Approximate Distance from Falmouth WWTF to Discharge Site along Conceptual Force Main Route (miles)
Falmouth WWTF to Allen Parcel	4
Falmouth WWTF to Falmouth Country Club	5
Falmouth WWTF to Buzzards Bay Outfall	2
Falmouth WWTF to Augusta Parcel	4
Falmouth WWTF to Site Abutting Recharge Beds 14 and 15 to the North	<1
Falmouth WWTF to Nobska Point Ocean Outfall	7
Falmouth WWTF to existing JBCC Collection System ¹	7
Notes:	
1. Per the conveyance route outlined in the Shared Wastewater Management Study Towns of Bourne, Falmouth, Mashpee, Sandwich, and Joint Base Cape Cod, prepared by Wright-Pierce, dated November 2017.	

5.3 Conceptual Effluent Disposal Layout

A description of the conceptual layouts is summarized below.

5.3.1 Allen Parcel

A conceptual layout for the Allen Parcel with sand beds is shown on Figure 4. The following basis of design was used to develop the layout:

- Open Sand Beds 1 through 4 are sized to recharge TASA flow during maximum month conditions with one open sand bed out of service.
- A 50-foot buffer is maintained from the utility easement to provide a visual barrier.
- A 20-foot buffer is maintained around the perimeter of Lot 3 for the development of a future service road.
- Open Sand Beds 5 through 15 provide a conceptual layout for future expanded conditions to maximize the available area of the site.
- The open sand beds are sized based on a design hydraulic loading rate of 7 gpd/sf.
- The conceptual layout assumes that the open sand beds will be fed by gravity from a distribution box at the end of the effluent force main.

5.3.2 Augusta Parcel

A conceptual layout for the Augusta Parcel with open sand beds is shown in Figure 5. The following basis of design was used to develop the layout:

- Open Sand Beds 1 through 4 are sized to recharge TASA flow during maximum month conditions with one open sand bed out of service.
- A 100-foot buffer is maintained from the property boundaries.



- Open Sand Bed 5 provides a conceptual layout for future expanded conditions to maximize the amount of flow allowable per the deed restriction for the Teaticket Water Quality Improvement District (see Attachment No. 1).
- The open sand beds are sized based on a design hydraulic loading rate of 7 gpd/sf.
- The conceptual layout assumes that the open sand beds will be fed by gravity from a distribution box at the end of the effluent force main.

A second conceptual layout for the site with leaching trenches was developed and is shown in Figure 6. A leaching trench system could allow the site to maintain a secondary use such as a park or ballfield, if desired. The following basis of design was used to develop the layout:

- Leaching trench system is sized to recharge TASA flow during maximum month conditions with one leaching trench area out of service.
- The leaching trench system is sized based on a design hydraulic loading rate of 3 gpd/sf.
- The leaching trench system will be fed through a pressurized distribution system from an effluent lift station located on the site.

5.3.3 Falmouth Country Club

A conceptual layout for leaching trenches in the western portion of the FCC (Site 2B) is shown in Figure 7. The following basis of design was used to develop the layout:

- Leaching trench system is sized to recharge TASA flow during maximum month conditions with one area out of service.
- The conceptual layout was restricted to the Green Pond watershed (no effluent recharge on the eastern portion of the property which is primarily in the Bournes Pond watershed) to reduce transfer of flow and nitrogen load between watersheds.
- The leaching trench system is sized based on a design hydraulic loading rate of 3 gpd/sf.
- The leaching trench system will be fed through a pressurized distribution system from an effluent lift station located on the site.
- Leaching trench areas 1 through 4 are sized to recharge TASA flow during maximum month conditions with one leaching trench area out of service.
- Leaching trench areas 5 through 12 provide a conceptual layout for future expanded conditions to maximize the potentially available area of the site.

5.3.4 Site Abutting Recharge Beds 14 and 15

A conceptual layout for the site with open sand beds is shown in Figure 8. The following basis of design was used to develop the layout:

- Open Sand Beds 16 and 17 are sized to recharge TASA flow during maximum month conditions with all beds operational. If an open sand bed needs to be taken down for maintenance during maximum



month conditions, the existing open sand beds at the WWTF are anticipated to be used for additional capacity during this condition.

- A 100-foot buffer is maintained from the property boundaries.
- The open sand beds were sized based on a design hydraulic loading rate of 7 gpd/sf.
- The conceptual layout assumes that the open sand beds will be fed through the existing gravity line used to convey flow to existing Open Sand Beds 14 and 15.

5.3.5 Nobska Point Ocean Outfall

The basis of design for the potential Nobska Point Ocean Outfall is outlined in TASA TM-6 and summarized below:

- 3-foot-diameter High Density Polyethylene (HDPE) force main from the Falmouth WWTF to Nobska Point (approximately 7.3 miles) sized to convey 4 mgd annual average flow.
- 3-foot-diameter HDPE outfall (approximately 2,000 feet from Nobska Point into Vineyard Sound) based on the original study.
- The existing open sand beds at the Falmouth WWTF provide redundancy to the system. If the ocean outfall needed to be taken offline for a period of time, effluent flow would be diverted to the existing open sand beds.

5.3.6 Buzzards Bay Ocean Outfall

The basis of design for the potential Buzzards Bay Ocean Outfall is outlined in TASA TM-6 and summarized below:

- 2-foot diameter High Density Polyethylene (HDPE) force main from the Falmouth WWTF to a location off Chapoquoit Road (approximately 2 miles) sized to convey 4 mgd annual average flow.
- 2-foot diameter HDPE outfall (approximately 4,380 feet from Chapoquoit Road into Buzzards Bay).
- The existing open sand beds at the Falmouth WWTF provide redundancy to the system. If the ocean outfall needed to be taken offline for a period of time, effluent flow would be diverted to the existing open sand beds.

A smaller diameter outfall is used for the Buzzards Bay Ocean Outfall (2-foot diameter) than the Nobska Point Ocean Outfall (3-foot diameter) due to the reduced head losses from the shorter force main length.

6. Summary

Four different potential discharge sites and two potential ocean outfalls were evaluated, and discharge capacities were developed for each option. It is estimated that all of the potential sites have adequate effluent disposal for the estimated TASA flows if they are developed utilizing open sand beds. The basis of design for the seven conceptual layouts developed as part of this project are summarized in the following table.



Table 6.1 Effluent Disposal Conceptual Layouts – Basis of Design

Site	Technology	Design Maximum Month Flow (mgd)	Hydraulic Loading Rate (gpd/sf)	Design Capacity
New Site Abutting Recharge Beds 14 & 15	Open Sand Beds	0.53	7	Sized to handle TASA maximum month flow with all beds in service (existing open sand beds at WWTF provide redundancy in the system).
Allen Parcel	Open Sand Beds	0.53	7	Sized to handle TASA maximum month flow with one bed out of service.
Falmouth Country Club	Leaching Trenches	0.53	3	Sized to handle TASA maximum month flow with one bed out of service.
Augusta Parcel	Open Sand Beds	0.53	7	Sized to handle TASA maximum month flow with one bed out of service.
Augusta Parcel	Leaching Trenches	0.53	3	Sized to handle TASA maximum month flow with one bed out of service.
Nobska Point	Ocean Outfall	7	N/A	Sized based on Town-wide flow documented in the 2007 Needs Assessment Report and 1968 Whitman Howard Report.
Buzzards Bay	Ocean Outfall	7	N/A	Sized based on Town-wide flow documented in the 2007 Needs Assessment Report and 1968 Whitman Howard Report.

In the next phase of this project, cost estimates will be developed for four to five conceptual plans identifying sewer service area, collection/transmission system (and lift station sites), discharge plan, and WWTF upgrades.

Figures

Figure 1 – Falmouth Country Club – (Scenario 1E)

Figure 2 – Conceptual Layout – Force Main Routing for Effluent Discharge Scenarios

Figure 3 – Conceptual Layout – Force Main – Routing for JBCC Effluent Disposal Scenario

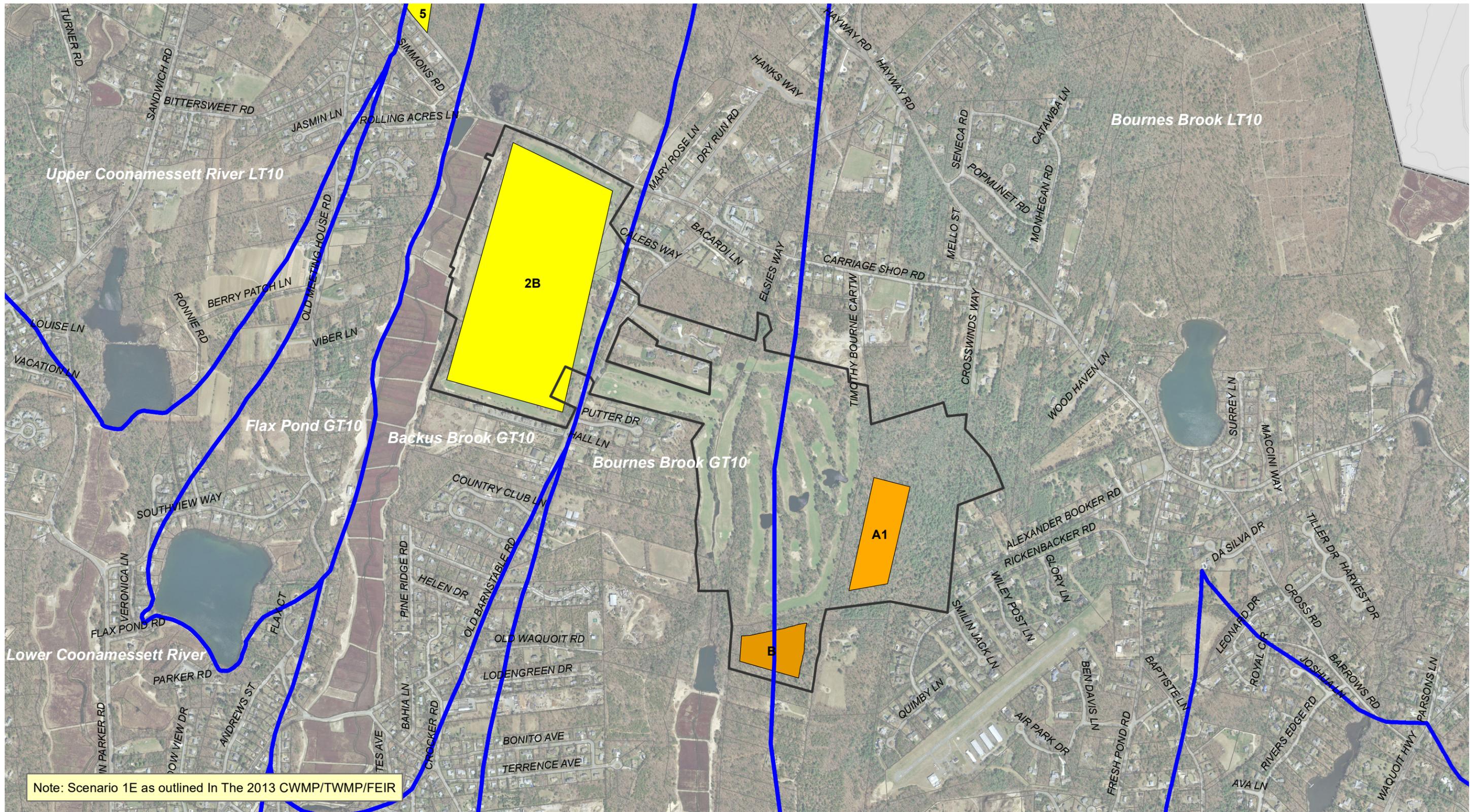
Figure 4 – Conceptual Layout – Open Sand Beds at Allen Parcel

Figure 5 – Conceptual Layout – Open Sand Beds at Augusta Parcel

Figure 6 – Conceptual Layout – Leaching Trench Effluent Disposal System at Augusta Parcel

Figure 7 – FCC Effluent Leaching Trenches – Conceptual Layout

Figure 8 – Open Sand Beds at New Site Abutting Recharge Beds 14 & 15



Note: Scenario 1E as outlined In The 2013 CWMP/TWMP/FEIR

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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1927
Grid: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001



LEGEND

-  Falmouth Country Club Site (As Outlined in 2007 ASAR)
-  Potential Open Sand Beds
-  MEP Watershed Boundary
-  Potential Subsurface Leaching Facility

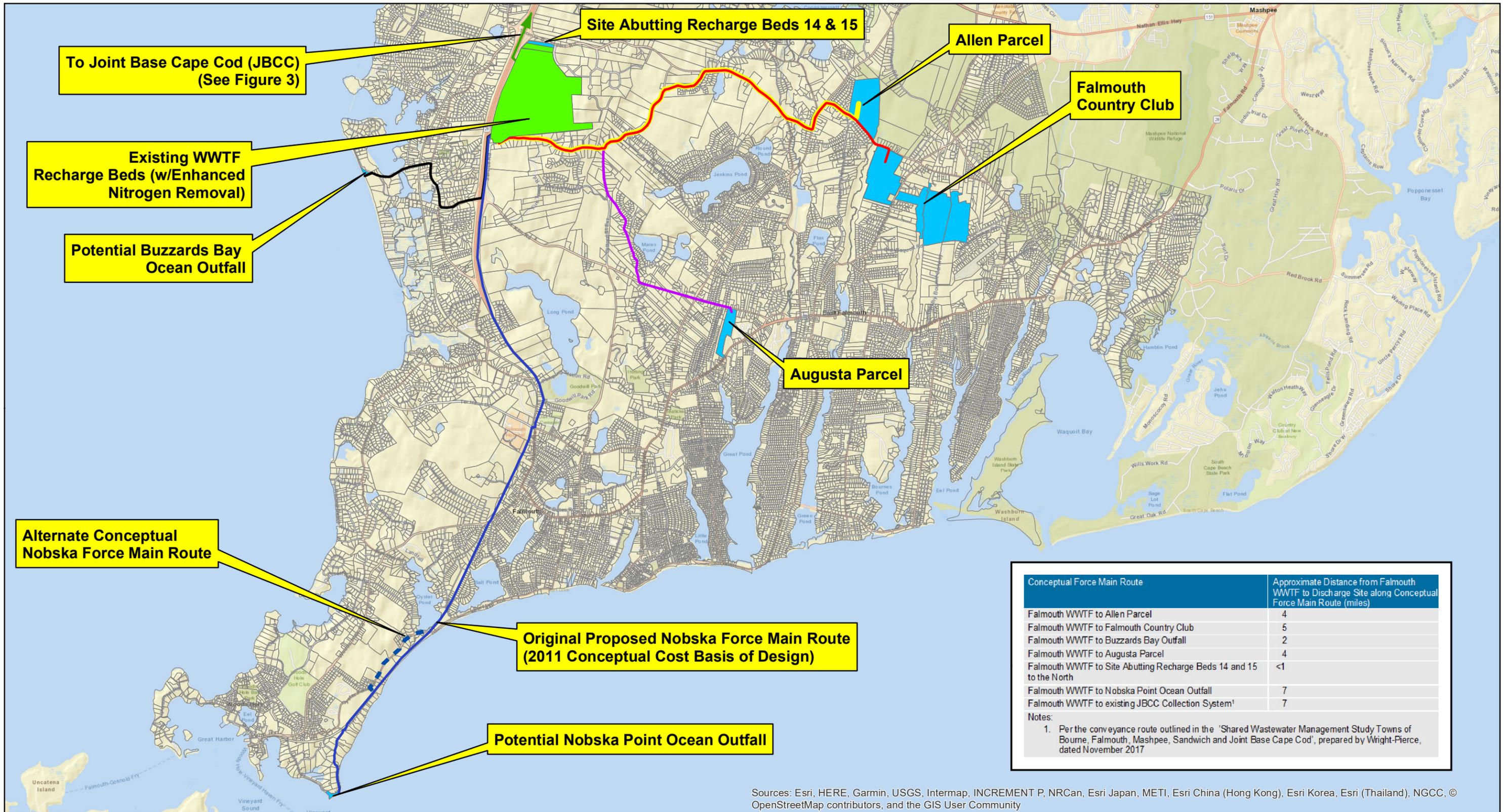


TOWN OF FALMOUTH, MA
Teaticket/Acapesket Preliminary Evaluation TASA (TM-3)

FALMOUTH COUNTRY CLUB -
(SCENARIO 1E)

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Date | 30 Oct 2018

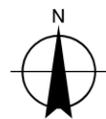
Figure 1



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Map Projection: Lambert Conformal Conic
 Horizontal Datum: North American 1983
 Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet



LEGEND

- Conceptual Force Main Routes**
- Falmouth Country Club
- Allen Parcel
- Augusta Parcel
- Potential Buzzards Bay Outfall
- Existing Effluent Disposal Parcel
- To Joint Base Cape Cod
- Potential Nobska Point Outfall
- Potential Effluent Discharge Site

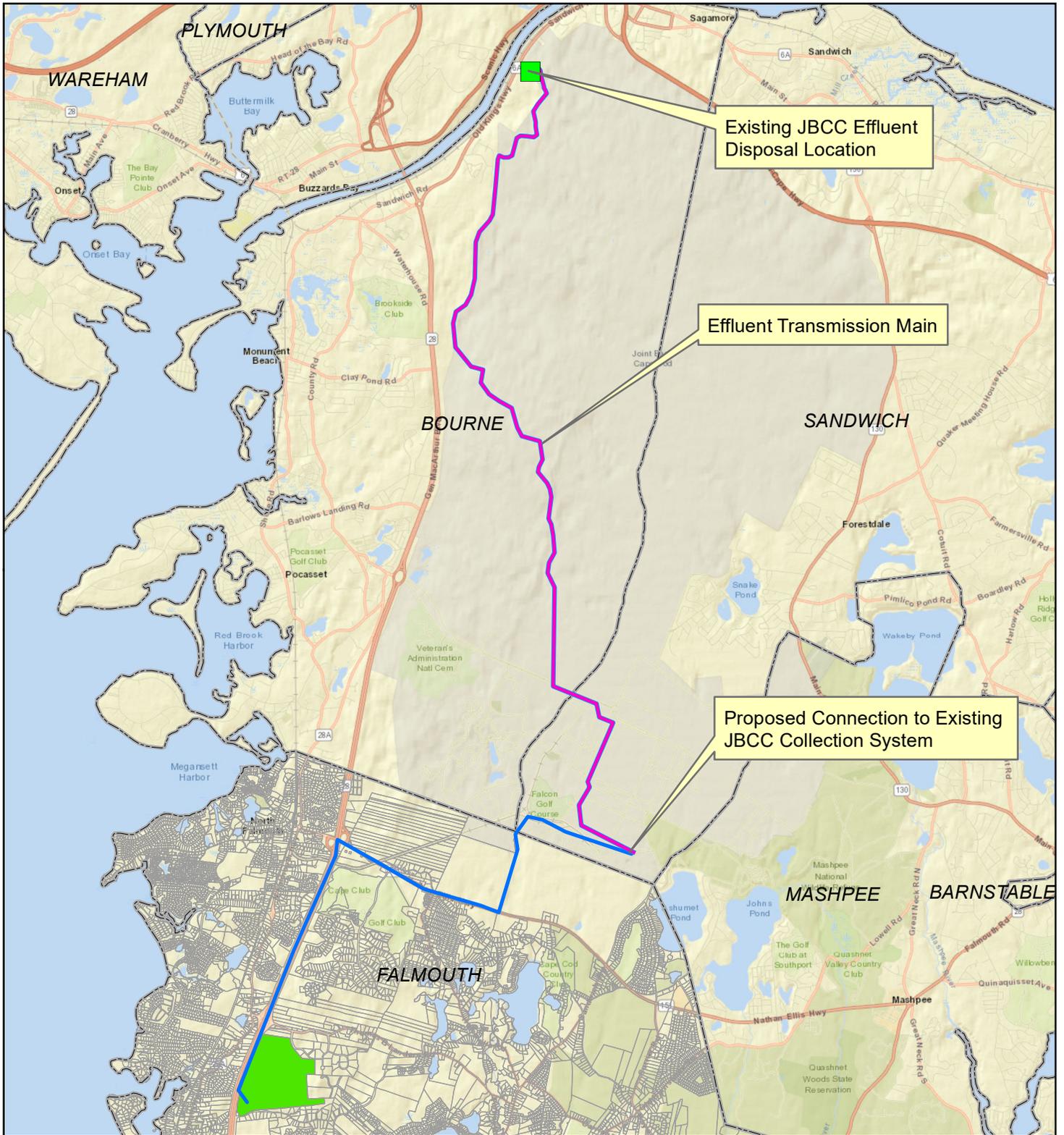


TOWN OF FALMOUTH, MA
 Teaticket/Acapesket Preliminary Evaluation TASA (TM-3)

Conceptual Layout - Force Main Routing For Effluent Discharge Scenarios

Job Number | 111-53041
 Revision | A
 Date | 01 Nov 2018

Figure 2



- LEGEND**
- Effluent Transmission Main
 - Proposed JBCC Force Main
 - Town Boundary
 - Falmouth WWTF Site

Note 1: Proposed Routing as Outlined in the "Shared Wastewater Management Study Towns of Bourne, Falmouth, Mashpee, Sandwich and Joint Base Cape Cod"

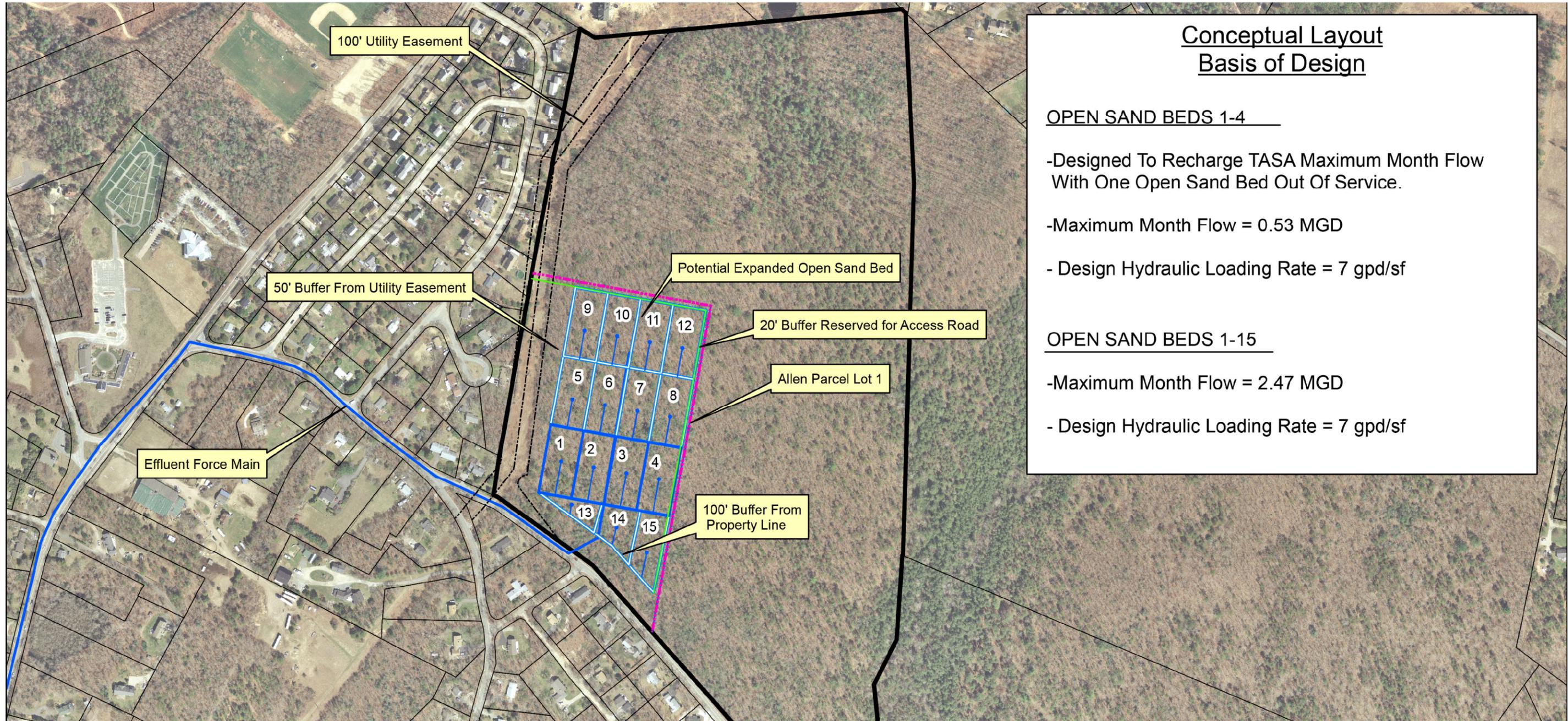


TOWN OF FALMOUTH, MA
Teaticket / Acapesket Preliminary Evaluation TASA (TM-3)

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CONCEPTUAL LAYOUT - FORCE MAIN - ROUTING FOR JBCC EFFLUENT DISPOSAL SCENARIO

Figure 3



**Conceptual Layout
Basis of Design**

OPEN SAND BEDS 1-4

- Designed To Recharge TASA Maximum Month Flow With One Open Sand Bed Out Of Service.
- Maximum Month Flow = 0.53 MGD
- Design Hydraulic Loading Rate = 7 gpd/sf

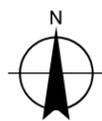
OPEN SAND BEDS 1-15

- Maximum Month Flow = 2.47 MGD
- Design Hydraulic Loading Rate = 7 gpd/sf

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Not To Scale

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet



LEGEND

- Access road
- Conceptual Open Sand Beds
- Lot 3 Border (General Municipal Use -Plan 2005)
- Conceptual Force Main
- Utility Easement
- Allen Parcel Lot 1 Border
- Potential Expanded Open Sand Bed

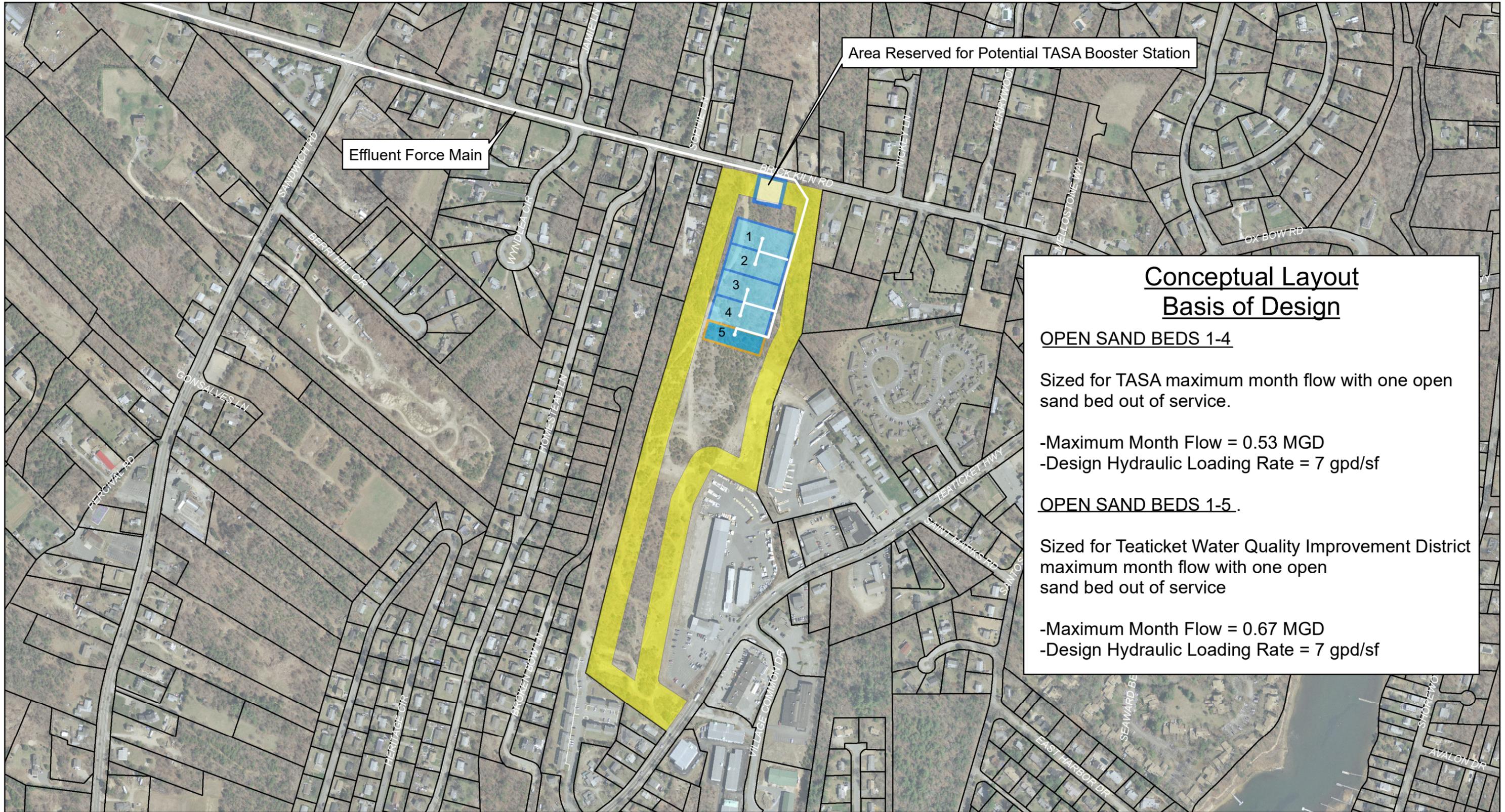


TOWN OF FALMOUTH, MA
Teaticket/Acapesket Preliminary Evaluation (TASA TM-3)

**Conceptual Layout - Open Sand
Beds at Allen Parcel**

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Figure 4



**Conceptual Layout
Basis of Design**

OPEN SAND BEDS 1-4

Sized for TASA maximum month flow with one open sand bed out of service.

- Maximum Month Flow = 0.53 MGD
- Design Hydraulic Loading Rate = 7 gpd/sf

OPEN SAND BEDS 1-5

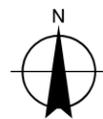
Sized for Teaticket Water Quality Improvement District maximum month flow with one open sand bed out of service

- Maximum Month Flow = 0.67 MGD
- Design Hydraulic Loading Rate = 7 gpd/sf

Paper Size ANSI B



Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet



LEGEND

- Lift Station
- Conceptual Open Sand Bed for TASA
- 100 Foot Buffer From Property Boundaries
- Potential Expanded Open Sand Bed



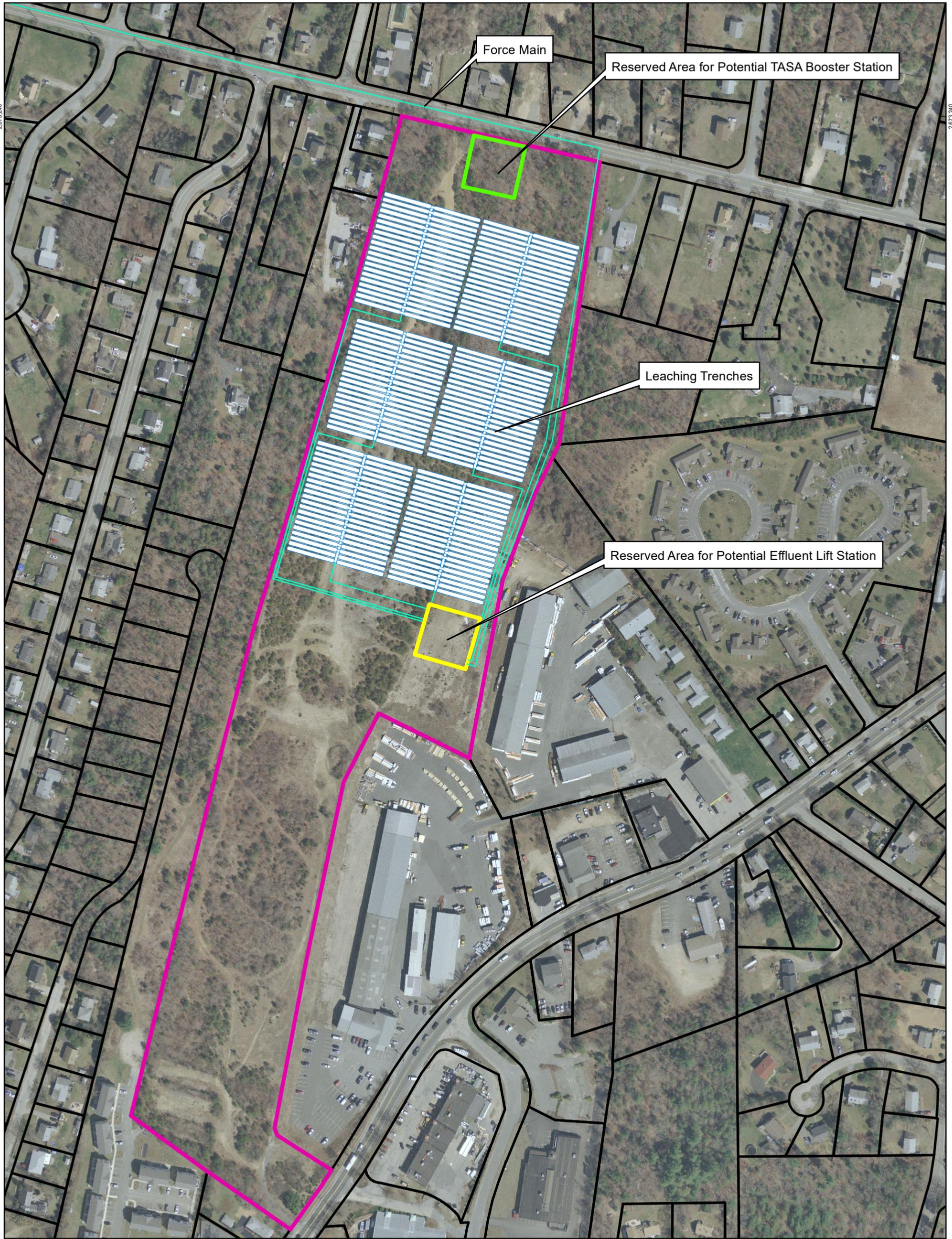
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Date | 14 Feb 2019

**Conceptual Layout - Open
Sand Beds at Augusta Parcel**

Figure 5

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Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:jjobrien



LEGEND

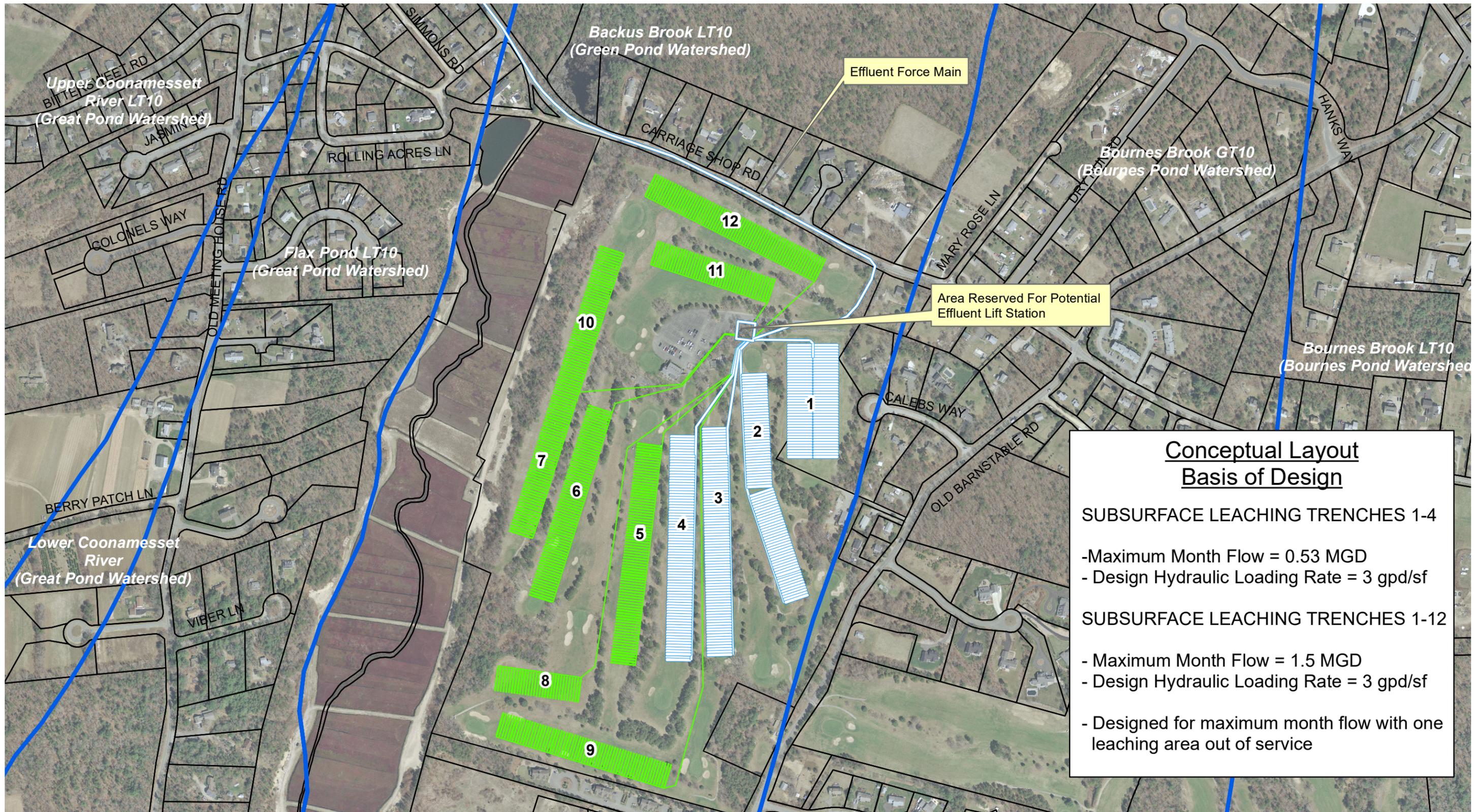
- Property Boundary
- Force Main
- Effluent Lift Station
- TASA Booster Station
- Conceptual Leaching Trench



TOWN OF FALMOUTH, MA
 Teaticket/Acapesket Preliminary Evaluation TASA (TM-3)
 Job Number | 111-53041-F06
 Revision | A
 Date | 30 Oct 2018

**Conceptual Layout - Leaching Trench
 Effluent Disposal System
 at Augusta Parcel**

Figure 6



Paper Size ANSI B

0 90 180 360

Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983

Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet



Legend

- Potential Future Infiltration Trench
- Conceptual Infiltration Trench for TASA
- MEP Watershed Boundary
- Parcel Boundary

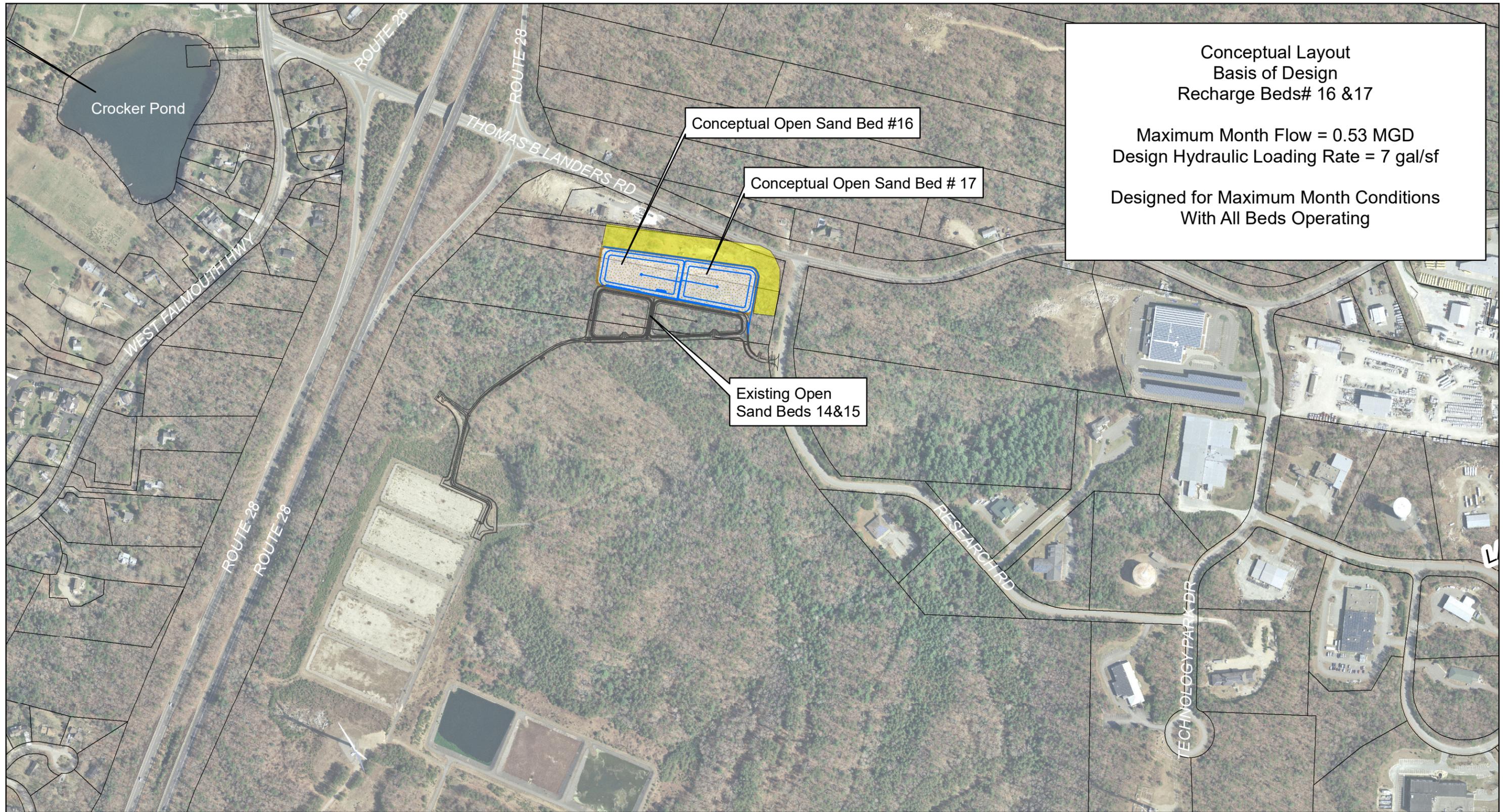


TOWN OF FALMOUTH, MASSACHUSETTS
Teaticket/Acapesket Preliminary Evaluation (TASA TM-3)

**Falmouth Country Club Effluent Leaching
Trenches - Conceptual Layout**

Job Number	111-53041
Revision	A
Date	14 Feb 2019

Figure 7



Conceptual Layout
 Basis of Design
 Recharge Beds# 16 & 17

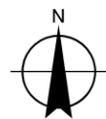
 Maximum Month Flow = 0.53 MGD
 Design Hydraulic Loading Rate = 7 gal/sf

 Designed for Maximum Month Conditions
 With All Beds Operating

Paper Size ANSI B



Map Projection: Lambert Conformal Conic
 Horizontal Datum: North American 1983
 Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet



LEGEND

-  Conceptual Open Sand Bed
-  100 Foot Buffer From Property Boundary



TOWN OF FALMOUTH, MA
 Teaticket/Acapesket Preliminary Evaluation TASA (TM-3)

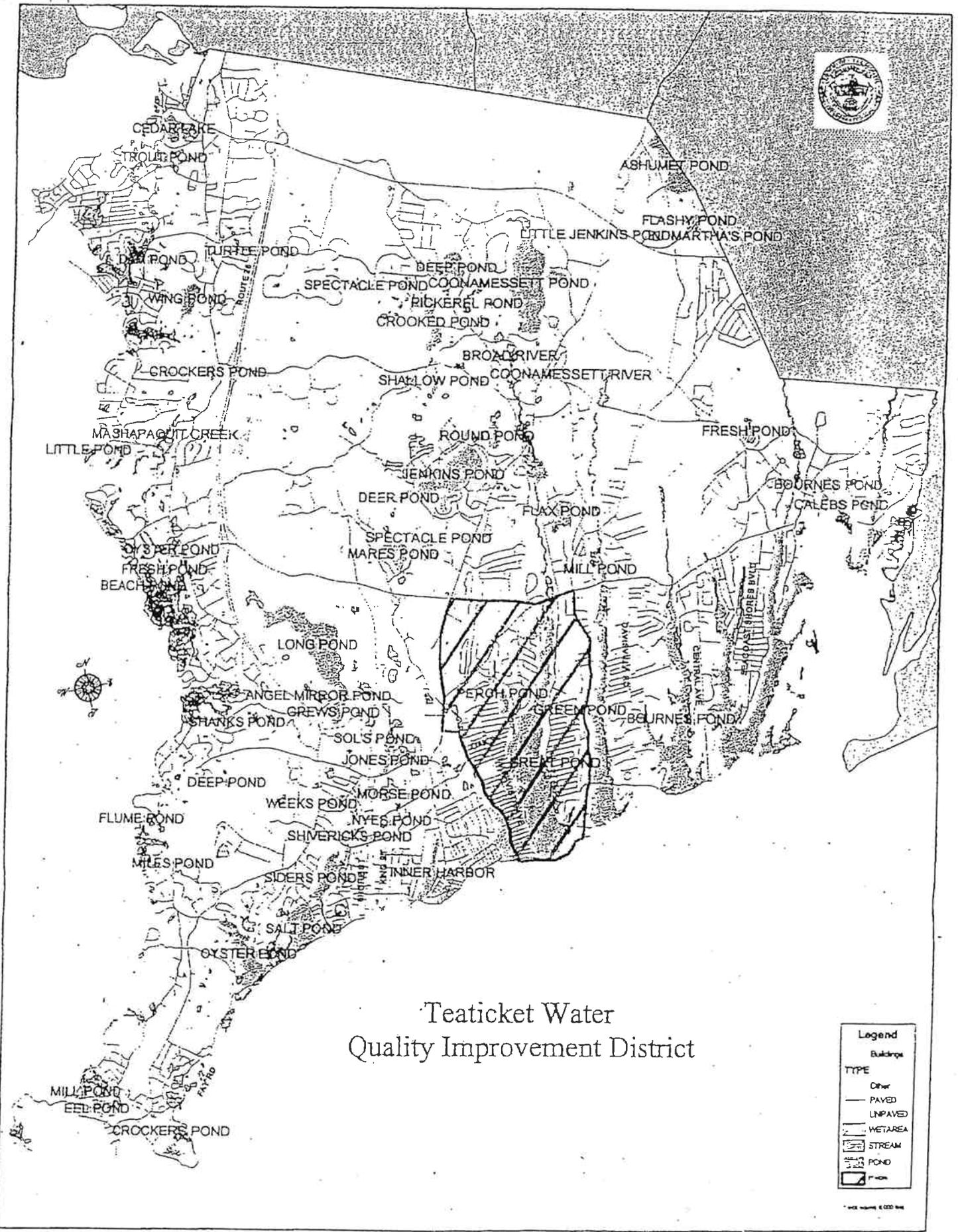
**Conceptual Layout- Open Sand Beds
 at New Site Abutting Recharge Beds 14 & 15**

Job Number 111-53041
 Revision A
 Date 01 Nov 2018

Figure 8

Attachment No. 1

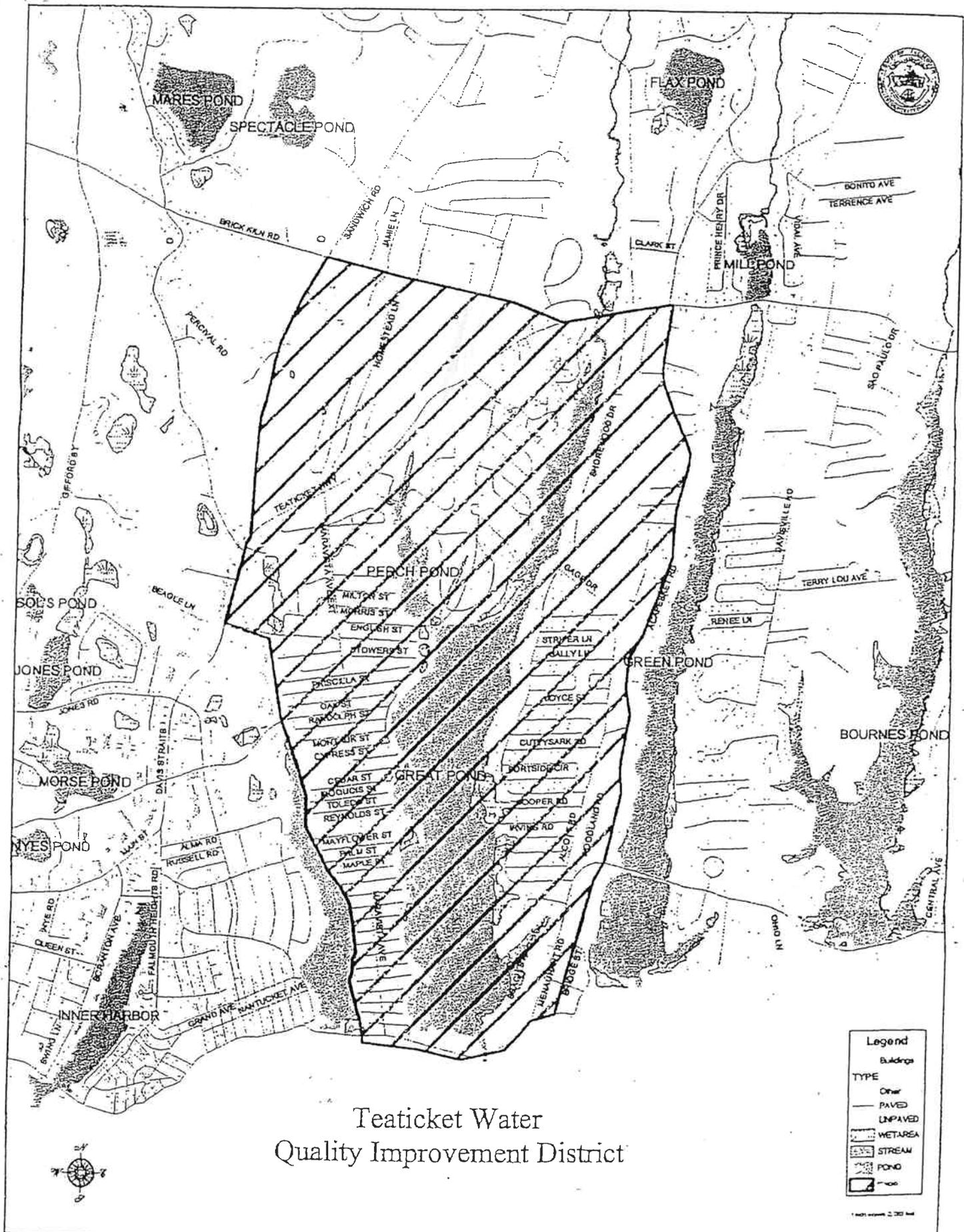
Teaticket Water Quality Improvement District Map



Teaticket Water Quality Improvement District

Legend	
	Buildings
TYPE	
	Other
	PAVED
	UNPAVED
	WETAREA
	STREAM
	POND
	WATER

Scale 1:25,000, 4/2002, 1:10,000

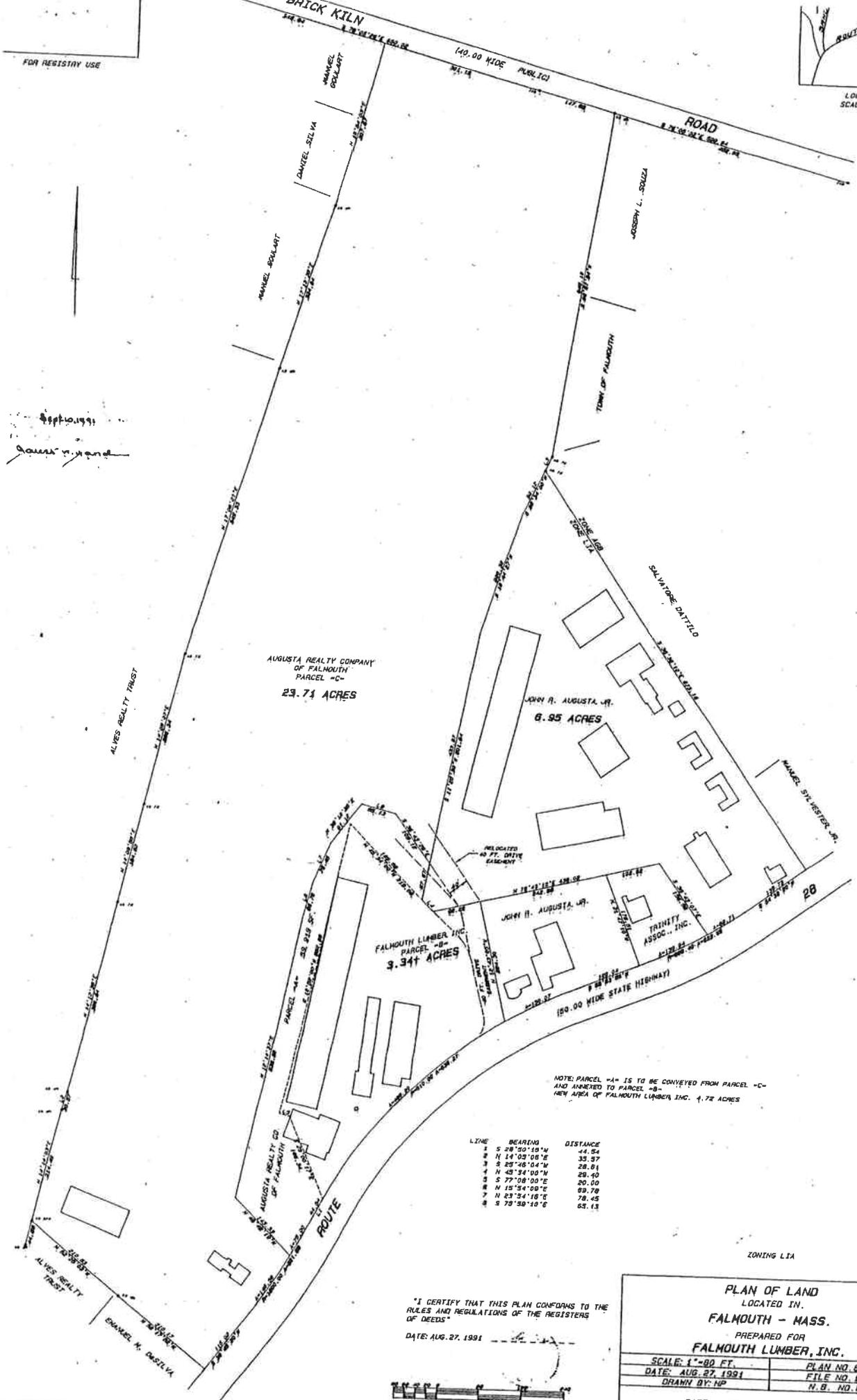
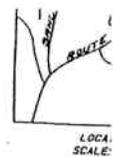


Teaticket Water
Quality Improvement District

Legend	
	Buildings
TYPE	
	PAVED
	UNPAVED
	WETAREA
	STREAM
	POND
	WATER



FOR REGISTRY USE



AUGUSTA REALTY COMPANY OF FALMOUTH PARCEL -C- 29.74 ACRES

JOHN R. AUGUSTA, JR. 8.95 ACRES

FALMOUTH LUMBER, INC. PARCEL -B- 3.34 ACRES

NOTE: PARCEL -A- IS TO BE CONVEYED FROM PARCEL -C- AND ANNEXED TO PARCEL -B- NEW AREA OF FALMOUTH LUMBER, INC. 4.72 ACRES

LINE	BEARING	DISTANCE
1	S 20° 50' 10" W	44.54
2	N 14° 03' 08" E	35.97
3	S 25° 16' 04" W	28.01
4	N 43° 34' 00" W	28.40
5	S 77° 08' 00" E	20.00
6	N 15° 54' 00" E	59.78
7	N 23° 34' 18" E	78.45
8	S 78° 50' 10" E	63.13

ZONING LIA

"I CERTIFY THAT THIS PLAN CONFORMS TO THE RULES AND REGULATIONS OF THE REGISTERS OF DEEDS"

DATE: AUG. 27, 1991



PLAN OF LAND
LOCATED IN
FALMOUTH - MASS.
PREPARED FOR
FALMOUTH LUMBER, INC.

SCALE: 1"=80 FT.	PLAN NO. 9
DATE: AUG. 27, 1991	FILE NO. 1
DRAWN BY: NP	N.B. NO. 1

CAPE & ISLANDS SURVEYING INC.
131 SPRING BARS ROAD
FALMOUTH - MASS.