TRI-TOWN BOARD OF WATER COMMISSIONERS
TOWNS OF BRAINTREE, RANDOLPH, HOLBROOK

REQUEST FOR QUALIFICATIONS (RFQ)
DESIGNER SERVICES

MGL Chapter 7C, Sections 44-57

NEW TRI-TOWN REGIONAL WATER TREATMENT PLANT

Due: Friday, August 23, 2019

No Later than 2:00 P.M.

Deliver to:

Lorraine See.

Contract Administrator

Braintree Town Hall

1 JFK Memorial Drive

Braintree, MA 02184

781-794-8144

lsee@braintreema.gov

Legal Advertisement

RFQ

DESIGNER SERVICES

REQUEST FOR QUALIFICATIONS (RFQ)

TRI-TOWN BOARD OF WATER COMMISSIONERS
TOWNS OF BRAINTREE, RANDOLPH AND HOLBROOK
MASSACHUSETTS

The Tri-Town Water Commissioners (Tri-Town) is seeking qualifications proposals (qualifications) from firms or persons for Designer Services in connection with services for the design of a New Tri-Town Regional Water Treatment Plant (RWTP). Submittals will be received at the office of the Procurement Officer, Town Hall, 1 JFK Memorial Drive, Braintree, MA 020184 until August 23, 2019 at 2:00 p.m., and at that time and place be opened and a record of submittals accepted.

The selection procedure that applies to the RFQ is the designer selection procedure for municipalities for the procurement of design services for a building project pursuant to M.G.L. c. 7 Sections 38A1/2-38O. The scope of services includes the design of new TTWTP including site development, building design, process treatment systems and related mechanical, electrical and control systems. Design services include services during the schematic design, design development and final design phases. All services shall be completed within 12 months. A Preliminary Conceptual Design Report of the Tri-Town RWTP has been completed and is provided with the RFQ. The estimated cost of the new treatment plant including transmission mains is approximately $70M.

Designer must be registered by the Commonwealth as an Architect or Professional Engineering, who has been in business for at least 10 years, with a minimum of ten (10) years of experience in the design of municipal surface water treatment plants (WTPs). Documented WTP design experience shall include three (3) surface water treatment plant facilities ranging in size from 5 to 15 MGD each with a construction value of at least $30M or greater within the last 10 years is also required. The fee for design services will be negotiated with the top-ranked finalist.

The RFQ document is available immediately at:
http://www.braintreema.gov/muniicpalfinance/Purchasing .html or via email from lsee@brtrainteema.gov .

A **mandatory** pre-response briefing session and site visit will be held on August 2, 2019 at the project site, Braintree Water Treatment Plant, 300 King Hill Road, Braintree, MA 02184.

The Tri-Town Board of Water Commissioners reserve the right to waive any informalities or irregularities in the qualifications received, or to reject any and all qualifications, wholly or in part, and to accept qualifications deemed to be in the best interest of the Tri-Town Qualifications may not be withdrawn within 30 business days after the opening.

RFQ – DESIGNER SERVICES, TTRWTP
Tri-Town Board of Water Commissioners

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DESIGNER SERVICES

SECTION I. GENERAL OVERVIEW

A. Introduction

The Tri-Town Board of Water Commissioners (Tri-Town) hereby requests qualifications proposals (qualifications) from firms or persons for Designer Services for the Design of a new Tri-Town Regional Water Treatment Plant (RWTP) This solicitation is being conducted in accordance with the provisions of Massachusetts General Laws Chapter 149, Section 44A 1/2, and all contracts must be strictly awarded in accordance with the requirements of the Request for Qualifications. If it becomes necessary to revise any part of this RFQ or otherwise provide additional information, an addendum will be issued to all prospective proposers who received copies of the original request.

In accordance with MGL Chapter 149, Section 44A 1/2, the term "Owner's Project Manager" (OPM) is intended to mean an individual, corporation, partnership, sole proprietorship, joint stock company, joint venture, or other entity engaged in the practice of providing project management services for the construction and supervision of construction of the Tri-Town RWTP.

The Designer shall be a person who is registered by the Commonwealth as an Architect or Professional Engineer and who has at least ten (10) years' experience in the design of water treatment facilities. The Designer shall demonstrate design experience of at least three (3) surface water treatment plant facilities ranging in size from 5 to 15 MGD each with a construction value of at least $30M or greater within the last 10 years. The Designer shall be independent of the OPM, general contractor or any sub-contractor involved in the building project. The "Awarding Authority" will be the Tri-Town Board of Water Commissioners (Tri-Town).

The Scope of Services is appended to this RFQ as Attachment "A", and will become part of the Agreement between Tri-Town and the Designer.

B. Background – Tri-Town Board of Water Commissioners

Tri-Town represents the towns of Braintree, Randolph and Holbrook. It was created through legislation in the late 1880's to manage the jointly utilized water supply known as Great Pond bordering the towns of Randolph and Braintree. The Great Pond Reservoir System consists of the Upper Great Pond Reservoir, the lower Great Pond Reservoir and the Richardi Reservoir. The Great Pond Reservoir System is the source of 100 percent of the drinking water for these three communities. Tri-Town maintains the reservoir dam system, has conducted dredging of the reservoir and provides overall management of the water supply system.

Braintree and the Joint Randolph/Holbrook Water Board own and operate individual WTPs on the Lower Reservoir portion of Great Pond. The two existing WTPs were constructed in the 1930's. Although upgrades have been conducted at both treatment plants the life expectancy of each plant has been greatly exceeded and upgrades have become increasingly challenging. Currently the design capacity of the Braintree Great Pond Water Treatment Plant is 6.0 MGD and the Randolph/Holbrook design capacity is 6.2 MGD.

Goal. The goal of the project is to replace the existing water treatment plants with one regional state-of-the-art water treatment plant. The design capacity of the treatment plant will be 12.5 MGD. The RWTP will be located on open space adjacent to the existing Braintree Great Pond WTP.

The Tri-Town Regional WTP (TTRWTP) construction is to be funded through the Drinking Water State Revolving Loan Fund and any other potential funding sources identified. Currently the estimated opinion of probable construction cost is $70.5 million dollars.

C. Project Description

The Tri-Town RWTP will have a maximum day capacity of 12.5 MGD. The OPM prepared and conducted a Water Treatment Plant Pilot Study to determine recommendations for treatment processes for a new facility to treat the Great Pond Lower Reservoir in 2003. The Pilot Study approach was approved and the results of the analysis were accepted by MassDEP in 2004. MassDEP has requested that supplemental information be provided to update water quality data and determine the potential impact of water quality changes on the approved Tri-Town RWTP processes. EP has prepared a draft BRP WS 22D (Water Treatment Approval of Pilot Study Report ≥ 1 MGD) application, which will be filed with MassDEP pending final supplemental water quality testing results to be received in July 2019. The current water quality has been found to be consistent with the original pilot study. The recommended treatment processes identified in the 2003/2004 pilot study report (provided in Appendix D) remains the final recommendation for the BRP WS:22D submission. Process treatment will include:

- Pre-oxidation
- Coagulation and flocculation
- Clarification with dissolved air flotation
- Media Filtration
- Chlorine for primary disinfection (in accordance with the 2004 MassDEP Pilot Study approval letter, the latest design is based on a sodium hypochlorite system rather than a chlorine gas system)
- pH adjustment as needed

Facilities to be designed are depicted in the conceptual design documents prepared by the OPM in October 2018, a copy of which is provided in Attachment C. Features include: raw water pump station, yard piping, treatment plant building structures, including all electrical, mechanical, structural, architectural and instrumentation needs, treatment processes to meet current and future water supply requirements, sludge dewatering system, finished water pumping and transmission systems, and all required site work . Four finished water transmission mains will be required to supply water to the three communities. A conceptual design prepared by the OPM outlines the specifics of the Preliminary Concept Design Report prepared by Environmental Partners in 2019, and is included with this RFQ as Attachment C. The report includes concept hydraulic profile, process diagram, site layout with survey information and floor plans.

D. Design Schedule

Preliminary design (30%) shall be completed within 4 months and includes final design criteria, hydraulic profile, concepts for each unit process and a flow diagram for major treatment systems. Preliminary design drawings shall include at minimum a site plan with major process units and yard piping as well as floor plans and/or cross sections of principal buildings or facilities showing major equipment, piping, elevations and the relations of floor level to finish grade. An estimate of probable construction costs is shall also be included.

Submission of 60% plans and Opinion of Probable Construction Cost shall be completed within 6 months of finalization of preliminary design (30%). With submission of 90% and final design plans and specifications within 6 months of the finalization of 60% submission.

The OPM shall provide the bidding, construction administration and resident engineering services.

SECTION II. GENERAL REQUIREMENTS

A. Key RFQ and Project Dates and Schedule

The following is a preliminary schedule noting target dates for RFQ and Project phases and tasks to be completed. Please note that all phases and tasks are subject to appropriation and considered individually.

	<u>RFQ Dates</u>
July 24, 2019 (on or before)	RFQ Issued & Advertised: Patriot Ledger, Town Hall Bulletin Boards (Braintree, Randolph, Holbrook), Town websites (Braintree, Randolph, Holbrook), Central Register, COMMBUYS
August 2, 2019	**Mandatory Pre-Response Conference and Site Visit**
August 16, 2019	Deadline for Questions
August 23, 2019 at 2PM	Last Day for Question Responses
August 28, 2019 at 2PM	**Qualifications Due**
September 9, 2019 (goal)	Designer Short List Notification
September 23-27, 2019 (goal)	Interviews for Finalists (goal)
October 2019	Fee Negotiations with Top-Ranked Designer
	<u>Project Dates</u>
February 2020	Submission of Preliminary Design (30%) including plans and Opinion of Probable Construction Cost
February to May 2020	OPM Review of Preliminary Design (30%)
June 30, 2020	Appropriations voted and approved
August 2020	Submission of 60% plans and Opinion of Probable Construction Cost
October 2020	Submission of SRF Drinking Water Funding Application (requires 80% plans and specifications)
December 2020	Submission of 90% plans and specifications and Opinion of Probable Construction Cost
December 2020	Final Plans and Specifications for Bidding
January/February 2021	Project Bidding
May 2021	Construction Commencement
June 2024	Project Completion

B. Delivery and Marking Responses

Responses must be delivered in person or via mail carrier to:

Ms. Lorraine See, Contract Administrator
Tri-Town Board of Water Commissioners
Braintree Town Hall
1 JFK Memorial Drive
Braintree, MA 02184

Postmarks will not be considered. Neither telephone nor email transmission of responses will be accepted. Tri-Town shall not be responsible for responses arriving late due to couriers, deliveries to wrong addressees, express mailing service errors, etc. If, at the time that responses are due, the office is closed due to uncontrolled events, responses will be accepted until Noon on the next day that the office is open. For the purposes of determining whether a respondent has met the deadline, the clock on the computer of the Contract Administrator shall indicated the official time. No individual extensions of this deadline will be granted. Late responses will be deemed "non-responsive" and will not be opened. They may be picked up by the respondent if so desired.

Response materials must be placed in a sealed envelope, and labeled on the outside with: "**RFQ: Tri-Town Regional Water Treatment Plant – Designer Services"** followed by the Designer's name, address and contact name. No responsibility shall be attached to any person or persons for the premature openings of Responses not properly marked.

C. Modification/Withdrawal of Responses

A Designer may correct, modify, or withdraw a Response by written notice received by Tri-Town prior to the due date and time. Each modification package must be sealed and marked with the Designer's name and address and "**RFQ: Tri-Town Regional Water Treatment Plant – Designer Services – Modification #_____"** The Modification must be a complete Response. The highest numbered Modification will be taken as the only submission by a Designer. No modifications or request for withdrawal will be accepted after the Response due date and time.

SECTION III. QUALIFICATION SUBMITTAL INSTRUCTIONS

A. Instructions to Parties submitting Qualifications ("Proposers")

1. Tri-Town may cancel this RFQ, in whole or in part, or may reject all Qualifications submittals, or may procure only some goods and/or services outlined in this RFQ whenever such action is determined to be fiscally advantageous to Tri-Town, or if it is otherwise in the best interest of the Tri-Town.

2. Tri-Town may request that supplementary information be furnished to assure Tri-Town that a party submitting qualifications has the technical competence, the business and technical organization, and the financial resources adequate to successfully perform the necessary work.

3. The Certificate of Non-Collusion Disclosure and Tax Compliance Certification Form are provided as Attachment G-4 and G-5, and the Standard Form for Designer Selection (DSB Form) link provided in Attachment G-6, shall be completed and submitted with the responder's

qualifications. All submittals shall be in ink or typewritten and must be presented in an organized and clear manner.

5. Each party submitting qualifications shall acknowledge receipt of any and all addendum issued to the Request for Qualifications by so indicating in the Cover Letter/General Response. Failure to do so shall be cause to reject the submittal as being unresponsive.

6. The party submitting qualifications shall sign the submittal correctly in ink; or in the case of an organization, firm, partnership or corporation, a person having the legal authority from said organization to sign the submittal shall sign the document.

7. The party submitting qualifications may correct, modify or withdraw the original submittals on or before **August 28, 2019 at 2 p.m**. Corrections or modifications shall be in sealed envelopes, clearly marked to indicate the contents, with the name and address of the party submitting qualifications. Any late correction or modification to the submittal will not be accepted.

8. Each proposer shall be presumed to have read and be thoroughly familiar with these documents. Unfamiliarity with these documents shall in no way relieve any proposer from any obligation in respect to his or her submittal.

9. It is understood that the proposer's submittal to the Tri-Town to provide said services and products will remain valid for 90 days past the submission deadline. The successful proposer's Qualifications submittal shall be attached thereto and become a part of the contractual Agreement between the Tri-Town and the proposer the same as though therein written out in full.

10. The proposer's attention is directed to the fact that all applicable state laws, municipal by-laws, and the rules and regulations of all authorities having jurisdiction over these services shall apply to the Agreement throughout, and they shall be deemed to be included in the contractual Agreement the same as though herein written out in full.

11. It is understood that the proposer has submitted the Qualifications submittal in good faith and without collusion or fraud with any other individuals, firms, or corporations.

12. All costs involved in preparing the Qualifications submittal will be borne by the proposer; Tri-Town will not be liable for any costs associated with the creation of the Qualifications submittal. The proposer shall be familiar with all state, local and other laws relating to this type of work.

13. All responses are to include a statement that the Qualifications submittal is in accordance with this Request for Qualifications and that the proposer has read and understands all sections and provisions herein. Exceptions, if any, are to be clearly stated.

14. Qualifications submittals, which are incomplete, conditional or obscure, will be rejected. No award will be made to any proposer who cannot satisfy the Awarding Authority that he/she has sufficient ability and sufficient capital to enable him/her to meet the requirements of these specifications. The Awarding Authority's decision or judgment on these matters shall be final, conclusive and binding.

15. The Qualifications submittals will be opened on **August 28, 2019 at 2 p.m**. at the Braintree Town Hall, 1 JFK Memorial Drive. Braintree, MA 02184. The name of the person or organization submitting qualifications will be read, recorded and submitted to the Tri-Town Qualifications Selection Committee for review. A register of Qualifications submittals will be completed indicating the name of each proposer available for interested parties.

16. The evaluation of the submitted qualifications will be conducted by Tri-Town or appointee, and the OPM. The judgment of the evaluators will be based upon the evaluation criteria set forth in this RFQ and shall be final. Interviews will be conducted with three or more selected finalists. Following final evaluation, the party having the highest evaluation shall be deemed the top-ranked finalist. The top-ranked finalist and Tri-Town will attempt to negotiate a fee amount. If negotiations are unsuccessful, the town will terminate negotiations and commence negotiations with the second-ranked designer.

17. Any contractual Agreement resulting from this RFQ shall be awarded to the proposer whose Qualifications submittal is deemed to be the most highly advantageous to the Tri-Town. Tri-Town or appointee will be the sole judge in determining whether a proposer's Qualifications submittal satisfies the requirements of this RFQ and whether or not the Qualifications submittal will prove advantageous to Tri-Town.

18. Response to this Request for Qualifications acknowledges the proposer's acceptance of all sections and requirements of this document. If the proposer's qualifications submittal does not comply with the requirements of this request for qualifications, or if an item is not understood in any way, a copy of that section of the request for qualifications must then be included in the submittal and all its copies must clearly state the deviation, additions, or other comments.

B. Pre-Response Briefing and Site Visit

All potential proposers are required to attend a mandatory pre-response briefing and site visit will be held on **August 2, 2019 at 10:00 AM EST at the project site, Braintree Water Treatment Plant, 300 King Hill Road, Braintree, MA 02184**. A listing of all individuals/firms attending will be kept. This is a mandatory meeting.

C. Questions and Clarifications

Questions requiring clarification shall be submitted in writing to the Contract Administrator at lsee@braintreema.gov or via fax no later than **August 16, 2019 at 2:00 PM EST** in order to afford the Tri-Town adequate time to respond with a correction or additional information prior to the deadline for submission of qualifications. Should it be found necessary, a written addendum will be incorporated into the RFQ and will become part of the Agreement. Those who have received a copy of the RFQ will be notified of such changes.

D. Addenda

In order to maintain a fair procurement environment, all responses to questions and comments received will be issued in the form of written Addendum. Addenda must be acknowledged in the Cover Letter. Failure to acknowledge the receipt of Addenda in the Cover Letter may result in a rejection of that Response.

E. Notification of Award

All proposers will be notified of the selection decision within 90 days of the date Qualifications submittals are due to the Tri-Town unless otherwise notified by Tri-Town.

F. Subject to Law

The procurement, contract and contract performance are subject to all applicable federal, state and municipal laws, regulations, condes and ordinances as if fully written out here.

G. Agreement Between Proposer and the Tri-Town

This Request for Qualifications, as well as the selected proposer's Qualifications submittal, and any addenda to that RFQ will become part of the final Agreement. The Agreement shall be subject to Force Majeure considerations, and in the event that either party hereto shall be prevented from the performance of any act required there under by reasons of strikes, lockouts, labor trouble, inability to procure materials, failure of power, fire, winds, Acts of God, riots, insurrections, war or other reason of a like nature not reasonably within the control of the party in performing any obligations, shall be excused for the period of the non-performance, and the period for the performance of such obligation shall be extended for an equivalent period for no additional cost to the Town. In the event that the extension is not possible, the provider may be required to rebate to the Town a portion of the fee.

It is agreed, however, that since the performance dates of the agreement are important to the implementation of the requested services, continued failure to perform for periods aggregating thirty (30) or more days, even for causes beyond the control of the contractor, shall be deemed to render performance impossible, and the Town shall thereafter have the right to terminate this Agreement in accordance with the provisions of the section entitled "Termination of Agreement."

It is also agreed that Tri-Town may terminate the agreement for no cause and without prejudice by a written notice at least thirty (30) days in advance to the firm/individual. The Tri-Town may also terminate the agreement if an appropriation is not available to continue the project.

H. Insurance Requirements

Insurance requirements are provided in the Sample Agreement found in Attachment B.

I. Interview

Interviews will be conducted with the key project personnel of the design firms identified as Finalists for further consideration. The interviews shall be subject to the state's open meeting law pursuant to M.G.L. c. 30A, §§ 18-25.

J. Licenses and Permits

The proposer is responsible for attaining and holding in good standing all relevant licenses and certificates associated with the completion of these services. Evidence of these requirements is to be made part of the Qualifications submittal. If a permit is not currently held or the application process is pending, the proposer should indicate such. Tri-Town reserves the sole right to decide if the Agreement may be awarded to the successful proposer despite the failure to produce the actual permits or copies thereof. Licenses and permits must be held in force throughout the terms of the services as contractually agreed upon.

K. Miscellaneous Information

All information acquired by the DESIGNER from Tri-Town, or from others at the expense of the Tri-Town, in performance of the agreement, shall be and remains the property of the OWNER. All records, data file, computer records, work sheets, deliverable products complete and incomplete, and all other types of information prepared or acquired by the proposer for delivery to Tri-Town shall be and will remain the property of Tri-Town.

The DESIGNER agrees to use this information only as required in the performance of this Agreement and will not, before or after the completion of this agreement, otherwise use said information, or copy, nor reproduce the same in any form except pursuant to the sole written instructions of Tri-Town.

L. Affirmative Action/Equal Opportunity

Tri-Town is an affirmative action/equal opportunity owner/purchaser. The Designer's attention is directed to all applicable State Laws and rules and regulations regarding affirmative action/equal employment opportunity requirements. Failure of a Designer's to comply with any such law, bylaw, rule or regulation shall constitute grounds for Tri-Town to reject a Response or to otherwise reject or terminate the award of the contract pursuant to these contract documents. The Tri-Town encourages full participation in the RFQ process by minority, women, veteran, service-disabled veteran, disability and lesbian, gay, bisexual and transgender-owned businesses.

M. Minority or Woman Business Enterprise Participation

Minority-Owned Business Enterprises (MBE) or Woman-Owned Business Enterprises (WBE) are strongly encouraged to submit qualifications in response to the Request for Qualifications (RFQ). For the purposes of this RFQ, the term MBE or WBE shall mean a vendor who is certified as a minority business enterprise by the State Office of Minority and Women-Owned Business Assistance (SOMWBA), and who is still certified at the time the vendor's Qualification submittal is submitted. All minority owned businesses are encouraged to apply for SOMWBA certification. For further information on SOMWBA qualifications, or access to SOMWBA vendor lists, contact the State Office of Minority and Women-Owned Business Assistance at 617-727-8692.

N. Public Record

All responses and information submitted in response to this RFQ are subject to the Massachusetts Public Records Law, M.G.L. c. 66, § 10 and c. 4 § 7(26). Any statements in submitted responses that are inconsistent with the provisions of these statutes shall be disregarded.

SECTION IV - MINIMUM SUBMITTAL REQUIREMENTS

A. Qualification Submittals Contents

One sealed envelope or container containing an original and ten (10) copies of the Qualifications submittal marked "RFQ: Tri-Town Regional Water Treatment Plant – Designer Services" followed by the Designer's name, must be received no later than **2 p.m. on August 28, 2019.** A digital copy of the qualifications shall also be provided on compact disk or thumb drive.

Within your Qualifications submittal, please supply each of the following items and clearly structure and label your Qualifications submittal:

- Cover Letter including name of Firm, address and telephone number, signed in ink by someone authorized to sign such documents.
- Company Profile
- Similar Project Experience.
- Project Approach.
- Designer Project Team
- Designer Comparative Evaluation Criteria Narrative, Section V. C. 1-18.
- Attachments – Forms provided in Attachment G of this RFQ.

  Attach a Financial Statement for the two previous calendar years attested by a CPA or Bank Officer. In respect of confidentiality, this may be submitted (one copy) in a separate envelope. This information will only be used if financial information provided in the submittal is not adequate to communicate financial capabilities. If you do not provide financial statements, you must include a letter to that effect and provide some other means to determine the financial status of your company.

All Qualifications submittals shall be submitted to the Contract Administrator or designee as stated in the legal advertisement. Each Qualifications submittal shall be in SEALED envelopes, clearly marked on the outside of the envelope to indicate the contents, and the name and address of the proposer.

The Qualifications submittal must be received by the Contract Administrator or their designee no later than **2 p.m. on August 28, 2019** and must be complete (must include or address all items specified in Section VI - Qualifications Submission Requirements).

The proposer must have signed the Certificate of Non-Collusion Form, Tax Compliance Certification Form and the Standard Designer Application Form and shall include them in the Qualifications submittal package.

The Qualifications submittal must be signed by an agent of the company who has authority to bind the company.

- A corporate officer/partners/manager as listed with the MA Secretary of State;

- An individual who is authorized by a Corporate Certificate of Vote (Certificate must be provided with the Response);
- An individual who is authorized by a Certificate of Authorization.

B. Contact Information

Clarification and interpretations of this Request for Qualifications must be requested in writing no later than **2 p.m. on August 16, 2019.** Responses shall be furnished in writing and may be sent electronically.

Lorraine See, Contract Administrator
lsee@braintreema.gov
Braintree Town Hall, 1 JFK Memorial Dr., Braintree, MA 02184
Tel: 781-794-8144
Fax: 781-794-8181

SECTION V. QUALIFICATIONS SUBMITTAL REQUIREMENTS

A. Cover Letter

1. All responses are to include a statement that the Qualifications submittal is in accordance with this Request for Qualifications and that the proposer has read and understands all sections and provisions herein. Exceptions, if any, are to be clearly stated.
2. An acknowledgement of any addendum issued to the RFQ.
3. An acknowledgement that the Designer has read the Standard Contract.
4. A specific statement regarding compliance with the minimum requirements identified in Section IV of this Request for Qualifications, to include identification of registration or certification, number of years of experience and where obtained (as supported by the resume section of Attachment B).
5. The name, title and address of the Principal In Charge and the Project Manager for the project including years of experience and resumes.
6. The name, title, address, e-mail and telephone number of the contact person who can respond to requests for additional information.
7. A statement regarding familiarity with the Surface Water Treatment Rule, Lead and Copper Rule, and associated related Federal and State water quality regulations that apply to the Tri-Town Surface water supply.

B. Company Profile (limit 2 pages)

1. A description of the Designer's organization and its history including proposed sub-consultants for inclusion on this project. Information to be provided: office address, contact name, phone number and email address, size of the organization, years in operation and services provided.

2. Summarize what you believe your company offers that differentiates it from other companies in this field.

C. Similar Project Experience/Qualifications

1. The Qualifications submittal must be from an individual or established business, corporation, partnership, sole proprietorship, joint stock company, joint venture, firm, or other entity engaged in the practice of providing designer services for public buildings and surface water WTPs, including its staff, and all of its sub-consultants.

2. Submittal must contain a response containing all qualifications and supporting data to the minimum criteria and the comparative evaluation criteria stated in Section V

3. Experience Provide a narrative for each project summarizing the project scope, treatment capacity, unit processes, influent and effluent quality, and site and building features. Identify projects with extensive renovations and new construction components.

4. Provide a list of projects for surface water supplies and the details of the treatment processes, Identify and describe unique process and building features.

5. Provide a cost summary for each project, including engineering services costs, construction costs, and change orders. Provide the final total construction cost and the Designer's initial project construction estimate. Describe and explain cost variances.

6. Provide a list of all public-sector Designer Services contracts completed at surface WTPs in the last ten (10) years in New England or National Identify projects where the Designer worked with an OPM and the contact information.

7. Complete Standard DSB Application form (Attachment G-6).

D. Project Understanding and Approach, Scope of Work

1. A specific statement about the approach you would take to this project, and your firm's particular suitability to the work.

2. The Designer shall provide design services as described in the Scope of Services. Refer to Attachment "A" for the detailed Scope of Services required for this project.

E. Designer Project Team Requirements

1. The Proposer must set forth the Designer team to be utilized for this service. Include resumes that include education, relevant past experiences, qualifications, licenses, and any other pertinent information that will assist in making the selection. Resumes to be included as an Attachment to the Qualification submittals. Each resume to be limited to 2 pages.

2. Each individual, their duties, the number of days each will spend providing this service must be broken down into the following categories:

    - Name, Work Assignment, and Responsibilities

3. The Submitting firm must be prepared to contractually commit all individuals as submitted in their Qualifications submittal, to this service. Any deviation from the proposed individuals will constitute a breach of agreement to any contractual agreement which may result from this Request for Qualifications.

4. Include resumes, experience, and qualifications of any proposed designers that would be utilized by the Proposer in the performance of this contract.

5. Should it become impossible for a contractually committed individual to complete his duties, for a reason such as termination of employment, any change in the proposer's staffing as outlined in the Qualifications submittal will be subject to the approval of Tri-Town The Contract Administrator of the Town of Braintree, or designee, shall notify the proposer of the acceptance or rejection of any such staff substitutions. Any substituted person must be of an experience level equal to or greater than the person being replaced unless approved by Tri-Town.

SECTION V. SELECTION PROCEDURES, INTERVIEW, AND NEGOTIATION

A. Review Process

Tri-Town, OPM and appointees will make the final selection for this project for the Tri-Town.

The OPM and Contract Administrator will review all Qualifications submittals to make sure minimum requirements are met. Those Qualifications submittals that meet all of the minimum requirements as outlined in this RFQ, and are determined to be both responsive (those that offer all of the services requested in the RFQ and contain all of the required information and forms properly completed) and those that are responsible (those with the capability, integrity, and reliability to perform under the contractual Agreement) will be further reviewed Tri-Town using the evaluation criteria outlined herein.

Based upon the ranked submittals, the Tri-Town will select the highest ranked submittals. A minimum of three (3) finalists shall be selected and interviewed by the Tri-Town, OPM and appointees. Relevant Town officials from Braintree, Randolph and Holbrook may also be included in this interview process.

After the interview process, the OPM will rank each of the submittals on the pre-selection list based on the evaluation criteria and interview.

Negotiations will then take place with the Tri-Town, OPM and the highest ranking submittal. The highest ranking submittal shall meet with the Tri-Town appointees and OPM to finalize the scope of work and the schedule for completion, as well as determine the contracting arrangement. Following agreement on final scope and schedule, the proposer shall submit fee proposal that includes a breakdown of proposed effort and costs, including a detailed breakdown of the estimated labor and expenses the successful proposer believes are necessary to perform each task. All related cost information requested by the Awarding Authority shall be furnished by the successful proposer for the purpose of complete disclosure during negotiations. Cost information includes, but is not limited to:

1. Percentage of time to be devoted to the project by key individuals, such as the Project Manager, Lead Design Engineer, Architect, etc.;

2. Hourly rates for the Designer's personnel and the estimated number of hours each will devote to the project;

3. An itemized breakdown of all other costs included in the fee proposal.

The awarding authority shall be the Tri-Town Board of Water Commissioners (Tri-Town).

If Tri-Town is unable to negotiate a contractual Agreement, including the fee, with the highest ranked submittal, Tri-Town will then commence negotiations with the next ranked submittal and so on, until a contract is successfully negotiated and approved by Tri-Town.

The Tri-Town reserves the right to award the contract to the responsive and responsible proposer who submitted the Qualifications submittal which best meets Tri-Town's needs, taking into account the Qualifications submittal quality and evaluation criteria. The Awarding Authority's decision or judgment on these matters shall be final, conclusive and binding.

B. Minimum Evaluation Criteria

Failure to meet the minimum evaluation criteria will result in the immediate rejection of the Qualifications submittal and will not be subject to further review.

Minimum Requirements: Proposers must meet the minimum requirements as specified in Section IV.

C. Comparative Evaluation Criteria Proposal

NOTE: Responding Proposers are to respond to each of the following criteria in a clearly labeled section of their response to this RFQ, in the same order. The following criteria will be used in the evaluation of the proposal firm to be selected:

1. <u>Water Treatment Plant Design Experience</u> (0-15 points)

   - Relevant experience in the last 10 years of surface water treatment plant design (<u>documented</u> design experience in surface WTP design on a minimum of three (3) projects facility size between 5-15 MGD and larger with a construction value of $30 million or greater);

   - Water treatment processes including iron/manganese removal, dissolved air flotation, media filtration, disinfection and sludge dewatering.

   - Capability to conduct cost estimating with documented comparisons of initial project estimates to final completed costs.

   - Civil, Structural and Architectural Design for treatment buildings, including new construction, and experience with sustainable-green building features

   - Electrical systems, Plumbing and HVAC systems

   - Instrumentation, Security, and SCADA systems.

2. Multi-Disciplinary design disciplines including mechanical/process, structural, architectural, HVAC, electrical, instrumentation, site/civil, and environmental permitting. Designer must identify personnel to be assigned for each of those disciplines and state which firm employs them and from which office each person works. (0-15 points)

3. Qualifications of Project Team. The project team members must have demonstrated experience on similar water treatment plant projects. Demonstration of previous experience working together as a project team will be considered advantageous (0-10 points)

   - Key personnel's professional qualifications, background, caliber and availability for project. Provide available start date for key personnel.

   - Current and anticipated workload for the proposed staff.

4. Demonstrated ability to meet schedules or deadlines. Provide 5 references for completed projects demonstrating control of schedules and deadlines (0-10 points).

5. Demonstrated experience working collaboratively with town staff and construction contractors to ensure completed projects without having major cost and time escalations or overruns. (0-10 points)

6. Massachusetts Experience (0-5 points)

   - Experience with Commonwealth of Massachusetts M.G.L. Chapter 149 design and construction procurement laws, regulations, policies, and procedures for surface water supply treatment facilities and building projects

   - Demonstrated understanding of MassDEP requirements, MHC requirements and other Massachusetts regulations

7. Demonstration of the design teams' history of working together on similar projects. If subconsultants are utilized, demonstrate prior experience working together on similar projects. (0-10 points)

8. Demonstrate an understanding of the project's potential problems and Tri-Town's special concerns, including any recommended modifications to the Scope of Services believed to be necessary or appropriate to the successful completion of the project. (0-10 points)

9. Reference Checks (0-15 points)

D. Comparative Evaluation Criteria Interview

Upon Review of all qualifications the TOWN may select up to three (3) DESIGNER finalists to interview. DESIGNERS will be scored on the above criteria and will be given additional points as follows.

1. Verbal Presentation 0 to 5 points

2. Written Presentation 0 to 5 points

3. Visual Presentation 0 to 5 points

4. Knowledge of treatment facilities and location of the project 0 to 5 points

5. Ability to Spontaneously Respond to Questions 0 to 5 points

ATTACHMENT "A" - SCOPE OF SERVICES

SCOPE OF SERVICES

Furnish designer services in connection with the design of TTRWTP. The design criteria is summarized in the Preliminary Concept Design Report Attachment C. to the RFQ.
The design services, providing full, bid-ready plans and specifications shall be completed within 12 months after the submission of the preliminary design (30%).

Task I: Design

The design scope of services is organized into three distinct phases as described herein. Each phase will include engineering and architectural services associated with all aspects of the following disciplines:

- Civil (surveying, wetland delineation, earthwork, geotechnical, utilities, landscaping, parking, paving)
- Process-Mechanical (treatment systems, piping, valves, and pumping)
- Instrumentation & Controls (I&C) and SCADA
- Architectural
- Structural
- Electrical (including communications)
- Building Systems (Plumbing, Fire Protection, HVAC, Security)

The design phase will consist of meetings with the Tri-Town and OPM, the preparation of deliverables (including construction cost estimates), the review of deliverables and concepts with the Tri-Town and OPM, addressing Tri-Town's and OPM comments, and the preparation of construction documents suitable for public bidding as outlined below.

1. Preliminary Design Phase (30%) Design

The goal of this Phase will be to seek agreement on a single design concept based on the Preliminary Concept Design (Attachment C). The deliverables for this task will include diagrams, sketches and preliminary drawings which will provide sufficient information for Tri-Town, OPM and agency review. Concepts developed at the end of this phase will be used for the Design Development phase. The following specific tasks shall be performed during the schematic design phase:

- Coordinate and attend one (1) two-day interactive workshop with Tri-Town and OPM. This workshop will serve as a kickoff for the design phase of the project. The goal of this workshop will be to review the critical design decisions of the Conceptual Design, identify Tri-Town requirements and preferences, and identify areas to be finalized later.
- Confirm location of wetlands
- Confirm the site layout and access road details including parking, pavement, drainage, and landscaping requirements.
- Confirm the connectivity and layout of all site utilities (water, sewer, stormwater, electricity, gas, telephone, and cable).
- Prepare a preliminary layout of the treatment process using the recommended processes outlined in the Preliminary Conceptual Design Report, (Attachment C) s.

- Complete a detailed building code review.
- Confirm preliminary room sizes, adjacencies and functional requirements of each space, architectural theme for exterior of building, interior and exterior construction materials (including insulation rating), and roof system for each building.
- Prepare building layouts (hand sketches, sections, elevations, and equipment layouts).
- Complete the selection and size of all major process equipment from the intake raw water pump station through to the transmission to Braintree, Randolph and Holbrook distribution systems including yard piping, raw water pump station, clarifiers, filters, chemical addition (i.e. disinfection and pH adjustment, clearwell sizing, sludge handling, and all related tanks, pumps, blowers, piping, valving, and junction structures and cross pond transmission mains. Prepare preliminary hydraulic calculations.
- Prepare overall process control narratives for the operation and control of the TTRWTP.
- Confirm building ventilation and air conditioning requirements and systems.
- Confirm building heating and cooling requirements and systems. Confirm fire protection and sprinkler requirements with local Fire Department.
- Determine facility potable water layout, non-potable water, sanitary waste, floor drain, and natural gas concepts and details.
- Confirm building and facility structural requirements.
- Develop process and instrumentation diagrams (P&IDs) for each treatment process. Each P&ID will include: process configuration, flow streams, valve and gate locations (manual and powered), chemical additions points/types, process equipment location/type including packaged control panels and adjustable-speed drives, flow meters and other process control devices for measuring, transmitting, and recording information (e.g. analytical, pressure, level).
- Prepare a facility SCADA system schematic.
- Confirm preliminary facility electrical loads and voltages and modify the preliminary overall one-line diagram for proposed facilities, including power feeds, substation requirements, and standby power generation.
- Prepare a security plan and concept for the treatment facilities.
- Prepare a conceptual plan for radio and telephone communications for the facilities.
- Prepare an estimate of probable construction costs once the Schematic Design concept is complete.
- Prepare a Schematic Design report based on completing the above outlined tasks.
- Attend one (1) two-day value engineering workshop with the OPM to identify alternatives and cost savings, and review these with the Tri-Town and OPM. Refine the schematic design accordingly.
- Coordinate and attend a one-day workshop with the Tri-Town and OPM. The Tri-Town must agree on the Schematic Design concepts to allow the design to progress into the next phase.
- Revise the design report based on the workshop with the Tri-Town and the OPM.

2. Design Development Phase – 60%

This phase will result in the preparation of draft engineering plans which constitute the facility design to be approximately 60% complete. The purpose of this task is to utilize the decisions made in the previous phase and complete and finalize all preliminary calculations. The Design Development phase will consist of the following subtasks:

- Selection of main process-mechanical equipment. Finalize the selection and size of major process equipment including: yard piping, raw water pump station, clarifiers, filters, chemical addition (i.e. disinfection and pH adjustment, clearwell sizing, sludge handling, and all related tanks, pumps, blowers, piping, valving, and junction structures and cross pond transmission mains. Finalize hydraulic calculations.
- Prepare mechanical drawings (plans, sections and elevations as necessary) for all process improvements.
- Complete a constructability and operability review.
- Prepare site plans that include facility layouts, site access, grading, drainage, and utilities.
- Finalize room sizes and layouts. Prepare and develop building floor plans, elevations, and sections for all buildings.
- Finalize structural requirements for buildings and facilities. Prepare and develop structural plans, sections, and details.
- Coordinate with electrical and building services on all interior utility routing.
- Finalize major and ancillary equipment sizing and line sizing calculations. Assemble catalog cut sheets.
- Prepare sizing calculations for HVAC equipment based on energy code requirements and selected building construction materials. Prepare cut sheets.
- Prepare HVAC system block diagrams, and confirm HVAC system control philosophy. Prepare and develop HVAC plans, sections, and details.
- Finalize plumbing and fire protection requirements. Prepare and develop plumbing and fire protection plans, sections, and details.
- Finalize P&IDs for all processes. Summarize I&C, SCADA, and other control interfaces and equipment requirements (including location, number, manufacturer, and size).
- Finalize facility security features and plans.
- Finalize the number and location of motor control centers (MCCs) to be provided and location of MCCs, and equipment to be powered from each MCC.
- Update one-line electrical diagrams and confirm all facility loads and power distribution.
- Develop infrastructure requirements and layout for telephone communications, data highways (LAN, WAN, SCADA), cable, and radio communications.
- Develop lighting concepts and layouts for facility interior and exterior lighting.
- Prepare a first draft of all facility technical specifications.
- Prepare a first draft of permit submissions for review by OPM
- Prepare an estimate of probable construction costs after completion of the Design Development Phase.
- Submit a design development report summarizing the key elements of this phase of work, including the basis of design for sizing and selecting all process equipment and building systems, and an updated construction cost estimate.
- Attend one (1) two-day value engineering workshop to identify alternatives and cost savings, and review these with the Tri-Town and OPM. Refine the Design Development work products based on the findings of the VE workshop and guidance from the Tri-Town and OPM.

- Attend one (1) two-day workshop to review the work products with the Tri-Town and OPM.

3. Draft and Final Design Documents Phase 90% and 100%

The purpose of this task is to develop the final drawings, specifications, and schedules suitable for construction and competitive bidding. This phase will consist of the following key subtasks:

- Finalization of final calculations.
- Preparation of construction drawings suitable for public bidding in accordance with MA Bid Law.
- Preparation of final technical specifications in Construction Specifications Institute (1995 CSI) format suitable for public bidding in accordance with MA Bid Law.
- Preparation of an estimate of probable construction costs at 90% and 100% design completion.
- Submit progress submittals at the 90% and 100% % design completion milestones to the Tri-Town and OPM for review.
- Coordination and attendance of two (2) one-day workshops to review the work products with the Tri-Town and OPM. Workshops to be scheduled at approximately 90% and 100% design completion.
- Incorporate workshop review comments into the For Construction plans and specifications.

Task II: Permitting Assistance

Unless otherwise instructed by the Tri-Town, the Designer shall support the OPM to obtain all permits required to implement the project design at the site, other than standard building permits customarily obtained by the general contractor. Any permit application fees shall be paid directly by the Tri-Town. Permits may include but not be limited to the following:

MEPA ENF, MassDEP NOI, Massachusetts Historic Commission, US Army Corp of Engineers Section 10/404 and 103, 401 Water Quality Certificate submissions to be prepared by the OPM with the support of the Designer.

The Designer will be responsible for preparing submissions for the Drinking Water SRF PER application, BRP WS 24, Site Plan/Building approval; Fire Department; and MWRA connection for sludge disposal.

Task III: Construction Assistance

The Designer shall provide assistance to the OPM during construction of the project in the following areas:

1. Attendance at construction meetings as needed.
2. Shop Drawing Review and Request for Information
3. Interpretation of specifications and plans

ATTACHMENT "B" - STANDARD CONTRACT TERMS AND CONDITIONS

STANDARD CONTRACT BETWEEN

THE TRI-TOWN BOARD OF WATER COMMISSIONERS

AND
DESIGNER

FOR WATER TREATMENT PLANT DESIGN SERVICES

This Agreement is made on this____day of___________, 20___between the Tri-Town Water, acting by and through its Chairman (hereinafter, the "BOARD") and (DESIGNER), whereby the parties contract for services under the terms and conditions set forth herein.

I. PARTIES

The parties to this contract are the towns of Braintree, Randolph, and Holbrook (hereinafter the Tri-Town Board or BOARD, and DESIGNER. The towns of Braintree, Randolph, and Holbrook are municipalities of the Commonwealth of Massachusetts having principal places of business at 1 JFK Memorial Drive, Braintree, MA 02184; 41 South Main Street, Randolph, MA 02368; and 50 N. Franklin St., Holbrook, MA 12343, respectively. DESIGNER is a (sole proprietor/limited liability corporation/corporation) with a principal place of business at

____.

II. DESIGNATED REPRESENTATIVES

The BOARD designates James Arsenault, Braintree DPW Director and (DESIGNER) designates (name), (Title), as their authorized representatives to provide approvals, directives, and permissions including changes, and to receive notices or other communications under this Agreement at the addresses stated above.

III. CONTRACT DOCUMENTS

The contract documents shall consist of the following:

1) This Agreement;
2) The BOARD’s Request for Qualifications;
3) (DESIGNER’s) bid or proposal;
4) (DESIGNER’s) Certificate of Non-Collusion;
5) (DESIGNER’s) Certificate of Tax Compliance;
6) (DESIGNER’s) Certificate of Authorization;
7) (DESIGNER’s & SUBCONSULTANT’s) Certificates of Insurance;
8) (DESIGNER’s & SUBCONSULTANT’s) Additional Insured Endorsement Pages;
9) CONTRACT FOR PROJECT MANAGEMENT SERVICES, adapted from MASSACHUSETTS SCHOOL BUILDING AUTHORITY STANDARD OPM CONTRACT (APPENDIX).

Such contract documents shall be incorporated herein by reference and made a part of this Contract, which represents the entire agreement and understanding between the Parties. If the terms of any of the documents are in conflict, the terms of this Agreement shall prevail.

IV. SERVICES

The scope of services to be provided by (DESIGNER) is as follows:

Preparation of Design plans and specifications for the construction of a 12.5 MGD Regional Water Treatment Plant to be located on a lot of land owned by the Town of Braintree, MA and redundant transmission mains across Great Pond to connect at the Randolph/Holbrook Water Treatment Plant 24 inch transmission main. Work will include preparation of preliminary and final plans and specifications, support to the Owner's Project Manager (OPM) in the preparation of documents for review meetings and public presentations, attendance at meetings as required and support during bidding, construction and Startup.

V. QUALITY OF WORK

(DESIGNER) represents that it will perform services for the BOARD using that degree of care and skill ordinarily exercised by and consistent with the standards applicable to persons performing similar services under similar conditions in the same locality. (DESIGNER) shall be liable for its services rendered under this Contract.

VI. COMPENSATION

On a monthly basis, (DESIGNER) shall submit invoices to the BOARD with any reasonable supporting documentation requested by the BOARD, reflecting the services performed during said month. Upon satisfactory review of said invoices and documentation, the BOARD shall remit payment to (DESIGNER). Total compensation to be paid to (DESIGNER) pursuant to this contract shall not exceed $______________.

VII. TIME FOR PERFORMANCE

All services to be performed pursuant to this contract shall be completed by (DESIGNER) by (Insert Date).

VIII. SUBJECT TO APPROPRIATION

Notwithstanding anything in the contract documents to the contrary, any and all payments which the BOARD is required to make under this contract shall be subject to appropriation or other availability of funds, as certified by the Accountants of the member Towns.

IX. ENFORCEABILITY OF CONTRACT

This contract is binding upon and enforceable against the BOARD if this contract is signed by the Mayor of Braintree, Town Manager of Randolph, and Selectmen of Holbrook; endorsed by the Accountants of the member Towns as to appropriation or availability of funds, and endorsed as to form by the Town Solicitors of the member Towns. This contract is binding and enforceable against (DESIGNER) if signed by their authorized representative.

X. ASSIGNMENT

(DESIGNER) shall not delegate, assign or transfer its duties or interest in this Contract without the express written consent of the BOARD. If approved by the

BOARD, this contract shall be binding upon (DESIGNER's) assigns, transferees and/or successors in interest.

XI. PREVAILING STATUTORY AUTHORITY

The validity, interpretation and performance of this Contract shall be governed by and construed in accordance with the laws of the Commonwealth of Massachusetts.

XII. CONFLICT OF INTEREST

Both the BOARD and (DESIGNER) stipulate to the applicability of Massachusetts General Law Chapter 268A, the Conflict of Interest Statute. The Parties further stipulate that the terms and conditions of this contract expressly prohibit any activity which constitutes a violation of this statute. By executing this contract, (DESIGNER) certifies that neither it nor any of its agents, employers or subcontractors is in violation of Massachusetts General Laws Chapter 268A.

XIII. INSURANCE

(DESIGNER) shall maintain the insurance coverage listed below. With the exception of Workers' Compensation and Professional Errors and Omissions insurance coverage, (DESIGNER) is required by this agreement to name the Tri-Town Board of Water Commissioners and the OPM as additional insured and to provide the BOARD with certificates of insurance coverage indicating that the BOARD and OPM have been added as an additional insured under all insurance coverages required by this contract. Further, (DESIGNER) is required to provide the BOARD with a copy of the current additional insured endorsement page, reflecting that the BOARD and OPM have been listed as an additional insured, for each insurance policy to which the BOARD and OPM have been added. <u>If Subconsultants are used, all of the provisions of this section apply to the Subconsultant.</u>

A. General Comprehensive Liability in the amount of $1,000,000 for each occurrence and $3,000,000 in the aggregate;

B. Automobile Liability (applicable for any DESIGNER who has an automobile operating exposure) in the amount of $1,000,000 for bodily injury and property damage per accident;

C. Professional Errors and Omissions Liability (applicable for any DESIGNER providing design, architectural, engineering, financial advising or similar services) in the amount of $1,000,000 for each occurrence and $5,000,000 in the aggregate;

D. Pollution Liability (applicable for any DESIGNER or subconsultant who has pollution exposure) in the amount of $1,000,000 for each occurrence and $3,000,000 in the aggregate;

E. Umbrella Liability of $2,000,000 for each occurrence and $5,000,000 in the aggregate; <u>and</u>

F. Workers' Compensation and Employer's Liabilityin the amount as may be required by Massachusetts General Laws Chapter 152.

The parties acknowledge that the types of insurance and coverage limits listed herein are the minimum necessary for the (DESIGNER) to be awarded this contract. The types of insurance and coverage limits stated herein are not intended in any way to limit the (DESIGNER's) liability for any damages arising from the (DESIGNER's) performance of services under this contract.

The (DESIGNER) is required to maintain the above-referenced insurance coverage throughout the duration of this contract. If, at any time while this contract is in effect, any of the above insurance coverages should lapse, the (DESIGNER) shall immediately notify the BOARD, and within thirty (30) days of said lapse, the (DESIGNER) shall provide the BOARD with a new certificate of insurance coverage.

XIV. IDEMNIFICATION

(DESIGNER) hereby indemnifies and agrees to hold harmless the BOARD and the OPM against any liability including all claims for professional liability related to design, bodily injury or property damage that may arise out of (DESIGNER's) performance of its obligations under this contract by itself or a subcontractor, officer, agent or employee.

XV. TERMINATION

This contract may be terminated by either party upon receipt of thirty (30) days advance written notice by certified mail to the Designated Representative identified in Paragraph II. In case of such written notice of termination, all services under this contract shall cease with the exception of such work as may be necessary to bring the work in progress to a reasonable and safe condition. (DESIGNER) shall then submit a final bill based on work actually performed. There shall be no penalty for termination for the convenience of the BOARD

XVI. BREACH OF CONTRACT

Failure of (DESIGNER) to comply with any of the terms or conditions of the contract shall be deemed a material breach of contract, and the BOARD shall have all the rights and remedies provided in the contract documents, including the right to terminate or suspend the contract and to pursue its rights in any and all actions of law or equity or other proceedings with respect to a breach of contract.

In the event that a breach of contract may occur, this contract may be deemed null and void upon fourteen (14) days written notice by certified mail to the Designated Representative identified in Paragraph II, and the BOARD may pursue any remedies deemed necessary to secure the interests of the BOARD, provided, however, that this contract shall be and remain in full force and effect, and no action shall be taken by the BOARD if (DESIGNER) cures said breach within the fourteen day period.

XVII. . CERTIFICATION OF TAX COMPLIANCE

This contract shall include a certification by (DESIGNER) that (DESIGNER) is in full compliance with all laws of the Commonwealth of Massachusetts relating to taxes, as required by Massachusetts General Laws Chapter 62C, §49A. Said Certification is attached hereto.

XVIII. PREVAILING WAGE RATES (applicable to any public works or public building project, including tree removal)--

(DESIGNER) represents that it shall comply with the provisions for prevailing wages as governed by M.G.L.c.149, §§26-27, and as established by the Department of Labor, Division of Occupational Safety. (DESIGNER) shall furnish the BOARD a copy of (DESIGNER's) certified weekly payroll records throughout the duration of this Agreement.

In addition, (DESIGNER) shall be responsible for ensuring that it, and any of its subcontractors, furnish the Department of Labor and Workforce Development/Division of Occupational Safety a Statement of Compliance with the provisions of M.G.L.c.149, §§26-27 upon completion of the services performed under this Agreement.

XIX: **OWNERSHIP OF DOCUMENTS**

Unless provided otherwise by law, ownership and possession of all information, data, reports, studies, designs, drawings, specifications, materials, computer programs, ,documents, models, inventions, equipment, and any other documentation, product of tangible materials to the extent authored or prepared, in whole or in part, by (DESIGNER) pursuant to this Contract (collectively, the "Materials"), other than (DESIGNER's) administrative communications, records, and files relating to this Contract, shall be the sole property of, and shall vest in, the BOARD as "works made for hire" or otherwise, provided that the BOARD complies with its payment obligations under this Contract. The BOARD will own the exclusive rights, worldwide and royalty-free, to and in all Materials prepared and produced by (DESIGNER) pursuant to this Contract, including, but not limited to, United States and International patents, copyrights, trade secrets, know-how and any other intellectual property rights, and the BOARD shall have the exclusive, unlimited and unrestricted right, worldwide and royalty free, to publish, reproduce, distribute, transmit and publicly display all Materials prepared by (DESIGNER). The BOARD shall provide appropriate credit to (DESIGNER), in terms agreed upon by (DESIGNER), in any publicity about or plaque at the Project. (DESIGNER) shall have a license to publish and publicly display all Materials prepared by (DESIGNER) in its normal marketing and related professional and academic activities. (DESIGNER) shall have a license to use the typical or standard details and all other replicable elements of the Materials for this Project on other future projects.

At the completion or termination of (DESIGNER)'s services required pursuant to this Contract, copies of all original Materials shall be promptly turned over to the BOARD.

SIGNATURES:

For DESIGNER.:

____
(Date)

____
(Printed Name and Title)

(SIGNATURES FOR TRI-TOWN BOARD Of WATER COMMISSIONERS FOLLOW ON NEXT THREE PAGES)

SIGNATURE PAGE FOR BRAINTREE

____
Joseph C. Sullivan, Mayor (Date)

Approved as to Form:

____
Nicole Taub, Town Solicitor

Approved as to Availability of Funds:

____
Mark Lin, Town Accountant
Account #: ____________________

SIGNATURE PAGE FOR <u>RANDOLPH</u>

<u>For the Town of Randolph</u>:

____
Signatory Authority

____
Printed Name & Title

____
Date

Approved as to Form:

____
Town Solicitor

____
Print Name:

____
Date

Approved as to Availability of Funds:

____
Town Accountant

____
Print Name

____
Date

Account #: ____________________

SIGNATURE PAGE FOR <u>HOLBROOK</u>

<u>For the Town of Holbrook</u>:

BOARD OF SELECTMEN

___________________________________ ___________________________________

___________________________________ ___________________________________

____

Approved as to Form:

____
Town Solicitor

____
Printed Name

____
Date

Approved as to Availability of Funds:

____
Beth Moseley, Town Accountant
Date:
Account #: ____________________

ATTACHMENT "C" - PRELIMINARY CONCEPT DESIGN REPORT

Tri-Town Regional Water Treatment Plant

Preliminary Design Report

Tri-Town Water Commissioners

April 2019

Environmental Partners GROUP

A partnership for engineering solutions

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List of Acronyms

ACH	Air changes per hour
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ATS	Automatic Transfer Switch
AWWA	American Water Works Association
BELD	Braintree Electric Light Department
BRP-WS	Bureau of Research Protection – Water Supply
BTU	British Thermal Units
CFM	Cubic feet per minute
CI	Cast Iron
CIP	Cast-in-place
Cl_2	Chlorine
cm	Centimeters
CMR	Code of Massachusetts Regulations
CMU	Concrete masonry units
CO	Carbon monoxide
DAF	Dissolved Air Flotation
DCW	Domestic chilled water
DHW	Domestic heated water
DI	Ductile Iron
EIR	Environmental Impact Report
EMT	Electrical Metallic Tubing
ENF	Environmental Notification Form
EP	Environmental Partners
ERV	Energy Recovery Ventilator
F	Fahrenheit

FACU	Fire alarm control unit
FMC	Flexible metallic conduit
FRP	Fiber reinforced plastic
GAC	Granular activated carbon
gal	Gallons
GFCI	Ground-fault Circuit Interrupter
GPM	Gallons per Minute
Gpm/sf	Gallons per minute per square foot
HDPE	High Density Polyethylene
H/O/A	Hand-off-auto
HP	Horsepower
H_3PO_4	Phosphoric acid
HVAC	Heating, ventilation, and air conditioning
IMC	Intermediate Metal Conduit
$KMnO_4$	Potassium permanganate
KOH	Potassium hydroxide
kW	Kilowatt
LED	Light-emitting diode
LMFC	Liquid-tight Flexible Metallic Conduit
LVP	Low Voltage Panel
MassDEP	Massachusetts Department of Environmental Protection
MC	Metal clad
MCC	Motor Control Center
MCP	Main control panel
MEPA	Massachusetts Environmental Protection Act
MG	Mega-gallon
MGD	Million Gallons Per Day

mg/L	Milligrams per liter
MHC	Massachusetts Historical Commission
mL	Milliliters
mm	Millimeters
MMF	Mixed media filtration
MSB	Main Distribution Switchboard
MWRA	Massachusetts Water Resources Authority
MW	Megawatt
NAC	Notification Appliance Circuit
NaOCl	Sodium hypochlorite
NEMA	National Electrical Manufacturers Association
NPDES	National Pollutant Discharge Elimination System
OPM	Owner's Project Manager
O-PO$_4$	Orthophosphate
PCH	Polyaluminum chloride
PLC	Programmable logic controller
Pre-Ox	Pre-oxidation
PVC	Polyvinyl Chloride
PSI	Pounds per Square Inch
PSIG	pounds per square inch gauge
RCP	Reinforced Concrete Pipe
RMC	Rigid Metal Conduit
RPR	Resident Project Representative
RTU	Roof-top unit
RWPS	Raw water pump station
SCADA	Supervisory Control and Data Acquisition
SCFM	Standard Cubic Feet per Minute

SF	Square foot
SWPPP	Stormwater Pollution Prevention Plan
TOC	Total organic carbon
WTP	Water Treatment Plant
TDH	Total Dynamic Head
TTRWTP	Tri-Town Regional Water Treatment Plant
USC	United States Code
UV	Ultraviolet
VAV	Variable Air Volume
V	Volt
VFD	Variable Frequency Drives
W&V	Waste and Vent

Section 1 - Executive Summary

The Braintree Water Treatment Plant and the Randolph/Holbrook Water Treatment Plant (WTP) are nearing the end of their useful life. The Town of Braintree and the Joint Water Board (Randolph/Holbrook) have completed a number of upgrades at each WTP over the years, however, it has come to a point in time where a new facility is required to replace each of the treatment plants. Rather than construct two separate plants the communities determined the most cost effective approach was to construct one Tri-Town Regional WTP (TTRWTP) on available land adjacent to the town of Braintree's WTP. After many years of planning and preparing for the construction of the TTRWTP, the Tri-Town Water Commissioners (Tri-Town) have contracted Environmental Partners (EP) as their Owner's Project Manager (OPM). Phase 1 of EP's work was to conduct a review of the pilot plant report prepared by EP and Approved by MassDEP in 2004; and the concept design prepared in 2010 by CDM Smith.

EP conducted a review of the following materials prepared for Tri-Town over the past fifteen years. They included:

- Great Pond Reservoir Pilot Study Report dated April 2004 prepared for the Town of Braintree by EP in 2004,
- Final Draft Preliminary Design Report- Tri-Town Regional Water Treatment Plant prepared by CDM Smith in September 2008,
- CDM Smith plans dated February 2010 titled Tri-Town, MA Request for Proposal Volume IV – Preliminary Base Design Drawings Tri-Town Water Treatment Plant Design/Build Project,
- Tri-Town Water Treatment Plant Opinion of Probable Construction Cost, 10% Design, by CDM Smith in February 2010.
- Tri-Town Firm Yield Study Surface Water Supply System prepared by EP in May 2014

After review of these documents it was determined that the initial proposed layout and design of the facility exceeded the appropriated funds for the construction of the TTRWTP. Tri-Town requested that EP revisit the available information and prepare a new conceptual design with the goal of reducing the overall cost of the project while maintain the output of the TTRWTP at 12.5 million gallons per day (MGD).

During our refinement we have analyzed the possibility of stacking the Dissolved Air Flotation (DAF) Units on the filtration beds, reducing the footprint of the building, refining the external building treatment, confining the facility to a single story and discharging water treatment facility sludge to the MWRA sewer system, following dewatering.

The new Conceptual TTRWTP layout reduced the square footage of some administration areas, reduced the number of filters, reduced finished water storage, relocated the wet well under ground closer to the TTRWTP, changed the residuals management approach, and refined the process layout to reduce the building height from a full two-story building to a one and one-half story building. The resulting opinion of probable construction cost is presented in Table ES-1 below:

Table ES – 1 Tri-Town Regional Water Treatment
Opinion of Probable Construction Cost
November 2018

Water Treatment Plant Construction Costs	
Construction Labor, Material, Equipment	$36,411,881
Construction Permits, Insurance, Bonds, General Field Conditions Overhead & Profit	$7,282,376
Construction Contingency	$8,738,851
Escalation to Mid-Point of Construction	$5,662,776
Total TTRWTP Construction	**$58,095,884**
Additional Project Costs	
Engineering: Design of Water Treatment Plant	$6,390,547
Owner's Project Manager (includes Construction Services, RPR)	$2,904,794
Total Project	**$67,391,225**
Construction and Design of Randolph/Holbrook Transmission Main	$2,863,866
Demolition of Braintree WTP	$1,545,164
Demolition of Randolph/Holbrook WTP	$1,658,890

1. Based on Turner Index of August 18 & August 20, 2018
2. Construction Midpoint Adjustment also applied

Section 2 - Background

2.1 WATER SUPPLY SOURCE

The Tri-Town Water Commissioners (Tri-Town) represents the towns of Braintree, Randolph and Holbrook. It was created through legislation in the late 1880's to manage the jointly utilized water supply known as Great Pond bordering the towns of Randolph and Braintree. The Great Pond Reservoir System consists of the Upper Great Pond Reservoir, the lower Great Pond Reservoir and the Richardi Reservoir. The Great Pond Reservoir System is the source of 100 percent of the drinking water for these three communities. Tri-Town maintains the reservoir dam system, has conducted dredging of the reservoir and provides overall management of the water supply system.

A firm yield analysis was conducted in 2014 by EP at which point MassDEP accepted the firm yield as 7.88 MGD (see Appendix A). Demand management will continue to be required once the proposed TTRWTP is constructed and operations commence.

In years past a diversion from the Cochato River Watershed was opened to pump supplemental source supply to the Great Pond Reservoir System. The diversion was closed in the 1980's due to concern of potential contamination from the Baird & McGuire Superfund site located in Holbrook Massachusetts. If, in the future, Tri-Town desires to re-open the Cochato River Diversion it would increase the Firm Yield to 9.81 MGD. Approval of this re-opening would require a significant long-term testing program, public participation, and MassDEP permitting process.

The TTRWTP, as proposed, will be a 12.5 MGD dissolved air flotation (DAF) treatment facility.

2.2 NEED FOR PROJECT

Braintree and the Joint Randolph/Holbrook Water Board own and operate individual WTPs on the Lower Reservoir portion of Great Pond.

EP prepared and conducted a Distribution System Master Plan and Modeling of the three community water distribution systems and finalized the report in August 2018. Part of the report was to identify the anticipated future population projections and water use requirements for the three communities (see Appendix B). The results indicate that by 2050 the needs of the three communities will be 7.3 MGD for an average day demand and a maximum day demand of 10.29 MGD. The planned and proposed developments listed in Table 1-1 along with an additional 5 percent of the maximum day demand (MDD) (which accounts for losses within the water treatment plant) have been added to the projected 2050 demand, bringing it to 12.46 MGD.

Table 2-1 Future Water Demand Estimates (MGD)

Description	Randolph	Holbrook	Braintree	Total
Average Day Demand	3.11	0.80	4.33	8.24
Maximum Day Demand	4.39	1.12	6.10	11.61
Water Treatment Plant Losses				0.58
Planned and Potential Developments		0.08	0.19	0.27
Total Maximum Day				12.46

The two existing WTPs were constructed in the 1930's. Although upgrades have been conducted at both treatment plants the life expectancy of each plant has been greatly exceeded and upgrades have become increasingly challenging due to the age of the facilities. The Tri-Town and the three communities have determined that the most cost effective approach is to construct one regional type facility to serve all three communities. The goal is to fund the project through the Drinking Water State Revolving Loan Fund and any other potential funding sources identified. A Project Evaluation Form was submitted on behalf of Tri-Town in August 2018 and is on the Intended Use Plan for 2019.

2.3 SUMMARY OF FACILITY SIZE

Based on this analysis it is Tri-Town's intent to construct the TTRWTP with a maximum day demand capacity of 12.5 MGD. It is important to note that the safe yield of Great Pond is not enough during drought periods to meet the demands of 7.3 MGD and therefore water use restrictions will be required during those periods to limit demand.

Section 3 - Pilot Plant Analysis

3.1 SUMMARY OF PILOT PLANT RESULTS

EP prepared and conducted a Water Treatment Plant Pilot Study to determine recommendations for treatment processes for a new facility to treat the Great Pond Lower Reservoir in 2003. The Pilot Study approach was approved and the results of the analysis were accepted by MassDEP in 2004. MassDEP has requested that supplemental information be provided to update water quality data and determine the potential impact of water quality changes on the approved TTRWTP processes. In addition, MassDEP requested further clarification about managing corrosion control in the three systems as the new treatment plant is brought online. To address MassDEP's recent requests, EP prepared a BRP WS 22D (Water Treatment Approval of Pilot Study Report ≥ 1 MGD) application, which is included in Appendix C Consistent with the original pilot study, this application continues to recommend the following treatment processes for the TTRWTP:

- Pre-oxidation
- Coagulation and flocculation
- Clarification with dissolved air flotation
- Media Filtration
- Chlorine for primary disinfection (in accordance with the 2004 MassDEP Pilot Study approval letter, the latest design is based on a sodium hypochlorite system rather than a chlorine gas system)
- pH adjustment as needed

3.2 HYDRAULICS

The overall treatment process utilizes a "pump-once" methodology whereby the intake water from Great Pond is only pumped once, from the water intake building through the new raw water pump station into the treatment plant process train. The water is not pumped again until the finished water is pumped out of the clearwell to the transmission mains by the finished water pumps. This concept is shown visually in the Hydraulic Profile included as Appendix D.

Section 4 - Site Civil

4.1 OVERVIEW

EP has prepared a conceptual site plan (see Appendix E) that shows the orientation of the proposed facilities in relation to the existing infrastructure. The TTRWTP is to be located northeast of the existing Braintree WTP. Approximately half of the proposed site is located within the 400-foot Zone A for Great Pond. By contrast, the entire existing treatment facility for Braintree is located within the Zone A. By keeping the proposed facilities as far away from Great Pond as practical, we have lessened the potential negative impacts to this sensitive resource area. The TTRWTP's back-up generator and fuel supply will be located outside of the Zone A. The raw water pump station's back-up generator and fuel supply will be located within the Zone A.

4.2 ACCESS/STORMWATER

A new access road is planned to reduce disturbance to the existing WTP operations during construction. The new access road will enter the site east of the existing backwash water tank and fully envelope the new TTRWTP footprint. Stormwater runoff generated by the new impervious areas will be collected, treated, and discharged in accordance with applicable regulations and best managements practices and determined during detailed design of the facility. This project will be subject to coverage under the EPA NPDES Construction General Permit as greater than one (1) acre of construction disturbance will occur and stormwater may potentially leave the construction site.

4.3 YARD PIPING

New yard piping will be required. The only existing pipe to be utilized will be the two 48 inch reinforced concrete submerged intake pipes. New pipe will include:

Raw Water Mains:

- Two 24-inch raw water mains to connect a refurbished intake structure to a new raw water pump station.
- Two 16-inch water mains will connect the raw water pump station to the TTRWTP at the pre-oxidation contact tanks.

Finished Water Mains:

- Randolph/Holbrook finished water mains will consist of two 20-inch finished water mains (for the purpose of redundancy) submerged on the bottom of Great Pond. The water mains westerly from the TTRWTP at the finished water pumps due west across the Pond to the Joint Water Board WTP and eventually tying into the existing Joint Water Board 24 inch transmission main located on Pond St at the JWTP.
- Braintree finished water mains will consist of two (redundant) 20-inch finished water mains traversing from the TTRWTP southerly toward King Hill Road and connect to Braintree's existing twin 12-inch transmission water mains into Braintree's distribution system.

Waste Piping:

- Residuals will be pumped from the TTRWTP to the MWRA sewer system through a force main which will run due south along the new access road and parallel to the new Braintree transmission mains to King Hill Road. The force main will ultimately discharge to the existing sewer manhole located near the Sons of Italy building on King Hill Road.
- Sanitary sewer from the TTRWTP will flow by gravity towards King Hill Road where it will intercept the existing sanitary sewer line that is pumped via ejector station to the above mentioned sewer manhole near the Sons of Italy.

Section 5 - Process Flow Concept

5.1 OVERVIEW

The conceptual process flow diagram is presented in Appendix F. Raw water will continue to be taken from the pond via the two existing 48-inch reinforced concrete intake pipes on the Braintree side of Great Pond and flow through the existing intake structure. A new raw water pump station will be constructed to house the new raw water screens, valves, raw water pumps, and flow meters. Potassium permanganate will be injected at the head of the TTRWTP for iron and manganese control. This will be followed by potassium hydroxide addition for pH adjustment prior to reaching a pre-oxidation contact tank.

Two pre-oxidation contact tanks will be installed in the new TTRWTP as the first step in the DAF treatment train process. The TTRWTP will consist of four (4) DAF treatment trains followed by five (5) granular activated carbon (GAC) media filters. As the water exits the pre-oxidation tank it will be dosed with poly-aluminum chloride (PCH-180) and a cationic polymer for coagulation. It will then be mixed in a rapid mix tank and flow into one of the two (2) two-stage flocculation tanks and then into one of the four (4) dissolved air flotation units. Each pre-oxidation tank will be capable of flowing to either of the rapid mix tanks. From there the effluent will be able to flow through any combination of the four DAF trains.

From the DAF units the water will enter one of the five (5) GAG filtration units. Final addition of potassium hydroxide for pH adjustment and sodium hypochlorite for disinfection will be applied prior to dischargine into the clearwell. The finished water will be pumped from the clearwell to the Braintree and Randolph/Holbrook distribution systems through new transmission mains. The finished water will be dosed with sodium hypochlorite for further disinfection, phosphorous acid for corrosion control, and potassium hydroxide for pH adjustment after the finished water pumps on an as needed basis.

Due to variances in hydraulics r water demands currently it is envisioned that two sets of dedicated pumps will exist. One set to pump to the Braintree distribution system and one set to pump to the Randolph/Holbrook distribution system. There will be a “swing” pump that is capable of pumping to either Braintree or the Randolph/Holbrook distribution system in the event of a failure to a dedicated pump. This concept will be further investigated during the final design of the TTRWTP.

5.2 RAW WATER INTAKE STRUCTURE AND PUMP STATION

Water will continue to flow through the existing water intake structure and new screen gates will be installed. The existing Braintree WTP must remain operational until the new TTRWTP has been commissioned and startup completed. Two new 24-inch raw water lines will be tapped into the sides of the existing intake structure and will be activated after complete construction and startup of the TTRWTP. The two (2) new 24-inch raw water mains will connect to a new raw water pump station.

The new raw water pump station below grade floor plan will consist of two (2) screen chambers with a passive intake screen in each chamber and a pump chamber with four (4) variable speed, 75 HP vertical turbine pumps. Each pump will have a maximum capacity of 2,894 gpm. One (1) pump will serve as a standby pump. The system will be designed so any combination of pumps can be operated as needed. The pumps will have VFD controlled motors flow-paced by plant flow settings. The raw water flows will be measured utilizing magnetic flow meters located in the new 16-inch raw water pipes exiting the ground floor of the raw pump station.

Two (2) 16-inch raw water mains will be constructed from the new raw water pump station to a header at the pre-oxidation tanks located on the ground level of TTRWTP.

5.3 CHEMICAL ADDITION AND MIXING

Once inside the TTRWTP the water will be dosed with potassium permanganate at 1.5 mg/L followed by potassium hydroxide at 9 mg/L and enter one of two (2) 31,000 gallon pre-oxidation contact tanks. The minimum contact time required is 5 minutes. Flow will then be dosed with poly-aluminum chloride (PCH-180) at a proposed dose of 65 to 75 mg/L (based on the pilot study) and a cationic polymer at a dose of 0.2 mg/L and enter one of two (2) rapid mix tanks for mixing and distribution to one of four (4) two-stage flocculation tanks.

5.4 DISSOLVED AIR FLOTATION

The dissolved air flotation (DAF) system is comprised of 4 cells which are hydraulically fixed two a dedicated two-stage flocculation tank upstream and constitute one train. Based on the results of the pilot study, the two-stage flocculation tanks have a hydraulic detention time of 11.25 minutes and the DAF cells have a loading rate of 8 gpm/sf. Approximately 12 percent of the DAF effluent is recycled and used in conjunction with recycle pumps, saturators, and air compressors to generate the dissolved air for this treatment process. Each DAF train will be approximately 14-feet by 31-feet and is rated at 4.17 MGD and able to receive influent water from either of the two rapid mix tanks and discharge effluent to either of the five gravity media filters. This allows the plant to run at 12.5 MGD if one of the DAF trains is offline. The DAF sludge is skimmed off the water surface level by mechanical means over the sludge beach where it will be conveyed by troughs or hoppers to the residuals tank by gravity. The DAF trains will be constructed of concrete and be at least 10 feet high.

5.5 FILTRATION

Based on the results of the pilot study the media selected for the filters will be granularly activated carbon (GAC) at a loading rate of 5 gpm/sf. Each GAC filter will be consist of 48-inches of GAC resting on an under-drain. Five (5) filters will be provided, each 15-feet by 30-feet with a rated capacity of 3.13 MGD each. The filters will be gravity type with a gravel-less underdrain system. Each filter will be designed with a gullet for filter influent distribution and backwash waste collection. Filter troughs will be connected to the filter gullet to distribute the filter influent and collect the filter backwash waste. Combined filter effluent will be collected and routed to the clearwell. Prior to entering the clearwell the water will be treated with 10 mg/L of potassium hydroxide (KOH) and 3.5 mg/L as Cl_2 of sodium hypochlorite (NaOCl). A backwash water/air supply system will be provided to clean suspended solids and turbidity that were removed during the filtration process. The backwash water will be supplied in combinations with air scour to create a vigorous filter backwash. The backwash water will be pumped from the clearwell via a duty and standby washwater pump with a maximum flow rate of 8,680 GPM. Two positive displacement blowers will be provided for air scour, one duty and one standby.

5.6 FINISHED WATER SYSTEM

The effluent from the filters will enter the two 0.5 MG clearwells through 24-inch ductile-iron pipes where it will be stored for approximately 51.6 minutes in order to provide adequate hydraulic detention time. From here water will be reused as washwater or pumped into the distribution systems of Braintree or Randolph and Holbrook. Three vertical turbine pumps at 1,445 GPM will be dedicated to providing water to Braintree, three vertical turbine pumps at 1,310 GPM will be dedicated to providing water to Randolph, and a 1,310 GPM “swing” pump will be able to pump water to either distribution system in the event that their pump fails or is off-line for routine maintenance. Water pumped to both distribution systems will receive 1 to 10 mg/L of KOH, 1 mg/L as Cl_2 of NaOCl, and 4 mg/L of phosphoric acid (H_3PO_4) after the finished water pumps so that dosages can be specific to each system's needs (as shown in Appendix F). Flow pacing of the finished water pumps will be based on the water height in the tanks of the respective distribution systems.

5.7 WASTEWATER MANAGEMENT

Residuals at the new TTRWTP will be generated as follows:

1. Float/Sludge from the DAF basins – sludge will be discharged to a residuals tank and will be pumped to the MWRA sewer system.
2. Filter backwash waste – backwash waste water will be directed to the backwash waste tank. The filter backwash wastewater will pumped to an inclined plate settler. The solids will be discharged to a residuals tank and clarified water will be recycled to the head of the treatment process.
3. Filter to waste water – filter to waste water will be directed to the backwash waste tank. The filter backwash wastewater will be treated with an inclined plate settler (see below). The solids will be discharged to a residuals tank and clarified water will be directed to the recycle tank for pumping to the head of the plant.
4. Process waste from draining basins – the effluent from the flocculation and DAF process basins will flow by gravity to the residuals tank. The effluent from the filters will flow by gravity to the backwash waste tank.
5. Process waste from laboratory sample lines – process water from the various facility sample lines will either be directed to the sewer (if analytes are used) or to the backwash waste tank.

A general flow schematic of the proposed residuals waste streams and facilities is provided in the TTRWTP process flow diagram (Appendix F).

Two plate settler units will be installed to provide 100% redundancy, in the event of an equipment failure. Spent backwash water will be pumped to a plate settler unit (located in the TTRWTP) where solids are separated and removed. Coagulant polymer is added at the integral rapid mixing tank located prior to the plate settler to coagulate the influent solids. Supernatant from the plater settler solids flows by gravity to the recycle tank. Recycle water is pumped from the recycle tank to the head of the treatment plant prior to potassium permanganate dosing. Sludge from the plate settler solids collection unit will flow by gravity to the residuals holding tank.

Residuals collected in the residuals holding tanks will be pumped to the local sewer system on King Hill Road. The residuals pumps will operate at a maximum flow rate of 125 GPM. A mixer will be installed in the residuals holding tank to ensure the solids in the residuals tank remain suspended.

A detailed discussion of the anticipated residuals flows and characteristics is found in the Braintree WTP DAF Pilot Study report (See Appendix G)(Environmental Partners Group, Inc., 2004, Section 3). Proposed design criteria and information for the residuals systems for the TTRWTP are outlined in Table 3-1 – Residuals Management Design Criteria.

Level indicators are used to measure the level of the water in the backwash waste tank, recycle tank, and residuals tank. Through SCADA, the operator can select lead/lag or automatic alternation sequence of the various pumps. Manual control will be provided through manipulation of SCADA or local switches located at the pumps. SCADA and local alarms (strobe and horn) will be provided for pump failure and high or low tank level. Water from the backwash waste tank will be pumped to the plate settler unit. The plate settler will include level switches which will alarm if a high level occurs. The polymer feed system will be flow-paced based on the plate settler influent flow and a desired dosage. A rapid mixer will be located at the entrance to the plate settler to mix the polymer into solution, followed by a flocculation tank to coagulate the solids prior to entering the plate settler. Clarified water from the plate settler will flow to the recycle tank while the sludge will directed to the residuals tank.

Section 6 - Design Criteria

6.1 OVERVIEW

The design criteria is presented in this section is based on planning, analysis and conceptual design for the TTRWTP over the last 15 years or more. This is intended to be utilized as the basis for the final design of the TTRWTP and will be further refined during the final design process.

Table 6 – 1 Tri-Town Regional Water Treatment Plant – Design Criteria
Flows and Loads

Process	Parameter	Value	Unit
Raw Water	Flow	8,681 (12.5)	gpm (MGD)
	Temperature	2 to 29	Celsius
	pH	6.6 to 7.6	Standard Units
	Alkalinity	13 to 34	mg/L CaCO3
	Turbidity	0.4 to 20	NTU
	Color	8 to 60	C.U.
	UV-254	0.08 to 0.23	cm^{-1}
	TOC	2.20 to 5.70	mg/L
	Iron	0.04 to 0.48	mg/L
	Manganese	0.02 to 0.29	mg/L
	Total Coliform	5 to 860	#/100 mL
Finished Water	Flow	8,265 (11.9)	gpm (MGD)
	pH – Braintree	7.5 to 7.8	Standard Units
	pH – Randolph-Holbrook	7.0 to 7.8	Standard Units
	Turbidity	≤ 0.10	NTU
	UV-254	< 0.035	cm^{-1}
	TOC	>45% Removal when TOC > 4 mg/L >35% Removal when TOC ranges 2 to 4 mg/L	
	Iron	≤ 0.10	mg/L

Table 6 – 1 Tri-Town Regional Water Treatment Plant – Design Criteria
Flows and Loads (cont'd)

Process	Parameter	Value	Unit
	Manganese	≤ 0.05	mg/L
	Free Chlorine	1.0-1.5	mg/L
	Inactivation Goals	2- log *Cryptosporidium* *3 log Giardia* *4-log* Viruses	

Table 6 – 2 Tri-Town Regional Water Treatment Plant – Design Criteria
Raw Water Screening and Pumping

Process	Parameter	Value	Unit
Intake Screens	# of Screens	2 (1 duty, 1 standby)	
	Flow Capacity	12.5	mgd
	Type	Drum	
Raw Water Pumps	# of Pumps	4 (3 duty, 1 standby)	
	Flow Capacity	2,894	gpm
	Head	66	feet
	Size	75	hp
	Drive	2 Constant, 2 VFD	
	Type	Vertical Turbine	

Table 6 – 3 Tri-Town Regional Water Treatment Plant – Design Criteria
Pre-Oxidation

Process	Parameter	Value	Unit
Pre-Oxidation Tank	# of Units	2	(1 duty, 1 standby)
	Total Design Flow Rate	8,681 (12.5)	gpm (MGD)
	Minimum Contact Time Required	5	minutes
	Contact Time Provided	5	minutes
	Tank Size and Configuration	31,000 Gallons Baffled	
	Baffling Factor	0.7	

Table 6 – 4 Tri-Town Regional Water Treatment Plant – Design Criteria
Flocculation & Coagulation and Dissolved Air Flotation

Process	Parameter	Value	Unit
Rapid Mix4	# of Mixers	2	
	Type	Axial	
	Rapid Mixer Motor Size	10	hp
Flocculation/Coagulation	# of Trains Type	4 Two-Stage, Variable Speed	
	Capacity (each)	1,450 (2.1)	gpm (MGD)
	# of Flocculators	8	
	Flocculator Motor Size	1-1.5	hp
	Total Flocculation Time (per train at 12.5 MGD)	11.25	minutes
Dissolved Air Flotation	# of Trains	4	
	Capacity (each)	2,900 (4.17)	gpm (MGD)
	Loading Rate at Design Flow Rate	8	gpm/sf
	Recycle Rate at Design Flow Rate	8-12%	
	# of Recycle Pumps Recycle Pump Motor Size	3 75	 hp
	# of Saturators	2	
	# of Compressors	2	
	Compressor Size (motor)	5	hp

*Motor size subject to change.

Table 6 – 5 Tri-Town Regional Water Treatment Plant – Design Criteria Filtration

Process	Parameter	Value	Unit
Filters	# of Filters	5	
	Type	Granular Activated Carbon, Gravity	
	Capacity (each)	2,170 (3.13)	gpm (MGD)
	Maximum Hydraulic Loading Rate	5	gpm/sf
	Filter Area (min)	434	sf
Filter Media - GAC (Final Design Selection)	Bottom Media Effective Size	Sand 0.35 to 0.45	mm
	Uniformity Coefficient	<1.4	
	Bottom Media Depth Top Media	6 Granular Activated Carbon	in
	Effective Size	0.8 to 1.0	mm
	Uniformity Coefficient	2.1	
	Top Media Depth	48	in
Underdrains	Type	HDPE Dual Lateral Air/Water	
	Profile Depth	<12	in
Washwater Pumps	# of Pumps	2 (1 duty, 1 standby)	
	Flow Capacity	8,680	gpm
	Head	55	feet
	Size	150	hp
	Drive	Variable	
	Type	Vertical Turbine	
Air Scour Blowers	# of Blowers	2 (1 duty, 1 standby)	
	Capacity	1,736	scfm
	Head	7	psig
	Size	150	hp

Table 6 – 6 Tri-Town Regional Water Treatment Plant – Design Criteria
Residuals Handling

Process	Parameter	Value	Unit
Plate Settler	# of Units	1	(1 duty)
	Type	Scroll and Bowl	
	Capacity per Unit	150	gpm
	Inlet Solids Concentration	0.032%	
	Outlet Solids Concentration	1-2%	
	Projected Loading Rate	0.3	gpm/sf
	Flocculation Tank Volume	1,425	gal
	Flocculator Drive Size	1/4	hp
	Rapid Mix Drive	1/2	hp
	Polymer System Type	Liquid Polymer Dilution	
Residuals Waste Tank Mixer	# of Units	2	(1 duty, 1 standby)
	Type	Submersible	
	Motor Size	4*	hp
Residuals Waste Tank Pump	# of Units	2	(1 duty, 1 standby)
	Type	Vertical Turbine	
	Capacity (each)	125	gpm
	Motor Size	3	HP
Backwash Waste Tank Mixer	# of Units	2	(1 duty, 1 standby)
	Type	Submersible	
	Motor Size	5*	hp
Backwash Waste Tank Pump	# of Units	2	(1 duty, 1 standby)
	Type	Vertical Turbine	
	Capacity (each)	140	gpm
	Motor Size	3	hp
Recycle Tank Pump	Capacity (each)	185	gpm
	Motor Size	3	hp

*Motor Sizes subject to change

Table 6 – 7 Tri-Town Regional Water Treatment Plant – Design Criteria
Chemical Feed and Storage Design Criteria

Chemical	Parameter	Value	Unit
Potassium Permanganate	Proposed Dose	1.5	mg/L as $KMnO_4$
	Supplied Form	Dry	
	Feed Form	Liquid	
	Strength	3%	as $KMnO_4$
	Bulk Storage	2,825	pounds
	Dissolving Tank Volume	50	gallons
	Frequency of Use	Continuous	
	Feed Rate	35 to 157	pounds per day
		140 to 645	gallons per day
Potassium Hydroxide	Proposed Dose – Pre-Oxidation	9	mg/L as KOH
	Proposed Dose – Finished Water	10	mg/L as KOH
	Supplied Form	Liquid	
	Feed Form	Liquid	
	Strength	45%	as KOH
	Frequency of Use	Continuous	
	Bulk Storage Tank Volume	6,400	gallons
	Day Tank Volume – Pre-Oxidation	175	gallons
	Day Tank Volume – Finished Water	200	gallons
	Feed Rate – Pre-Oxidation	38 to 172	gallons per day
	Feed Rate – Finished Water	42 to 112	gallons per day

Table 6 – 7 Tri-Town Regional Water Treatment Plant – Design Criteria
Chemical Feed and Storage Design Criteria (cont'd)

Chemical	Parameter	Value	Unit
Polyaluminum Chloride (PCH-180)	Proposed Dose	65 to 75	mg/L as Product
	Supplied Form	Liquid	
	Feed Form	Liquid	
	Strength	33%	as Product
	Frequency of Use	Continuous	
	Bulk Storage Tank Volume	12,500	gallons
	Day Tank Volume	700	gallons
	Feed Rate	145 to 695	gallons per day
Sodium Hypochlorite	Proposed Dose – Filtered Water	3.5	mg/L as Cl_2
	Proposed Dose – Finished Water	1	mg/L as Cl_2
	Supplied Form	Liquid	
	Feed Form	Liquid	
	Strength	12.5%	as NaOCl
	Frequency of Use	Continuous	
	Bulk Storage Tank Volume	7,000	gallons
	Day Tank Volume – Filtered Water	300	gallons
	Day Tank Volume – Finished Water	100	gallons
	Feed Rate Filtered Water	65 to 292	gallons per day
	Feed Rate Finished Water	18 to 49	gallons per day

Table 6 – 7 Tri-Town Regional Water Treatment Plant – Design Criteria
Chemical Feed and Storage Design Criteria (cont'd)

Chemical	Parameter	Value	Unit
Orthophosphate	Proposed Dose	4	mg/L as $O\text{-}PO_4$
	Supplied Form Feed Form	Liquid Liquid	
	Strength	73%	as $O\text{-}PO_4$
	Frequency of Use	Continuous	
	Bulk Storage Tank Volume	800	gallons
	Day Tank Volume	30	gallons
	Feed Rate	9 to 44	gallons per day
Cationic Polymer	Proposed Dose	7.3	mg/L as Product
	Supplied Form	Liquid	
	Feed Form	Liquid	
	Strength	100%	as Product
	Frequency of Use	Cold Weather Operations	
	Bulk Storage Tank Volume	40	gallons
	Day Tank Volume	5	gallons

Table 6 - 8 Tri-Town Regional Water Treatment Plant – Design Criteria
Clearwell and Finished Water Pumping Design Criteria

Process	Parameter	Value	Unit
Clearwell	Tank Capacity	1,000,000	gallons
	Desired *Giardia* Log Inactivation (log)	0.5	
Braintree Finished Water Pumps	# of Pumps	3 (3 duty, 0 standby)	
	Flow Capacity	1,450	gpm
	Head	370	feet
	Size	200	hp
	Drive	Variable	
	Type	Vertical Turbine	
Randolph/Holbrook Finished Water and Swing Pumps	# of Pumps	4 (3 duty, 1 standby)	
	Flow Capacity	1,310	gpm
	Head	280	feet
	Size	125	hp
	Drive	Variable	
	Type	Vertical Turbine	

6.2 FUTURE CONSIDERATIONS

The TTRWTP will be designed to allow for future addition of ozonation to the treatment process. Blind-flanged ductile–iron tees in the treatment process between the DAF and the filters will be provided to allow for the future addition of ozone. It is anticipated the ozone equipment would be located in a future addition to the TTRWTP given that adequate space is not available at this time

Section 7 - Architectural Theme

7.1 BUILDING LAYOUT OVERVIEW

The building is laid out in a rectangular fashion and is nominally 238 feet by 147 feet with the majority of occupied space located on the first floor (see Appendix H). The building is nearly bisected by the treatment train which starts from a northwesterly direction with the pre-oxidation tanks and ends in the south west direction with the finished water pumps. All of the occupied spaces are on the perimeter of the building and face westerly to some degree which offers the employees a chance to observe Great Pond from many locations. All other perimeter areas are occupied by chemical feed and process-mechanical focused equipment.

The roof line of the building is highest at the beginning of the treatment train where the elevated pre-oxidation, rapid mixing, flocculation, and dissolved-air flotation basins benefit from the potential energy of the incoming raw water level. As you move southwesterly along the centerline of the building the treatment train loses energy, mainly due to the filters, and subsequent areas for the filter gallery and the finished water pump wet wells are located below ground. The clearwells are located entirely underground adjacent to the building wall that abuts the finished water wet wells. Treatment process waste tanks are located below ground within the footprint of the building (between the elevated treatment basins and the occupied spaces) to minimize the limits of construction and provide access to such appurtenant works in a temperature controlled environment and cost-saving manner by sharing common concrete slabs.

Current Design of the proposed TTRWTP's main building, which is roughly oriented northwest-to-southeast, shows a single-story above-grade component wrapping around a higher and larger component housing Filtration Equipment, including Pre-Ox Tanks, Flocculation Basins, DAF Cells and Filters.

The single-story component houses the building's:

- Vestibule/Main Entry
- Electrical Room
- Mechanical Room
- Chief Operator's Office
- Control Room

- Training/Meeting Room
- Men's Lockers & Restrooms
- Women's Lockers & Restrooms
- Laboratory with Lab Storage
- File Room
- Lunch Room with a Kitchen
- Janitor's Closet
- General Storage
- Workshop
- Chemical Tanks
- Air Compressors and Pumps
- Filter Gallery and Pump Room
- A below-grade Clearwell abuts the Filter Gallery and Electrical Room on the proximate south side of the Plant.

7.2 CODE REQUIREMENTS

In order to be in compliance with the fire code the building is required to have a sprinkler system. The building is rated as H-4 occupancy due to the storage of hazardous materials. The exact quantities of hazardous materials will be needed prior to discussions with the local building official (Braintree) to determine if control areas will be required. It is unusual for control areas to be required for a facility similar to this.

7.3 GENERAL OUTLINE OF MATERIALS & WORK

The building will be comprised of a concrete foundation, tanks, footings, and slab-on-grade construction. Pre-cast concrete insulated wall panels and hollow-core precast & pre-stressed concrete. Below-grade there will be concrete foundation walls and slabs on-grade requiring bituminous damp-proofing and self-adhering sheet air/vapor barriers for moisture protection.

The foundation will be covered with polyisocyanurate foam boards for insulation. The exterior walls will also receive polyisocyanurate foam boards and self-adhering sheet air/vapor barriers, as needed. The flat roof will also receive polyisocyanurate foam boards and self-adhering sheet air/vapor barriers.

The two viable options that can be selected for the exterior doors are insulated extra-heavy duty aluminum or Fiber Reinforced Plastic (FRP) flush doors. It’s preferable that they be coated either in polymer or with an anodized aluminum. The glazing will be comprised of triple-glazed, low-E insulating glass. Steel doors and windows are not recommended for this facility due to the excessive moisture inside the facility arising from the exposed process. If steel is desired it should be galvanized for rust protection. If a service door is incorporated into the building it is recommended that it be sectional, overhead, and made of insulated steel or aluminum with vision panels. It is recommended that it be powered by an electrical motor with fixed and remote control operators. Double-doors are not recommended for a facility of this nature. Extra heavy-duty aluminum flush doors with factory glazing are recommended for the interior.

Interior partitions could be either concrete masonry units (CMU) or moisture resistant gypsum board assemblies with galvanized steel framing. The choice depends on relative costs, the amount of interior moisture expected, and likelihood that the moisture resistant gypsum board will not be scraped or otherwise damaged. If CMU partitions are selected it is recommended that they be 4-inch wide and either field painted or unpainted with ground-faces. Stainless steel lintels, reinforcing steel, ties and anchors will be needed to secure these partitions in place. The lintels in the building should be constructed of stainless steel. Suspended moisture and mold resistant 5/8-inch gypsum board or acoustic tile ceilings will be provided in occupied areas as desired.

The metal fabrications in the building, including but not limited to ladders, stair cases, gratings, railings, and floor access panels, should be made of aluminum or stainless steel if desired. The lintels, miscellaneous metals, closure plates, and angle-iron used for lateral restraint of the CMU partitions should be made of stainless steel. Fiberglass reinforced plastics (FRP) are a suitable alternative to aluminum and stainless steel for the gratings, stairs cases, and railings. Louvers and vents will be fixed aluminum with a polymer coated finish, stormproof, and be provided with bird and insect screens.

The roofing system will be comprised of a white PVC membrane adhered to cover board over the polyisocyanurate foam board previously mentioned in this section. Lower roof drainage will be directed to aluminum gutters along the building perimeter and flow through leaders to infiltration units below finished grade. Upper roof drainage will be directed to interior roof drains that are connected to plumbing drain lines. The facility will be designed to adhere to all applicable stormwater regulations. PVC membrane and metal accessory flashing will be installed as needed. Access to the lower roof will be by portable ladder from finish grade. Access to the upper roof will be by interior access ladder to a steel roof hatch with an automatic safety-up post.

The sealant for vertical joints and non-traffic horizontal surfaces will be a one-part, non-sag polyurethane sealant. For exterior and interior joints a one-part, pourable polyurethane sealant will be used. Interior Joints in vertical surfaces and horizontal non-traffic surfaces will receive a paintable acrylic emulsion. A mildew resistant silicone sealant is recommended for at all interior joint surfaces. Backer rods and primers will be used as required. Painting systems will be either modified epoxy or polyurethane. Chemical containment coating systems will be as required in order avoid adverse chemical reactions in the event of a spill.

Flooring in the building will consist of ceramic mosaic floor tiles where needed. These areas will be accompanied by glazed wall and base tiles and stone thresholds. Resilient flooring will also be provided where needed and will be provided with a rubber wall base.

Signage on the exterior of the building will be constructed of stainless steel and wall-mounted. Interior room and door signs will be of mixed materials. Fiberglass signs will be furnished for signs providing information, for safety, or for identifying points of egress. Hazardous materials signs will be located throughout the building as needed. Identification labels will also be provided for piping and equipment as required by code.

7.4 INTERIOR AMENITIES

The Women's and Men's locker/restrooms will be furnished with metal wardrobe lockers measuring 12-inch (W) x 18-inch (D) x 72-inch (H), have a single door, and have factory-finished accessories and trim. These rooms will be furnished with sanitary facilities in accordance with applicable codes and also be furnished with a built-in wooden bench. Fire extinguishers and cabinets will be proved throughout the building. The janitor's closet will include a terrazzo mop receptor. The kitchen will be equipped with a base section counter, four-burner cooktop, stove, sink and refrigerator. A wall mounted upper section with microwave, exhaust, counter lights, and cabinets will also be provided. Integral plumbing and electrical appurtenances will also be provided. The laboratory will be furnished with standing base cabinets with doors, drawers, shelving. There will also be a fit-out molded epoxy resin laboratory worktop, backsplash, sinks and sink outlets. Wall-mounted glass-fronted laboratory casework storage cabinets will be provided in this room as well.

Section 8 - Structural Theme

8.1 OVERVIEW

Conceptually the structural approach for this facility has been chosen with an eye toward ensuring both ease of constructability and speed of erection. In the discussion that follows, each primary element of the structure will be presented to enable the reader to better understand the basic elements that make up this system.

8.2 CONCRETE FOUNDATIONS

Based on preliminary borings conducted by CDM Smith the good soil profile found here (see Appendix I) enables the designer to make use of shallow cast-in-place (CIP) concrete for footings, slabs on-grade, and tanks. On-grade construction without the need for deep foundations such as piles does provide for rapid construction and less expensive construction. CIP concrete is the building material of choice typically employed in water treatment facilities due to its proven ability to support the process equipment without requiring any special maintenance. Concrete floors provide options for long wearing tile applications or simply left with a steel formed finish which, in special areas may be ground to a terrazzo type of exposure. CIP tanks, channels, and water ways all provide a secure means of safely handling the water treatment process. It is anticipated that tank base slabs will be from 24-inch to 30-inch thick with walls from 12-inch to 18-inch thick, slab-on-grade floors from 8-inch to 12-inch thick depending upon location, column footings from 30-inch to 36-inch thick.

8.3 BUILDING SKELETON

A structural steel framework will be employed to support the building and its water treatment process needs. Use of structural steel beams and columns is well proven and does so with a measure of economy. From lifting cranes to supporting hung piping and duct work, steel enables the designer the freedom to ensure the process needs are met without difficulty. Maintenance is minimal, especially if the product is supplied as a hot-dipped galvanized element. Erection of the frame is quick and enables closure of the building to be accomplished without delay. A steel frame easily provides multiple options to the designer for handling building stability against the forces of wind, snow, and seismic events. A steel frame has been chosen here as it is easily modified, should future plant needs warrant. The building will also be supported by steel columns of tube sections or rolled flange sections 8-inch to 12-inch deep, steel beams of tube or rolled sections from 10-inch to 20-inch deep for crane beams and the like.

8.4 BUILDING EXTERIOR WALLS

Insulated precast prestressed concrete wall panels have been chosen to provide a one-step efficient means of erecting the building envelope with a product that is visually appealing and energy efficient. Prestressed insulated wall panels are typically provided in widths up to 8-feet and 8-inch to 10-inch thick. The panels can be provided with an exterior architectural finish of vertical ribs or simple bands using finish textures of exposed aggregate, each presenting a clean and pleasing wall texture. Panels may be stained in any number of earth tones and staining by itself presents a nearly maintenance-free color finish. Windows and doors, if enveloped by the panel, may be installed prior to erection at the fabrication plant. Sealants provide the jointing between each panel.

8.5 ROOF CONSTRUCTION

Use of precast hollow core construction, usually in 8-inch or 10-inch thicknesses, provides excellent load carrying capacity be that a need for hanging loads, roof top equipment, or simply to handle drifting snow loads. Hollow core is a factory fabricated product constructed in a controlled manner to ensure a uniform product that presents a pleasing underside and long life.

Section 9 - HVAC and Plumbing

9.1 HVAC

This section will provide a summary of the required Mechanical/HVAC project elements for the proposed TTRWTP.

Staff Support Offices:

The southwest exposure of the proposed water treatment facility primarily consists of staff support and office spaces. These spaces include a break room, janitor's closet, files, storage, men's and women's locker rooms, meeting room, control room, Chief Operator's office, and an entry vestibule. These areas are to be served by a conventional comfort cooling and heating rooftop unit. Insulated ductwork shall be run above the drop ceiling above the area served. Lay in ceiling diffusers and return grilles shall be constructed of powder-coated aluminum. A small Energy Recovery Ventilator (ERV) shall be utilized to pretreat ventilation air from non-hazardous exhaust sources and returned to the roof-top unit (RTU) return air ductwork. All branch ducts shall be equipped with volume dampers for system balancing at each takeoff. Ductwork shall be sized for .07-inch water gauge max pressure drop throughout. Space averaging thermostats shall be located in break room and chief operator office. Rooftop unit to have a multistage gas furnace, with a minimum of 25% turndown. Unit shall introduce minimum of 400 CFM of outside air (makeup for lab exhaust) to the building.

Break Room: The break room will be heated, and air conditioned for comfort conditions (heating to 70, cooling to 78), will not have humidification or dehumidification controls, and will require ventilation in accordance with ASHRAE 62.1 for an office-breakroom of 5 CFM/person and .12 CFM/FT^2. A manually initiated exhaust system capable of approx. 200 CFM will be implemented as a range hood ducted to rooftop gooseneck to evacuate cooling odors. When the exhaust fan is operational, the room will be maintained at a slight negative pressure to the building. When exhaust fan is not operational, the room will maintain a slight positive pressure to the building. As such, cooking odors can be contained to break room when required, otherwise break room will not draw air from process area.

Janitor's Closet: The janitor's closet will have a constantly operating exhaust system serving it. It will not have any supply or return air connections. It will either require a door undercut or a lower door louver to transfer air for exhausting. Exhaust to be combined with locker room exhaust and ducted to ERV system.

Laboratory: The laboratory will utilize a 4-foot fume hood located on the southwest exterior exposure of the structure. The fume hood exhaust will be approximately 400 CFM providing 80 feet per minute across the fume hood sash open area. The exhaust fan serving the hood should be located on the roof and ductwork between hood and exhaust fan shall be spiral seam welded stainless steel. Supply air shall be delivered at the interior wall of the laboratory and diffused in a downward blow pattern towards floor as to wash across lab. This system will provide approximately 6 air changes per hour (ACH) throughout the lab. No additional ventilation or HVAC systems are anticipated.

Men's and Women's Locker/Restrooms: The men's and women's locker/restrooms shall maintain a slight negative pressure to the building. Supply air shall be delivered to each room respectively close to interior wall through use of induction diffusers. Exhaust registers shall be ceiling mounted near exterior exposure and ducted to ERV serving area. Supplemental 3 kW electrical wall or ceiling concealed unit heaters shall be included near the external perimeter of each room.

Training/Meeting Room: The training/meeting room will be heated and air conditioned for comfort conditions (heating to 70, cooling to 78), will not have humidification or dehumidification controls, and will require ventilation in accordance with ASHRAE 62.1 for a "Conference/Meeting Room" ventilation requirement of 5 CFM/person and .06 CFM/FT^2. The training/meeting room shall utilize variable air volume (VAV) style induction diffusers and ducted returns.

Control Room: The control room will be heated, and air conditioned for comfort conditions (heating to 70, cooling to 78), will not have humidification or dehumidification controls, and will require ventilation in accordance with ASHRAE 62.1 for a "General-Office" ventilation requirement of 5 CFM/person and .06 CFM/FT^2. The control room shall utilize induction diffusers and ducted returns.

Chief Operator's Office: The chief operator's office will be heated and air conditioned for comfort conditions (heating to 70, cooling to 78), will not have humidification or dehumidification controls, and will require ventilation in accordance with ASHRAE 62.1 for an "General-Office" ventilation requirement of 5 CFM/person and .06 CFM/FT^2. The chief operator's office shall utilize induction diffusers and ducted returns.

Vestibule: The vestibule shall be pressurized with a small volume of supply air (approx. 1 CFM/FT^2) to control drafts and provide a minimal amount of ventilation air. It shall be equipped with an electric unit heater near the exterior perimeter.

Utility Rooms:

Mechanical Room: The Mechanical Room is considered unoccupied space. The mechanical room requires heat, but not air conditioning or humidity control. Heating for the mechanical room shall be provided from ceiling mounted gas fired unit heaters within the room. To alleviate potential summer overheating concerns, and exhaust fan capable of 12 ACH and an associated intake louver with interlocked damper shall be initiated by reverse acting thermostat within the space.

Electrical Room: The electrical room is considered unoccupied space. Because of the nature of the controls panels and drives to be located in the electrical room, both heating and cooling will be provided. Ventilation in the amount of .12 CFM/FT^2 will be required. We would propose a small rooftop air handling unit to serve this room.

Process Area:

The process area is a large open area that constitutes most of the building. This area consists of chemical storage tanks, pretreatment and DAF process chambers, filtering chambers, and distribution pumps.

This space does not have typical comfort heating or cooling requirements but does require heating for process purposes to approx. 65 degrees to keep piping from freezing and to temper air for employees working in area. Dehumidification of this area needs to be implemented as to keep the dew point of pipes and equipment containing reservoir water from condensing.

In a groundwater application, the water pumped from a deep well will be approx. 50 degrees F during summer months when humidity is of concern. Where this treatment plant is fed from a shallow reservoir, summer water temperatures will likely be higher than 50 degrees and traditional air conditioning equipment with 43 degree coil temperatures will provide satisfactory dehumidification of the space other than on very humid spring days, when water temperature is low, but humidity levels in the air are unseasonably high. Base design shall utilize traditional rooftop air conditioning units with reduced airflow across coil (400 CFM/ton fan selections). Units shall have gas fired heating sections, demand control ventilation control capacity, economizer, and barometric relief.

Air handling unit enclosures shall be selected for 'seacoast' grade coatings. Coils shall have anodized finish for use in wet or caustic environments.

A design utilizing desiccant dehumidification units in lieu of traditional air conditioning units shall be incorporated as a pricing alternate.

Air distribution shall be accomplished by running 304 grade stainless steel spiral round or flat oval ductwork tight to deck throughout the facility, with returns located below the air handling units.

The entrance on the Northwest exposure of the building shall have an electric unit heater located close to the perimeter.

Storage Room: The two rooms within the process area (Storage and Workshop) can utilize the HVAC system serving the staff support areas. The storage room does not have any specific environmental requirements, but contents will benefit from stable temperature and humidity set points.

Although this zone is on a separate exposure from the staff support offices, thus seeing separate solar gains, because of the nature of the space exact temperature and humidity control is not required.

Workshop: The workshop can utilize the HVAC system serving the staff support areas. Because this zone is on a separate exposure from the staff support offices, thus seeing different solar gains, VAV style induction diffusers shall be utilized.

9.2 PLUMBING

This section will provide a summary of the required plumbing project elements for the proposed TTRWTP.

Domestic Water Service:

Domestic water serving the building shall be taken off the discharge pumping arrangement prior to leaving the building (piped to mechanical room by others). Plumber shall connect to 3-inch domestic water service piping by others within Mechanical room and provide new water meter, pressure reduction valve, and two (2) 3-inch backflow preventers piped in parallel. Domestic piping to be run in Type L copper, sweat or pressed fittings. Hot and cold domestic water piping to be insulated and labelled throughout.

Domestic Hot Water Heater/Piping:

Domestic cold water shall be piped to 299 MBH (1 MBH = 1,000 BTU/hour) 109 gallon capacity commercial gas fired condensing water heater. Water from water heater shall be routed to hi/low mixing valve capable of 30 GPM flow at 15 psi pressure drop or less. Hot water distribution shall have no dead legs more than 35-feet. A brass recirculation pump shall be provided along with a ½-inch hot water recirculation line back to inlet of water heater and mixing valve.

Sanitary Waste and Vent (W&V) Piping:

Sanitary Waste systems serving staff support areas shall be sized per code requirements minimum pipe size under slab to be 3-inch. Pipe to be run in extra heavy hubless grade cast-iron. All underground joints to utilize min of 6 band clamps per connection. All underground couplers to be wrapped in plastic prior to backfilling. Vents shall be combined to minimize penetrations through roof and shall be run in service class hubless cast iron piping.

Specific Requirements:

Break Room: The break room shall include a bottle filler with 3/8-inch DCW feed line, a kitchenette style sink with kitchen style faucet, ½-inch DHW, ½-inch DCW, and 2-inch W&V piping.

Janitor's Closet: The janitor's closet shall be equipped with a corner mount soapstone janitors sink with wall mount vacuum breaker fixture with bucket hanger hook, ¾-inch DHW, ¾-inch DCW, and 2-inch W&V.

Laboratory: The laboratory shall be equipped with a hand-wash sink with ½-inch DHW, ½-inch DCW, and 2-inch W&V, a lab sink with ½-inch DHW, ½-inch DCW, and 2-inch W&V, and a combination eye wash/ emergency shower w/ integral mixing valve with 1-1/4-inch DCW and 1-inch DHW.

Men's Locker Room/Restroom: The men's locker/restroom shall be equipped with (2) wall mount water closets with carriers, 3-inch drain, and 1-1/2-inch DCW to flushometer, (1) wall mount urinal with 1-inch flushometer, (1) hose bib w/ ¾-inch DCW, (1) 3-inch floor drain w/ ½-inch DCW trap primer, (2) shower stalls with 2-1/2-inch drain, ½-inch DHW, ½-inch DCW and temperature limiting mixing valves, (3) hand wash sinks w/ hands free faucets, 2-inch drain, ½-inch DCW and ½-inch DHW.

Women's Locker Room/Restroom: The women's locker/restroom shall be equipped with (3) wall mount water closets with carriers, 3-inch drain, and 1-1/2-inch DCW to flushometer, (1) hose bib w/ ¾-inch DCW, (1) 3-inch floor drain w/ ½-inch DCW trap primer, (2) shower stalls with 2-1/2-inch drain, ½-inch DHW ½-inch DCW and temperature limiting mixing valves, (3) hand wash sinks w/ hands free faucets, 2-inch drain, ½-inch DCW and ½-inch DHW.

Mechanical Room: The mechanical room shall be equipped with (2) 3-inch floor drains each with ½-inch DCW trap primer.

Process Area: Because of the nature of the building, floor drains and drainage troughs will be located throughout. All floor drains will require trap primers in accordance with MA state plumbing code. Sanitary drainage shall be run under slab in Schedule 40 cast or ductile-iron. Careful attention must be paid to routing of sanitary waste lines due to below grade pumps, process piping, and tanks throughout. Floor drains will not be required in chemical storage areas, whereas containment curbs will be utilized. Each of these chemical storage areas (Typ. for 6) shall have a 20-inch round 30-inch deep sump basin with cover and corrosion resistant pump capable of discharging 50 GPM at 15-feet of head. Process area shall be equipped with (4) ¾-inch DCW wall hydrants connections independently protected with 1-inch double-check style backflow preventer. Exterior of building shall be equipped with (4) frost free extended stem keyed hose bibs. Process area to have (2) combination eyewash/emergency shower assemblies w/ 1-1/2-inch DCW and 1-inch DHW with dedicated mixing valves.

Gas Piping:

Natural gas piping will be required to be run from the gas meter located adjacent the building to (1) RTU serving electrical room, (1) RTU serving office support area, (2) RTU's serving process area, and (1) domestic water heater. All gas piping 4-inch and larger to be welded, all gas piping 3-inch and smaller to be threaded. Piping to be schedule 40. All piping to be painted and labelled throughout.

Roof Conductors:

The building will have a flat roof requiring roof drains and rain leaders. Overflow requirements will be met through use of perimeter scuppers. Horizontal drains to be insulated throughout.

Section 10 - Process Control and Instrumentation

10.1 OVERVIEW

During normal operation, SCADA will control the various chemical feed systems based on flow pace, pH, residual, etc. The operator will be able to use the SCADA system to select lead/lag or automatic alternation sequence of the metering pumps. The operator will be able to select a dosing ratio from 0 to 100% whereby the maximum dosing will occur at the maximum flow. Manual controls will be available through manipulation of SCADA or local switches at the chemical feed pumps. All bulk and day tanks will be supplied with level elements to monitor the level of liquid inside each chemical tank. SCADA and local alarms (strobe and horn) will be provided for metering pump failure, high pressure indication (via cut-out switch), high level bulk storage or day tank, low-level bulk storage or day tank, high level secondary containment area, and emergency shower and eye wash station activation.

10.2 INSTRUMENTATION AND CONTROLS

A main control panel (MCP) will be provided containing a programmable logic controller (PLC). This MCP will be integrated into the current SCADA systems of Braintree and Randolph/Holbrook. Shielded and unshielded pairs of control wiring will be provided to each piece of process equipment as is required for the intended functionality of the TTRWTP including at the raw water pump station.

10.3 FIRE ALARM SYSTEM

An addressable fire alarm control unit (FACU) will be provided. The FACU will be mounted on the interior wall near the main entrance. Smoke, Heat, and Carbon Monoxide (CO) detectors will be provided throughout the TTRWTP. Pull stations will be provided at each exit. Flow and Tamper Switches will be provided by the Fire Protection Contractor, which will be interfaced with the FACU via monitor modules. A Signal Line Circuit will connect each of the detection devices to the FACU.

Notification devices (horn/strobes) will be provided throughout the TTRWTP and connected to the FACU via a Notification Appliance Circuit (NAC). Exterior beacons will also be provided over the main entrance and over the Fire Department connection point, and will be connected to the NAC. Upon detection of smoke, heat, CO, or the activation of a manual pull station, the FACU will activate all of the horn/strobes and the exterior beacons. The FACU will report the alarm condition to a Central Station or the local Fire Department.

10.4 MANUAL ALARM SYSTEM

Per the 2015 International Building Code section 415.5, a manual alarm system is required within areas classified as Hazardous (H-1 through H-4.) The process areas of the TTRWTP are to be classified as H-4, therefore, a Manual Alarm System will be required. Per 415.5.1, the manual alarm system will consist of several pull stations at each access door to the hazardous area, along with horn/strobes located throughout the building. The pull stations and horn/strobes associated with the manual alarm system must be clearly designated as separate from the fire alarm system. The devices must be painted a color other than Red, and the strobe must flash a color other than White.

The manual alarm system is required to be constantly monitored. If the plant is staffed 24/7, installing a system horn/strobe at a constantly attended location qualifies as a means of monitoring the system. Otherwise, the manual alarm system must be monitored remotely. If approved by the local fire department, this can be achieved by tying the Manual Alarm System directly into the FACU to report to the local Fire Department or Central Station. Otherwise, a separate dialer must be provided, and private monitoring company contracted to meet these requirements. An intrusion alarm system will be provided with a dedicated dialer that reports to the Braintree police station.

Section 11 – Electrical

11.1 NEW ELECTRICAL SERVICE TTRWTP

BELD Responsibilities:

Braintree Electric Light Department will be responsible for providing power to the TTRWTP. Power is expected to be brought to the site from King Hill Road due East of the plant. BELD will provide a new 2 MW Utility Transformer at a location chosen by the customer. Per BELD, the existing infrastructure on King Hill Road is most likely adequate to feed the new plant. If the infrastructure on King Hill Road proves inadequate to pick up the TTRWTP, BELD will upgrade the infrastructure as required. BELD will provide a new set of fuses and underground primary feeders to the location of the new transformer. This feed will be a Radial Feed. BELD will charge a connection fee for this work. If redundancy is desired, BELD can bring a separate service in from the other side of the plant off of West Street in Braintree at an additional cost. BELD will provide an electrical utility meter at

Customer Responsibilities:

Primary conduits will be provided between the existing BELD utility pole and the new transformer per BELD standards for BELD's use pulling primary feeders. A new transformer pad will be provided for the new 2 MW transformer provided by BELD. The secondary voltage of the transformer will be 480Y/277V 3 phase. Secondary conductors, including conduit, wiring, trenching, spacing accessories, backfill, and land restoration will be provided.

The secondary conductors from the BELD transformer will terminate at a Service Disconnect Switch within a Main Distribution Switchboard (MSB) in the electric room at the new TTRWTP. Grounding and Bonding is to be provided per the latest Massachusetts Electrical Code. The MSB will contain Current Transformers and a Metering Section for the BELD utility meter. Finally, the utility service will terminate at an Automatic Transfer Switch (ATS) provided within the MSB.

11.2 TTRWTP GENERATOR:

Calculations indicate the need for a 2 MW Generator to power the entire TTRWTP in the event of a power outage. This will be a diesel generator, located externally and placed adjacent to the building. The footprint of the generator will be approximately 26 feet by 12 feet. A sound attenuated, weatherproof enclosure will be provided for the Generator.

A double walled diesel storage tank will be provided. A generator of this size running fully loaded consumes approximately 160 gallons of fuel per hour. The diesel storage tank will be sized according to the town's requirements for continuous generator run-time. For example, if the plant is required to run for 24 hours on generator power, about 4,000 gallons of stored diesel fuel would be required. The diesel storage tank can be installed above or below ground. A leak detection system is recommended when storing diesel in proximity to the Great Pond Reservoir. A containment structure will be constructed around the stored diesel fuel and generator area to ensure containment of any accidental diesel fuel leaks and to facilitate clean-up.

Conductors will be run underground from the generator, penetrating the exterior wall of the TTRWTP, and connecting to the main switchgear via the ATS in the MSB. A generator annunciator panel will be installed within the MSB. If so desired, equipment can be provided to synchronize the phase of the generator output with that of the utility power. This will allow for a closed transition between normal and generator power such that for testing or maintenance purposes, power can be transitioned to the generator without delay.

11.3 TTRWTP ELECTRICAL INFRASTRUCTURE:

Both the generator and the utility services will connect to an ATS within the MSB in the electrical room. The load side of the ATS will feed the busbar of the MSB. The MSB will contain draw-out circuit breakers.

One of these draw-out circuit breakers will feed a 480V Panel board referred to as "Panel HVP." Panel HVP will feed 480V HVAC equipment and 277V lighting loads. Panel HVP will also feed a 480V to 208Y/120V transformer, which will feed a 208Y/120V panelboard referred to as "Panel LVP." Panel LVP will feed any equipment requiring a 208V or 120V feed, including smaller HVAC equipment, process equipment and various control panels. Panel LVP will also feed any 120V circuitry throughout the building including general purpose receptacles.

The other draw out circuit breaker will feed a 480V Motor Control Center (MCC). The MCC will feed the process equipment. Motor Starters or Variable Frequency Drives (VFDs) will be provided for each piece of equipment throughout the plant based on equipment requirements. The MCC will be equipped with controls including pilot lights, H/O/A switches, power monitors, Control Power Transformers, and other appurtenances as required to achieve the desired monitoring and control capabilities for each piece of equipment.

VFDs can be integral to the motor control center or standalone. VFDs will be specified based on manufacturer recommendations and requirements of each motor. VFDs will be equipped with bypass capability, harmonic filters, and line reactors as appropriate for each application. VFDs will be capable of communicating directly to the TTRWTP Control Panel via an RS-45 connection. VFD Cable will be provided between each VFD and respective motor load.

11.4 TTRWTP NON-HAZARDOUS AREA

Electrical Raceways, Boxes, and Devices:

The non-hazardous areas of the TTRWTP will be treated as an office fit out. Standard NEMA 5-20R receptacles along with Telephone and Data outlets will be provided. Standard Electrical Metallic Tubing (EMT) conduit will be used when run exposed, and Metal Clad (MC) Cable will be allowed where run above ceilings or within walls. Flexible Metallic Conduit (FMC) will be used to connect to transformers or moving equipment. Electrical enclosures, boxes, and switches will be rated NEMA 1 or NEMA 12.

Non-Hazardous Area Lighting:

Lighting in the non-hazardous area will consist of 2x2 and 2x4 Troffer Style LED Luminaires mounted in the dropped ceiling. Specialized luminaires will be provided as appropriate for spaces such as the Mechanical Room, Electrical Room, Locker Rooms, and Laboratory.

11.5 TTRWTP HAZARDOUS AREA

Electrical Raceways, Boxes, Devices, and Lighting:

The Hazardous area (process area) of the TTRWTP will be treated as a wet location. General purpose receptacles will be surface mounted, GFCI protected, and equipped with weatherproof “while-in-use” covers. GFCI protection of other circuitry will be provided as required via GFCI type circuit breakers within the panelboard serving the load. Conduit will be Intermediate or Rigid Galvanized Metallic Conduit (IMC or RMC), and will be run exposed. Conduit connecting to a piece of moving equipment like a motor will be Liquid-tight Flexible Metallic Conduit (LFMC). Electrical enclosures, boxes, and switches will be rated NEMA 3R (water resistant) at a minimum. NEMA 4X (non-corrosive) and NEMA 6 or 6P (submersible) will be installed where required.

Lighting:

Lighting in the hazardous area will consist of LED troffers hung by aircraft cable. All luminaires will be wet location rated. Luminaires will be selected and arranged such that an even distribution of light averaging approximately 50 foot candles at the floor is provided throughout the hazardous space.

11.6 EXTERIOR LIGHTING:

Wall packs will be provided to illuminate the exterior of the building. The wall packs will be controlled by a switch inside the building and a photocell wired upstream of the switch. There will be one luminaire over each entrance controlled by an occupancy sensor that is integral to the fixture. If so TTRWTP, pole mounted luminaires will be provided for the parking lot and along the driving path to the TTRWTP.

11.7 RAW WATER PUMP STATION NEW ELECTRICAL SERVICE:

The Raw Water Pumping Station (RWPS) is going to be located approximately 300 feet from the TTRWTP. Rather than run 480V conductors between the TTRWTP and the RWPS, a separate service will be provided by BELD to the RWPS. Similarly to the service to be provided to the TTRWTP, BELD will provide a utility transformer and the primary conductors to the transformer. The customer will be responsible for the primary conduit, transformer pad, and secondary conduits between the transformer and the RWPS. The secondary feeders will feed an exterior disconnect, a current transformer cabinet with a meter socket, then the normal side of an ATS within the RWPS.

11.8 RWPS GENERATOR:

A 500 kW Diesel generator will be provided to serve the RWPS with a similar enclosure and diesel storage tank to that of the larger generator serving the TTRWTP. The diesel storage tank will also be constructed with a containment area around it to ensure containment of any spills and aid with cleanup. The footprint of a generator this size will be approximately 18 feet by 6 feet. The diesel storage tank will again be sized based on town runtime requirements. A generator this size utilizes approximately 30 gallons per hour. Again, synchronizing equipment can be provided to allow for a closed transition from utility power to generator power for testing or maintenance purposes if so desired. The generator service feeders will feed a generator disconnect switch on the exterior of the building, then the emergency side of the ATS within the RWPS.

11.9 RWPS ELECTRICAL INFRASTRUCTURE:

The ATS will then feed a 480V MCC. This MCC will contain buckets for each of the four 75 HP Raw Water Vertical Turbine Pumps, with all required accessories and appurtenances for functionality and control of the pumps. The MCC will also feed a 480V to 208Y/120V Transformer, which will feed a 208Y/120V panelboard. This panelboard will feed the basic HVAC, Lighting, and Controls equipment at the RWPS, along with general purpose receptacles.

Electrical Raceways, Boxes, and Devices:

General purpose receptacles will be surface mounted, equipped with weatherproof “while-in-use” covers and GFCI protected. GFCI protection of other circuitry will be provided as required via GFCI type circuit breakers within the panelboard serving the load. Conduit will be Intermediate or Rigid Galvanized Metallic Conduit (IMC or RMC), and will be run exposed. Conduit connecting to a piece of moving equipment like a motor will be Liquid-tight Flexible Metallic Conduit (LFMC). Electrical enclosures, boxes, and switches will be rated NEMA 3R (water resistant) at a minimum. NEMA 4X (non-corrosive) and NEMA6 or 6P (submersible) will be installed where required.

Lighting:

Lighting will consist of LED troffers, surface mounted or hung by aircraft cable. All luminaires will be wet location rated. Wall packs will be provided to illuminate the exterior of the building. Additionally, pole lights can be provided as directed.

Section 12 – Preliminary Permit Requirements

12.1 OVERVIEW

EP has reviewed local, state and federal requirements associated with the construction of the concept presented. The proposed withdrawal flows for the new TTRWTP fall within the Tri-Town Water Management Act 310 CMR 36.00 registered limits. It has been determined that there are no federal endangered species in the work area. Project construction of the raw water pump station, water treatment plant and associated yard piping is all located on Braintree town owned land. The construction of the proposed Randolph/Holbrook Transmission main will have disturbance within Braintree and Randolph town owned land across Great Pond from shore to shore. If needed a chemical feed system would be constructed at the current Randolph/Holbrook Joint Water Treatment plant and within the Holbrook distribution system on Holbrook town land. What follows is a listing of the minimum required permits associated with this project. Additional permits may be required based on final design decisions.

12.2 MASSACHUSETTS ENVIRONMENTAL PROTECTION ACT (MEPA)

EP conducted a fact finding meeting with MEPA to discuss the overall aspects of the project and thresholds associated with the following permits: MEPA Review thresholds and applicability for the Tri-Town Water treatment plant are as follows:

- **Land** – Creation of five or more acres of impervious area ENF and other review by MEPA no EIR.
- **Wetlands, Waterways, Tidelands** - Alteration of 500 or more linear feet of bank along a fish run or inland bank ENF and other review by MEPA no EIR.
- **Wetlands, Waterways, Tidelands** – Alternation of 5,000 or more square feet of bordering or isolated vegetated wetlands ENF and other review by MEPA no EIR.
- **Water** – Construction of a new drinking water treatment plant with a capacity of >/= 1MGD ENF and other review by MEPA no EIR. This project triggers this threshold so an ENF will be required.
- **Solid and Hazardous Waste** – New Capacity or expansion in capacity of 50 or more gpd for storage, treatment, processing, combustion or disposal of solid waste unless the project is exempt from site assignment. The design concept is to dewater solids and pump to MWRA sewer system therefore it is reducing the sludge management. Currently the Braintree Water Treatment Plant disposes of solids in lagoons for dewatering, storage and removal.

12.3 MA PUBLIC WATERFRONT ACT – 310 CMR 9.00 (CHAPTER 91 LICENSE)

The trigger for this application is work being conducted in, under or over a Great Pond. A Great Pond is defined as a pond which contains more than ten acres in its natural state, as calculated based on the surface area of lands lying below the natural high water mark. The application review process for this is just under 1 year at 276 days. The Randolph/Holbrook transmission main is laid on the bottom of the reservoir floor.

12.4 US ARMY CORPS OF ENGINEERS SECTION 10/404 AND 103

This regulation covers work associated with excavation into waters of the US. In addition it covers construction, maintenance or repair of utility lines in non-tidal waters of the US. The Randolph/Holbrook Transmission Main triggers this as a requirement.

12.5 401 WATER QUALITY CERTIFICATE FOR DREDGING/FILLING

The proposal to lay the Randolph/Holbrook Transmission main across Great Pond triggers this certification requirement. A minor certificate is for up to 5,000 square feet of wetlands/land underwater. A major certificate is required for anything over the 5,000 square feet. The concept plan calls for two 20-Inch transmission mains are proposed to be laid on the bottom of the pond from the Braintree shore to Randolph shore. The distance is approximately 3,300 feet and the width of the total trench is estimated at 10 feet. These dimensions result in a disturbance of 33,000 square feet resulting in the need for a major certificate.

12.6 BUREAU OF RESOURCE PROTECTION – WATER SUPPLY (BRP WS 24)

This project exceeds the threshold of the construction of a facility to treat 1 MGD or greater, therefore a BRP WS 24 is required.

12.7 MASSACHUSETTS HISTORICAL COMMISSION (MHC) – SECTION 106 NATIONAL HISTORIC PRESERVATION ACT

The proposed site for the Tri-Town Regional Water Treatment Plant is situated in an area deemed by the MHC to be “highly sensitive for Native American recovery”. Archaeological Services at University of Massachusetts Amherst completed a Phase 1 - Archaeological Reconnaissance and Intensive Locational Survey in February 2010. The four locus areas that they identified to possibly possess sensitive artifacts are shown in relation to the TTRWTF in Appendix J. The intent of the project was to comply with the existing State and Federal Heritage Management legislation Section 106 of the National Historic Preservation Act and determine the presence or absence of archaeological resources. The site is known as the King Hill Road Native American Site. Four concentrations of “lithic chipping debris, the result of manufacture and maintenance of stone implements and tools, were recorded in the project area” were identified. The age, relationship and potential importance of the archaeological site is not yet known.

- Biface STP39/ID1

Grey rhyolite with white mottling and black glassy phenocrysts.
Well-made, narrow Lanceolate blade, symmetrical, thin, slightly blunted tip.
52mm long, 24mm wide, 6-7mm thick
A knife/cutting tool or possibly a Woodland (Fox Creek) Stemmed or Lanceolate point

- biface STP62/ID1

Tan hornfels
Large, thick, coarsely flaked biface. Although roughly flaked, the edges are not wavy when viewed from the side, and flaking extends around the entire circumference
Asymmetrical: one edge straight, the other excurvate.
The thickest “ridge” is nearer the straight edge, suggesting the excurvate edge is the primary working edge while the tool is held along the thick part
Base is straight to slightly excurvate, the point is blunt and thick.
A heavy-duty cutting tool
72mm long, 36mm wide, 15mm thick

Because of the likely significance of the site, it is recommended that a site examination archaeological survey be conducted at the King Hill Road Native American site. The purpose of the additional archaeological testing is to provide sufficient information about the size, contents and arrangement of the artifact and features to determine if the site is significant, and then to consult on feasible alternatives to avoid, minimize, or mitigate any effects of the project on the archaeological site. The site examination of the Native American component of the area should include an additional 75 shovel test pits each 50 x 50 cm and 4 larger excavation units (each 1 x 1 m) to determine the extent of the site.

"Historic (European-American artifacts were identified at 24 survey unit locations. Artifacts included white-ware, bottle glass and modern trash. There were no locations within the project area where European-American artifacts were encountered in moderate or high concentrations…. The remnants of two granite quarry pits and possible associated buildings were recorded close to the southeast corner of the project site. The quarries should be recorded. Mapping and photography of the historical quarry pits, stone walls and related features should be conducted.

This work should commence immediately to ensure that the project schedule (see Appendix K) will not be impacted in a negative way.

12.8 BRAINTREE AND RANDOLPH CONSERVATION COMMISSIONS

The construction of the Randolph/Holbrook Transmission Main will result in disturbance on both the Braintree waterfront as well as the Randolph waterfront. A Notice of Intent will be required for each community including attendance at Conservation Commission meetings in both communities. Ultimately an Order of Conditions will be provided by each entity.

12.9 BRAINTREE/RANDOLPH/HOLBROOK NPDES CONSTRUCTION STORMWATER GENERAL PERMIT

There are two thresholds. A construction activity disturbing 1 to 5 acres of land is considered a small construction activity. A Braintree NPDES Construction Permit will be required for the construction of the water treatment plant and will disturb more than 5 acres categorizing it as a large construction activity and may require the contractor to obtain the permit and submit the required Stormwater Pollution Prevention Plan (SWPPP) to Braintree for approval. A Randolph NPDES Construction Permit will most likely be required for the construction associated with the terminus of the Randolph/Holbrook Transmission Main to house appropriate connection appurtenances including valve pit and potential small generator pad. A Holbrook NPDES Construction Permit would be required if a satellite chemical dosing facility is required within the Holbrook town limits.

12.10 MASSACHUSETTS STATE BUILDING CODE (BRAINTREE/RANDOLPH/HOLBROOK BUILDING PERMITS)

Building permits may be required in all three communities. At a minimum a building permit application must be submitted for the TTRWTP construction located in Braintree. Depending on the construction needs for the terminus of the Randolph/Holbrook transmission main and need for supplemental chemical addition within the Holbrook distribution system building permits maybe required for Randolph and Holbrook.

12.11 OTHER PERMITS

Other permits which may be required include but are not limited to:

1. Hazardous Materials Licenses/Permits Resource Conservation and Recovery Act. 42 USC 1101 310CMR 30.0000 may be required to submit under this permit based on types of chemicals to be used and stored at the treatment plant.

2. Underground Injection Control Regulations – 310 CMR 27.00 may be required if a new drywell is used for plant drains, overflows and discharges.

Section 13 - Project Schedule

The construction project schedule (see Appendix K) shows the major milestones of this project. The remaining phases in this project are designer selection, permitting, design, bidding, construction, start-up, and closeout. The construction of this project will be funded under the Massachusetts Drinking Water State Revolving Loan Program. Each of these phases will be discussed in further detail below.

Designer Selection

In this phase EP will work as the OPM to solicit the design services of a firm based on their qualifications and fee. This phase will begin with advertising for design services in the beginning April and responding to request for information, lasting approximately 2 months. Once the requests for qualifications have been received we will work with the Owner to select the design firm and then move into contract negotiation which is expected to last 4 months.

Permitting and Final Design

The major permits needed for this project have been identified in Section 12. Permitting is expected to take approximately nine months to complete. The critical permits that need to be obtained involve a MEPA Environmental Notification Form, 401 Water Quality Certification, Braintree and Randolph Conservation Commission Order of Conditions, and a Chapter 91 License. Final Design will take place concurrently with permitting and will incorporate any requirements received during the permitting process. The Final Design phase is expected to take fourteen months. Design plans will be submitted to MassDEP for review and comment by October 15th of the year which the Drinking Water State Revolving Loan Funds are provided for this project.

Bidding and Construction

This project will be publicly bid, include filed sub-bids, and last approximately 3 months. This portion of the work will not begin until MassDEP gives approval for the project to proceed to bid. The bidding phase will start with solicitation of bids by those trades which are expected to be in excess of fifty thousand dollars (i.e. electrical, masonry, etc.). Once these filed sub-bids have been received the general bid opening will be held at least 2 weeks later, allowing general contractors sufficient time to prepare their bids based on the filed sub-bids. Construction of this multi-million dollar project is expected to last approximately two years. Start-up and testing of the facility will be extensive and last approximately six months, after which Contract closeout and warranties will be submitted.

Appendices

Appendix A - 2014 Firm Yield Analysis

April 17, 2015

Honorable Mayor Joseph C. Sullivan
Braintree Town Hall
1 John F. Kennedy Memorial Drive
Braintree, MA 02184

Re: MassDEP Firm Yield Review of the Tri-Town Surface Water Supply System

Dear Mayor Sullivan:

On March 19, 2015 representatives from MassDEP conducted a conference call with Mr. Lou Dutton of the Braintree Water & Sewer Department, and Mr. Stephen Olson of Environmental Partners Group to discuss the status of MassDEP's review of the Tri-Town Water System's firm yield study. The discussion also focused on the reactivation of the Cochato River Diversion as a supply source and Braintree's registration volumes. The following summarizes our discussion on these matters.

Allocation Volumes
Information submitted by Environmental Partners Group supports Braintree's assertion that their original registration statement is based on finished water values. The following table outlines Braintree's and Tri-Town's compliance with their registration volumes for the last 3 years.

	Tri-Town's Raw Water (mgd)	Tri-Town's Finished Water (mgd)	Braintree's Finished Water (mgd)	Braintree's Raw Water (mgd)
2011	7.73	7.12	3.76	3.97
2012	7.08	6.78	3.52	3.61
2013	7.16	6.13	3.19	3.71
Compliance Value	7.88 Firm Yield	7.14 Registration	3.87 Registration	N/A

Note that in 2011, both Braintree's and the Tri-Town's water system's finished water volumes where both close to their compliance volumes. Should Braintree need more than their 3.87 mgd registration volume on an average annual daily basis, they will need to obtain a Water Management Permit prior to exceeding that value. A condition of any such Water Management Permit will be that the Town provide feasible mitigation for any volumes withdrawn above their 3.87 mgd registration volume. MassDEP's Water Management Permit Guidance Document offers information on the types, hierarchy, and crediting of mitigation activities. MassDEP would be available to walk through that permitting process with you.

Cochato River Diversion

While the reactivation of the Cochato River Diversion is a possibility, the source would need to complete the Department's Drinking Water Program's Source Approval Process and obtain a Water Management Permit before being returned to service. Although information was recently submitted by Environmental Partners that suggests the Cochato was an active source during the registration period, the source was not included in Braintree's original registration statement filing. Failure to include this information by January 1, 1988, requires that a Water Management Permit be obtained prior to the reactivation of the Cochato River Diversion as a source.

Firm Yield Study

MassDEP has reviewed the Environmental Partners Group's report *Tri-Town Firm Yield Study Surface Water Supply System* (November 2014). Specifically MassDEP reviewed this report for the purpose of establishing the Firm Yield for the Tri-Town Surface Water System, which currently includes active supply sources at the Richardi Reservoir (4040000-02S), Upper Great Pond (4040000-04S) and Lower Great Pond (4040000-01S). The report also included existing inflows from the Farm River and modeled yields if the Cochato River were returned as an active diversion source.

Environmental Partners Group modeled the Firm Yield based on MassDEP's Firm-Yield Estimator (FYE) which analyzes information between 1960-2004, and also included the following factors in their assessment:

- Dredging to the Richardi Reservoir which has increased usable volumes from 154.7 Million Gallons (MG) to 342.2 MG;
- Completion of a dredging project during the 2000s to the Upper Great Pond;
- Braintree Treatment Plant intake elevation of 109.72 feet; and
- Flow contributions from residual lagoons.

Based upon MassDEP's review of the report and supplemental information submitted by Environmental Partners Group we agree with their finding that the Firm Yield based upon the most conservative scenario provided in the report (1981 Drought with no Demand Management) is 7.88 MGD. Because the permitting requirements for the Cochato River Diversion would likely include conditions that require minimum streamflow levels for diversions to occur, MassDEP is unable to assign a Firm Yield value that includes this source until those diversion thresholds are established.

Additionally MassDEP did not have enough information to concur with Environmental Partners Group's Firm Yield assessments which included Demand Management with and without the Coachato River Diversion. While there are some assumptions in the report (Table 5 on page 3-11) on the projected demand management savings achieved by Tri-Town's Water Use Policy (Appendix D), MassDEP does not have enough information to evaluate the potential effectiveness of such a plan. The Water Management Act Regulations 310CMR 36.00 allow a permittee to develop a drought management plan that details specific steps to be taken in response to droughts and the means to measure the results of those savings. American Water Work Association's M60 Drought Preparedness and Response document outlines the required elements of what an acceptable plan should include.

We also understand that there has been some interest in exploring opportunities to either fully or partially supplement the Town's water needs from the MWRA. If we can be of any assistance in working through different cost scenarios for pursuing that further please let me know. MassDEP would be happy to meet and discuss our assumptions and answer any questions you may have regarding our review. Please feel free to contact me directly at (617) 292-5748 to arrange such a meeting.

Sincerely,

Beth Card
Deputy Commissioner for Policy and Planning

cc: Mr. Stephen Olson, P.E. Environmental Partners, 1900 Crown Colony Drive, Suite 402, Quincy, MA 02169
Mr. Lou Dutton, Braintree Water & Sewer Department, 85 Quincy Avenue, Quincy MA 02184

Y: DWPArchive\SERO\2015\Braintree-4040000-Firm Yield-4-17-2015

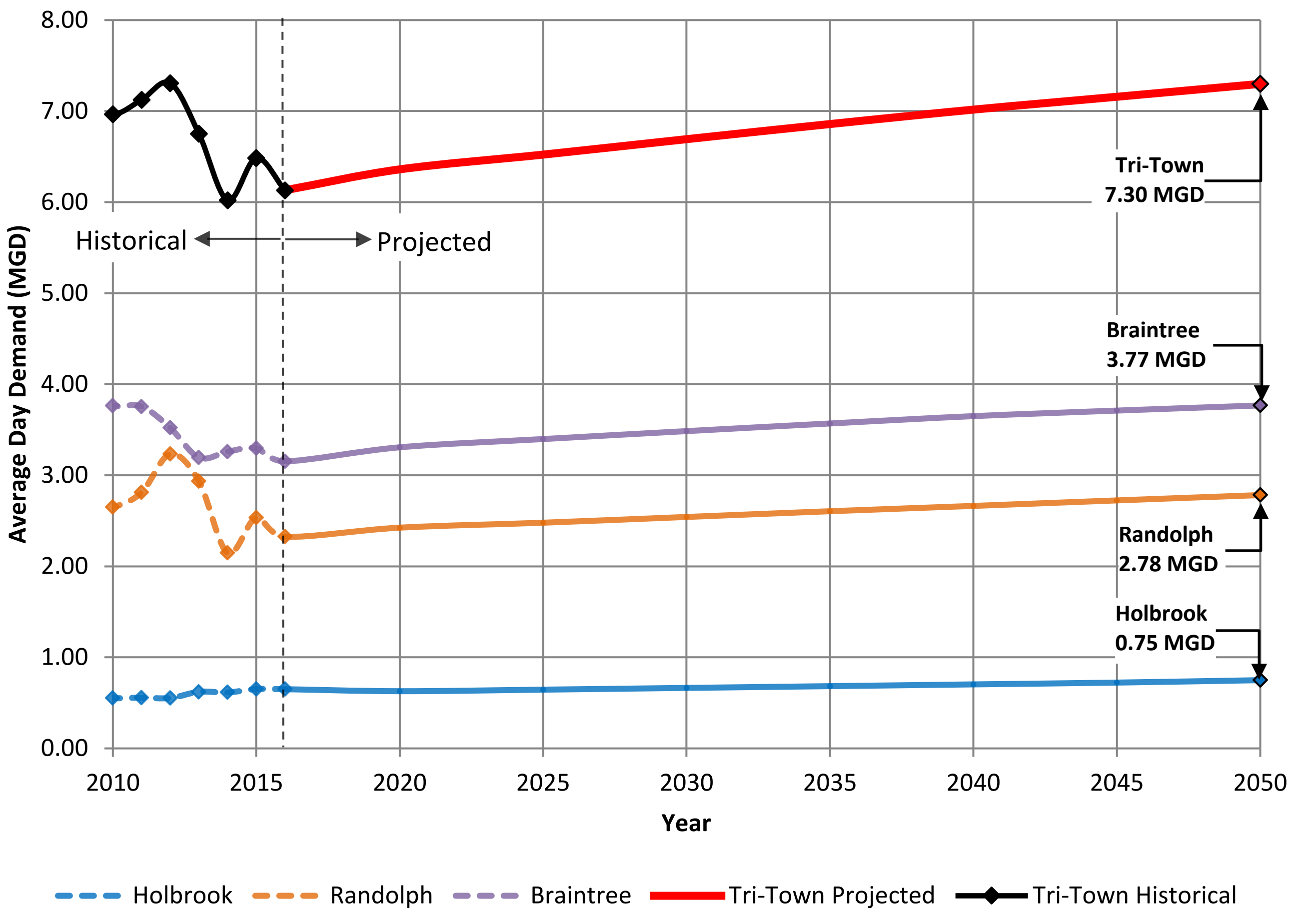
Appendix B - Tri-Town Distribution System Master Plan -

Water Demand Projections

3.5 WATER DEMAND PROJECTIONS

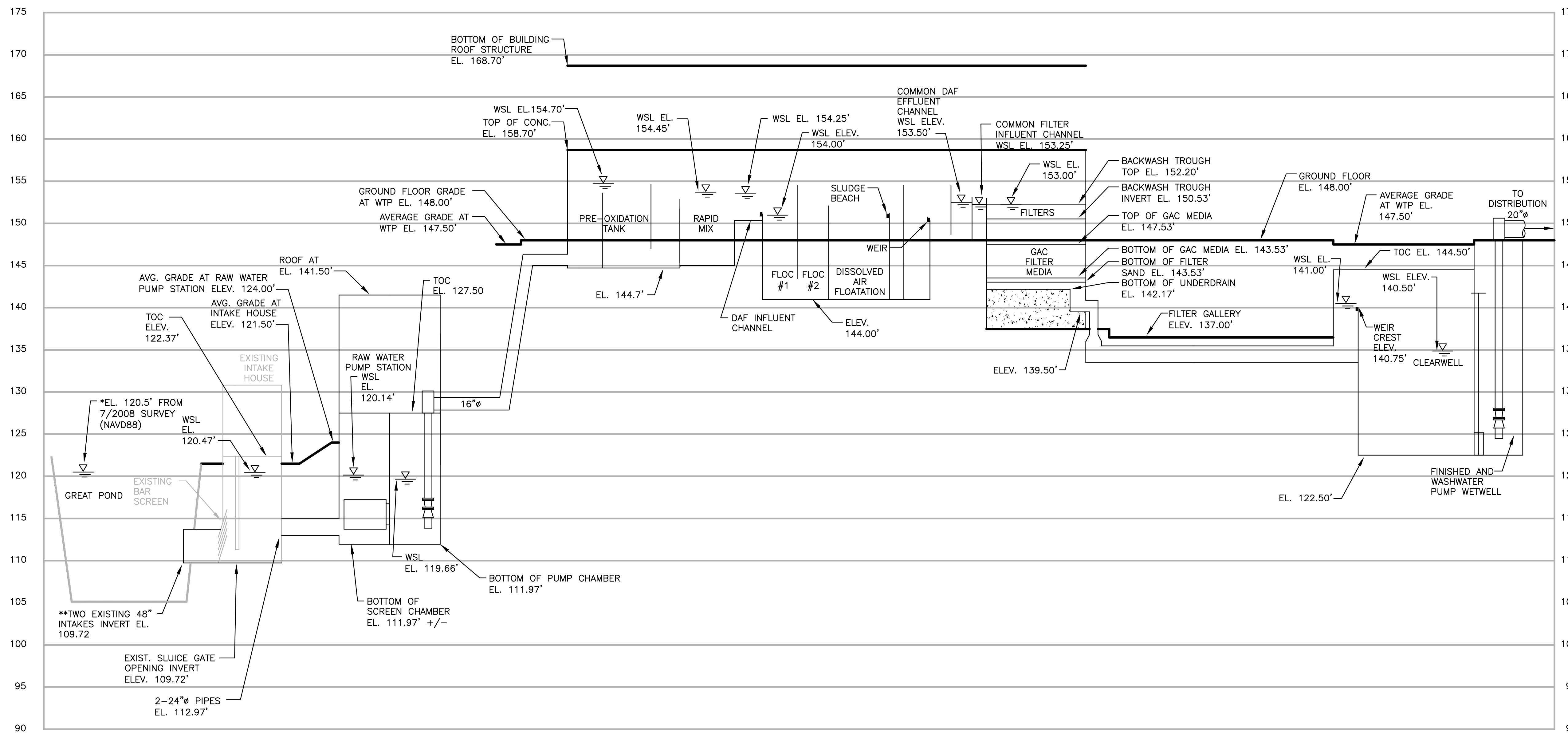
Along with population projections, Annual Statistical Report (ASR) data gives insight into a Town's water demand from residential, industrial, commercial, institutional, agricultural, municipal and unaccounted-for sources. Unaccounted-for water is reported as a percentage of total water demands, and was factored into future water use predictions by assuming that percentages in each Town will reach 10% by the year 2050. The ASR reports residential water demand in gallons/person/day, which can be tracked over time to estimate general water use culture. In the Tri-Town area, residential use per person is not expected to significantly deviate from the average, however due to population rise over the next 35 years the total water demands will grow, as seen in Figure 3-1 below.

FIGURE 3-1
POPULATION PROJECTIONS



Appendix C - BRP WS 22D

Appendix D - Hydraulic Profile



*NORMAL HIGH WATER ELEV. 121.3'
(TAKEN FROM EP FIRM YIELD STUDY)

**TAKEN FROM 1971 SEA PLANS FOR
INTAKE STRUCTURE

NOTES:
1. ALL ELEVATIONS ARE NAVD88 DATUM.

BASIS OF HYDRAULIC PROFILE

FLOW DESCRIPTION	FLOW (MGD)	NUMBER OF UNITS IN SERVICE
MAXIMUM DESIGN	12.5	3 – RAW WATER PUMPS 2 – PRE-OXIDATION 1 – RAPID MIX 3 – FLOCCULATION / DAF 4 – FILTERS 1 – CLEARWELL 6 – FINISHED WATER PUMPS

NOTE: MINIMUM DESIGN FLOW: 2.8 MGD

Environmental Partners GROUP
A partnership for engineering solutions.

MARK	DATE	DESCRIPTION

Scale	N.T.S.
Date	APRIL 2019
Job No.	181-1801
Designed by	DNRP
Drawn by	AJR
Checked by	DNRP
Approved by	HTG

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

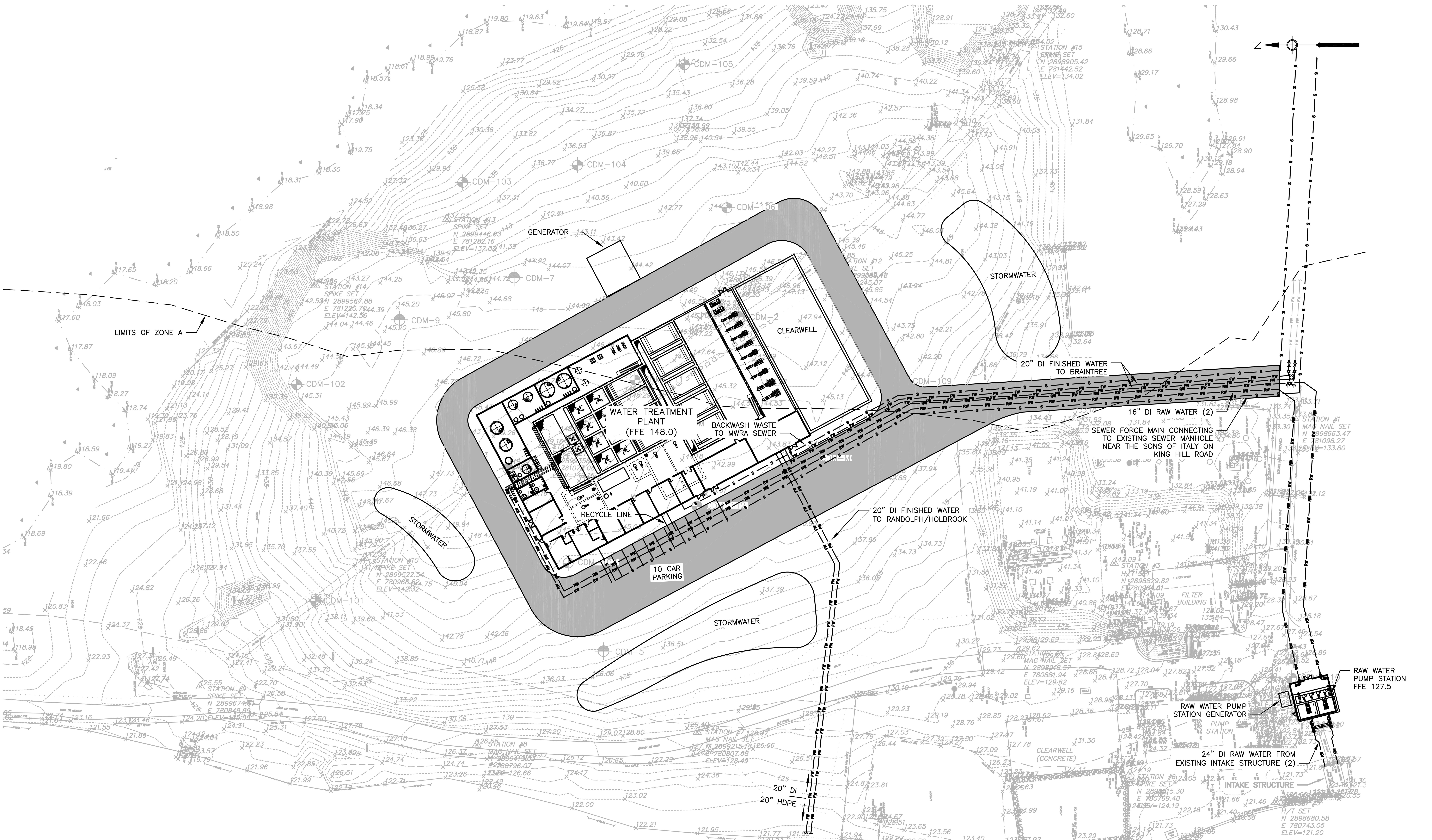
HYDRAULIC PROFILE

NOT FOR CONSTRUCTION

Sheet No.

G-2

Appendix E - Conceptual Site Plan



SITE LAYOUT AND GRADING PLAN

SCALE: 1"=40'-0"

MARK	DATE	DESCRIPTION

Scale	AS SHOWN
Date	APRIL 2019
Job No.	181-1801
Designed by	AJL
Drawn by	AJL
Checked by	AJR
Approved by	HTG

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

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TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

CONCEPTUAL SITE PLAN

NOT FOR CONSTRUCTION

Sheet No.

C-1

Appendix F - Process Flow Diagram

NOTES:
1. ALL CHEMICAL FEED POINTS LISTED AS DRY DOSE.

Drawing file: I:\Tri-Town (Brain,Rand,Holb) 181\181-1801 OPM Services WTP\Phase I - Value Engineering, Schematic Prep, Designer selection\06. Concept\Process Flow Diagram\Process Flow Diagram.dwg Plot Date: Apr 02,2019-7:23pm

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MARK	DATE	DESCRIPTION

Scale	AS SHOWN
Date	APRIL 2019
Job No.	181-1801
Designed by	DNRP
Drawn by	AJR
Checked by	DNRP
Approved by	HTG

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

PROCESS FLOW DIAGRAM

NOT FOR CONSTRUCTION

Sheet No.
G-1

Appendix G – Floor Plans

GROUND LEVEL PLAN

SCALE: 3/32"=1'-0"

Drawing file: C:\Users\a...\appdata\local\temp\AcPublish_16336\M-Sheets.dwg Plot Date: Apr 02,2019-7:18pm

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MARK	DATE	DESCRIPTION

Scale	AS SHOWN
Date	APRIL 2019
Job No.	181-1801
Designed by	AJL
Drawn by	AJL
Checked by	AJR
Approved by	HTG

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

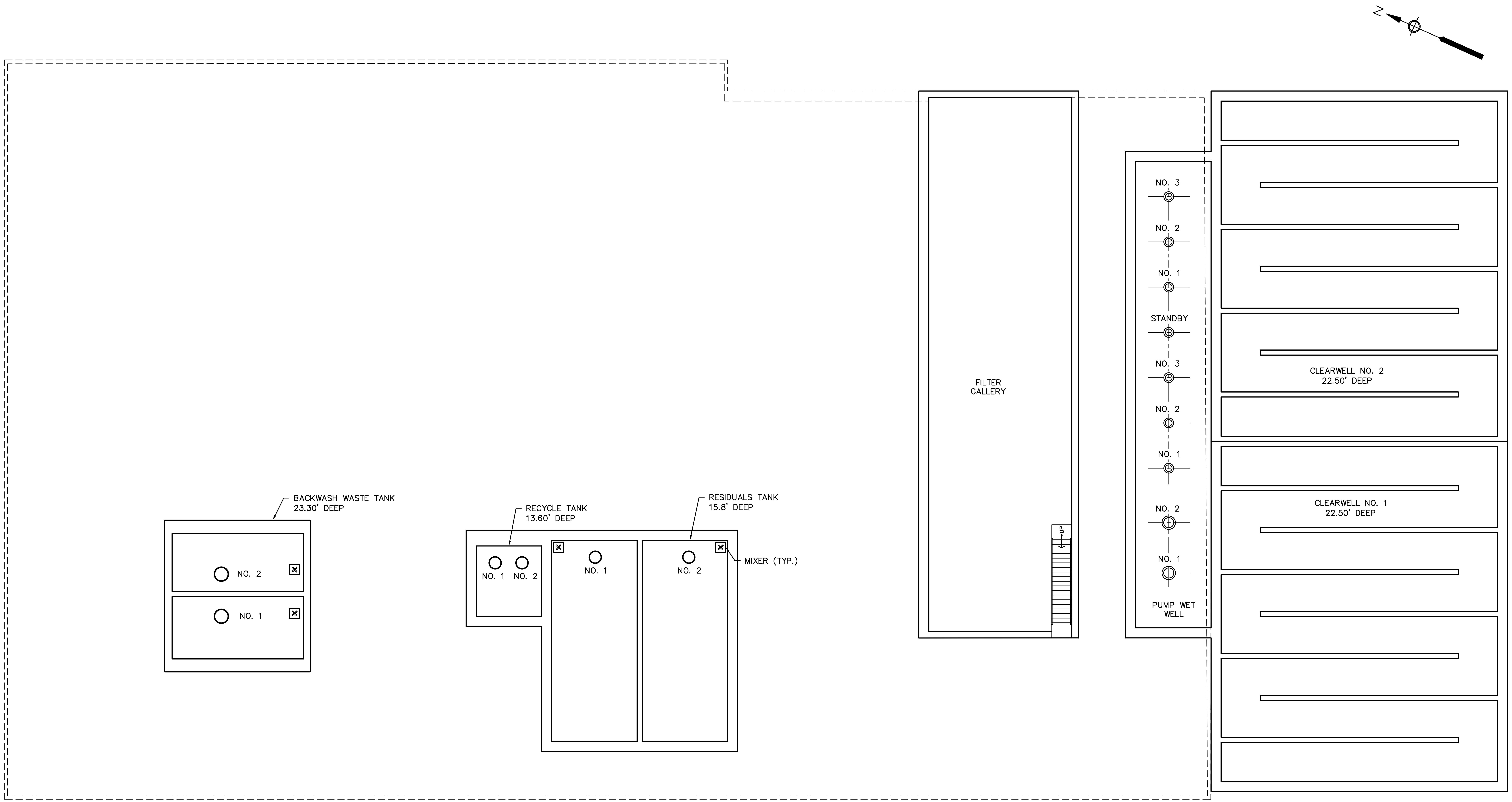
TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

GROUND LEVEL PLAN

NOT FOR CONSTRUCTION

Sheet No.

M-1



BELOW GRADE TANK PLAN

SCALE: 3/32"=1'-0"

Environmental Partners GROUP

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MARK	DATE	DESCRIPTION

Scale	AS SHOWN
Date	APRIL 2019
Job No.	181-1801
Designed by	AJL
Drawn by	AJL
Checked by	AJR
Approved by	DNRP

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

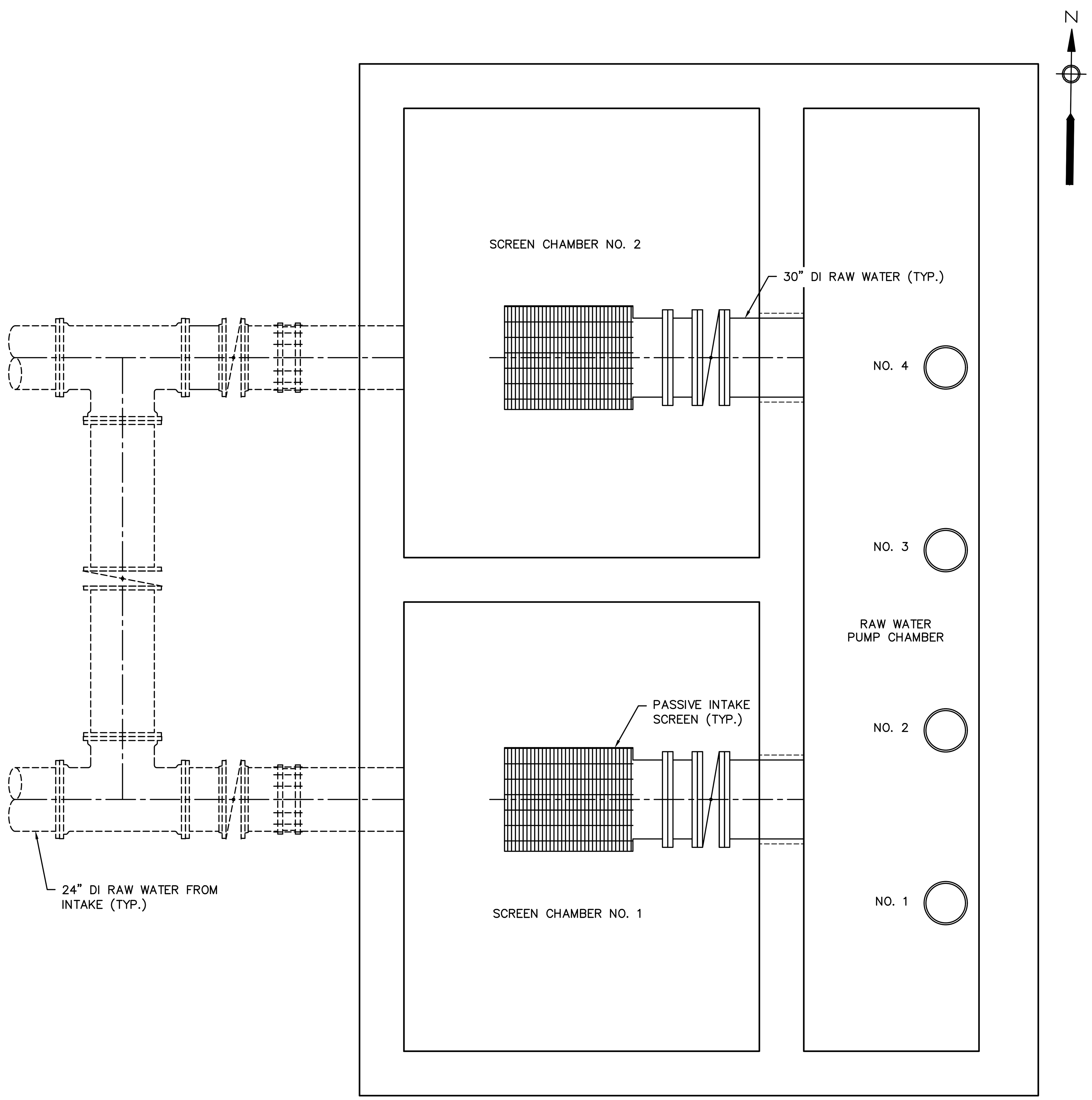
TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

BELOW GRADE TANK PLAN

NOT FOR CONSTRUCTION

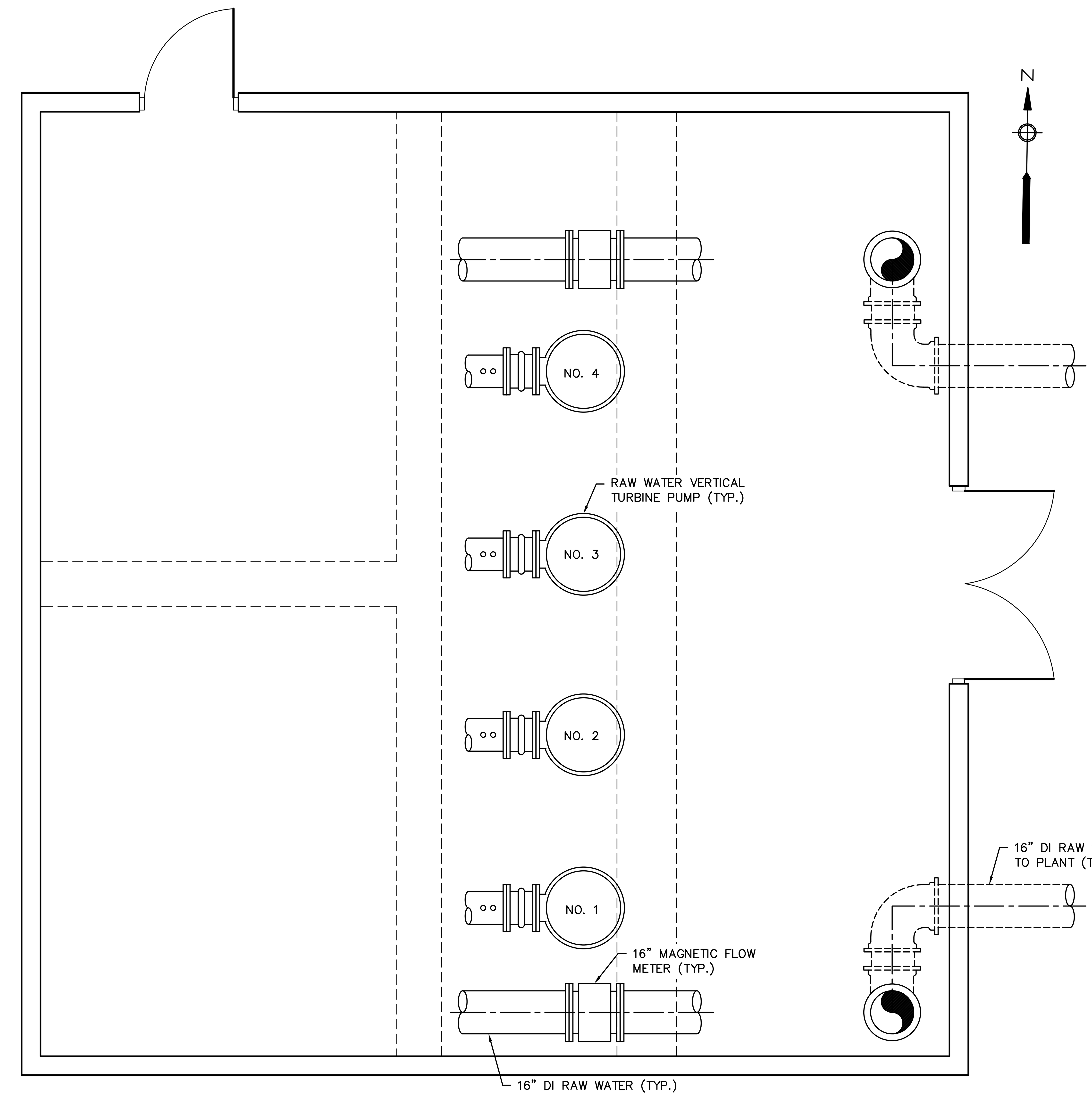
Sheet No.

M-2



RAW WATER PUMP STATION BELOW GRADE FLOOR PLAN

SCALE: 3/8"□1-0"



RAW WATER PUMP STATION GROUND FLOOR PLAN

SCALE: 3/8"□1-0"

Environmental Partners GROUP
A partnership for engineering solutions.

MARK	DATE	DESCRIPTION

Scale	AS SHOWN
Date	APRIL 2019
Job No.	181-1801
Designed by	AJL
Drawn by	AJL
Checked by	AJR
Approved by	DNRP

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

RAW WATER PUMP STATION

NOT FOR CONSTRUCTION

Sheet No.

M-3

Appendix H – Boring Logs

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-1

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Walter Hoeckele
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/15/2008 **End:** 8/18/2008

Surface Elevation (ft.): 143
Total Depth (ft.): 31
Depth to Initial Water Level (ft):
Depth Date Time
Abandonment Method: Backfill with Cutting
Logged By: M. Cronin

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
143.0 / 0	SS	S-1	24	2 4 5 18	6			TOPSOIL	Dry, loose, brown, SILT, little medium to fine sand	
138.0 / 5	SS	S-2	5	100/5"	5			GLACIAL TILL	Dry, very dense, light brown, SILT, little fine sand Boulder Encountered, 4.5'-5.5'	
133.0 / 10	SS	S-3	9	48 100/3"	8				Wet, very dense, brown SILT, little coarse to fine sand, little fine gravel	
									Boulder Encountered, 12'-13'	
128.0 / 15	SS	S-4	10	108 100/4"	3				Wet, very dense, brown, SILT, little coarse to fine sand, trace fine gravel	
123.0	SS	S-5	8	104 100/2"	5				Wet, very dense, brown, SILT, little coarse to fine sand, trace fine gravel	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):			
V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):			
V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-1**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-1

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
123.0 / 20	SS	S-5	8		5			GLACIAL TILL		
118.0 / 25	SS	S-6	7	144 100/1"	6				Wet, very dense, brown, SILT, little coarse to fine sand, trace fine gravel Boulder Encountered, 24.5'-25.5'	
113.0 / 30	SS	S-7	5	150/5"	0				No Recovery - Rock in Spoon	
									B.O.E. = 31'	
108.0 / 35										
103.0 / 40										
98.0 / 45										

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-2

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Walter Hoeckele
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location: See Boring Plan
N: E:
Drilling Date: Start: 8/18/2008 **End:** 8/18/2008

Surface Elevation (ft.): 147
Total Depth (ft.): 36
Depth to Initial Water Level (ft):
Depth Date Time
Abandonment Method: Backfill with Cutting
Logged By: M. Cornin

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
147.0 / 0	SS	S-1	24	19 22 20 19	2			TOPSOIL	Dry, dense, brown, medium to fine SAND, trace silt	
142.0 / 5	SS	S-2	11	78 100/5	8			GLACIAL TILL	Moist, hard, brown, SILT, some coarse to fine sand, trace fine gravel	
137.0 / 10										
132.0 / 15	SS	S-3	4	100"/4	4				Wet, very dense, brown, coarse to fine SAND, some coarse to fine gravel, little silt Boulder Encountered,15'-17'	
127.0										

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):			
V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):			
V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-2**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-2

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
127.0 / 20									Boulder Encountered, 20'-21'	
122.0 / 25	SS	S-4	7	130 100/1"	4			GLACIAL TILL	Wet, very dense, brown, coarse to fine SAND, some fine gravel, trace silt Boulder Encountered, 25'-26'	
117.0 / 30										
112.0 / 35	SS	S-5	7	160 100/1"	7				Wet, very dense, gray-brown SILT, little coarse to fine sand, trace fine gravel	
									B.O.E. = 36'	
107.0 / 40										
102.0 / 45										

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-5

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Walter Hoeckele
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/19/2008 **End:** 8/19/2008

Surface Elevation (ft.): 142
Total Depth (ft.): 27
Depth to Initial Water Level (ft):
Depth **Date** **Time**

Abandonment Method: Backfill with Cutting
Logged By: J. Morency

Elev. / Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
142.0 / 0	SS	S-1	24	5 10 8 6	14			TOPSOIL	Dry, medium dense, dark brown, SAND, some silt, little organic roots	
137.0 / 5	SS	S-2	24	35 63 65 93	17			GLACIAL TILL	Wet, very dense, light brown, coarse to fine SAND and SILT, little medium to fine gravel	
132.0 / 10	SS	S-3	5	100/5"	4			GLACIAL TILL	Wet, very dense, light brown, coarse to fine SAND and SILT, little medium to fine gravel Boulder Encontered, 9.5'-11'	
127.0 / 15	SS	S-4	5	100/5"	5			GLACIAL TILL	Wet, very dense, light brown, coarse to fine SAND and SILT, little medium to fine gravel	
122.0	SS	S-5	24	62 83	17			GLACIAL TILL	Wet, very dense, light brown, coarse to fine SAND and SILT, little fine gravel	

Sample Types

AS - Auger/Grab Sample	HP - Hydro Punch
CS - California Sampler	SS - Split Spoon
BQ - 1.5" Rock Core	ST - Shelby Tube
NQ - 2" Rock Core	WS - Wash Sample
	GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-5**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-5

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
122.0 / 20	SS	S-5	24	66 51	17			GLACIAL TILL		
117.0 / 25	SS	S-6	5	100/5"	0				No Recovery - Rock in Spoon	
	SS	S-7	5	100/6"	5				Wet, very dense, light brown, coarse to fine SAND, some silt, trace fine gravel Boulder Encountered at 27'	
									B.O.E. = 27'	
112.0 / 30										
107.0 / 35										
102.0 / 40										
97.0 / 45										

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-6

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Walter Hoeckele
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/14/2008 **End:** 8/15/2008

Surface Elevation (ft.): 147
Total Depth (ft.): 35
Depth to Initial Water Level (ft):
Depth Date Time
Abandonment Method: Backfill with Cutting
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
147.0 0	SS	S-1	24	7 12 7 14	24			TOPSOIL	Moist, medium dense, brown, coarse to fine SAND, some silt, little medium to fine gravel	
142.0 5	SS	S-2	24	86 55 53 63	24			GLACIAL TILL	Wet, hard, brown, SILT, some coarse to fine sand, little medium to fine gravel	
137.0 10	SS	S-3	9	74 100/3"	6				Wet, hard, brown, SILT and medium to fine GRAVEL, some coarse to fine sand	
	Core	C-1	8		8				Boulder Encountered, 11-11.8'	
132.0 15	SS	S-4	12	80 12/6"	3				Wet, brown, hard, SILT and medium to fine GRAVEL, some coarse to fine sand	
127.0	SS	S-5	10	32 100/4"	10				Wet, hard, brown, SILT and coarse to fine SAND, little medium to fine gravel	

Sample Types
AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):			
V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):			
V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-6**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-6

Client: Tri-Town Water Board

Project Location: Braintree, MA

Project Name: Tri-Town WTP

Project Number: 01920-65292

Elev. / Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
127.0 / 20								GLACIAL TILL		
	SS	S-6	9	95 100/3"	9				Wet, very dense, brown, fine to medium SAND, little silt	
122.0 / 25										
	SS	S-7	6	120/6"	6				Wet, very dense, brown fine SAND and SILT	
117.0 / 30										
	SS	S-8	9	135 103/3"	9				Wet, very dense, brown, SILT, some coarse to fine gravel, little coarse to fine sand	
112.0 / 35									B.O.E. = 36'	
107.0 / 40										
102.0 / 45										

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-7

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Walter Hoeckele
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/13/2008 **End:** 8/14/2008

Surface Elevation (ft.): 144
Total Depth (ft.): 25
Depth to Initial Water Level (ft):
Depth Date Time
Abandonment Method: Backfill with Cutting
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
144.0 / 0	SS	S-1	24	2 6 4 2	12			TOPSOIL	Moist, loose, dark brown, silty peat	
139.0 / 5	SS	S-2	4	100/4"	4			GLACIAL TILL	Wet, hard, brown, SILT and medium to fine GRAVEL, some coarse to fine sand	
	SS	S-3	10	61 100/4"	8			GLACIAL TILL	Wet, hard, brown, SILT, little fine sand	
134.0 / 10										
129.0 / 15	SS	S-4	4	100/4"	3			GLACIAL TILL	Wet, hard, brown, SILT and medium to fine GRAVEL, some coarse to fine sand	
	SS	S-5	10	51 100/4"	10			GLACIAL TILL	Wet, hard, brown, SILT, some coarse to fine sand, trace fine gravel	
124.0										

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):			
V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):			
V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-7**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-7

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Elev. / Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
124.0 / 20								GLACIAL TILL		
	Core	C-1	7		7				Boulder Encountered, 21'-21.6'	
	SS	S-6	9	75 100/3"	9				Wet, hard, brown, SILT and coarse to fine SAND, little fine gravel	
119.0 / 25									B.O.E. = 25'	
114.0 / 30										
109.0 / 35										
104.0 / 40										
99.0 / 45										

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-9

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Don Pamer
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/13/2008 **End:** 8/13/2008

Surface Elevation (ft.): 145
Total Depth (ft.): 19
Depth to Initial Water Level (ft):
Depth Date Time

Abandonment Method: Backfill with Cutting
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
145.0 / 0	SS	S-1	24	6 10 16 29	12			TOPSOIL	Moist, dark brown, medium dense, medium to fine SAND, some silt, little coarse to fine gravel.	
	SS	S-2	24	60 44 46 45	8			GLACIAL TILL	Moist, dark brown, very dense, coarse to fine GRAVEL, some medium to fine sand, little silt.	
140.0 / 5										
	SS	S-3	5	100/5"	0				No Recovery - Rock in Spoon	
135.0 / 10	SS	S-4	24	28 34 70 67	17				Wet, brown, very dense, medium to fine GRAVEL, little silt, little medium to fine sand. Wet, brown, hard, SILT, little medium to fine sand.	
130.0 / 15	SS	S-5	12	102 103	6				Wet, brown, very dense, coarse to fine SAND, some silt, little fine gravel.	
	SS	S-6	12	73 115	12				Wet, brown, very dense, coarse to fine SAND, some silt, trace fine gravel.	
125.0									B.O.E. = 19'	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

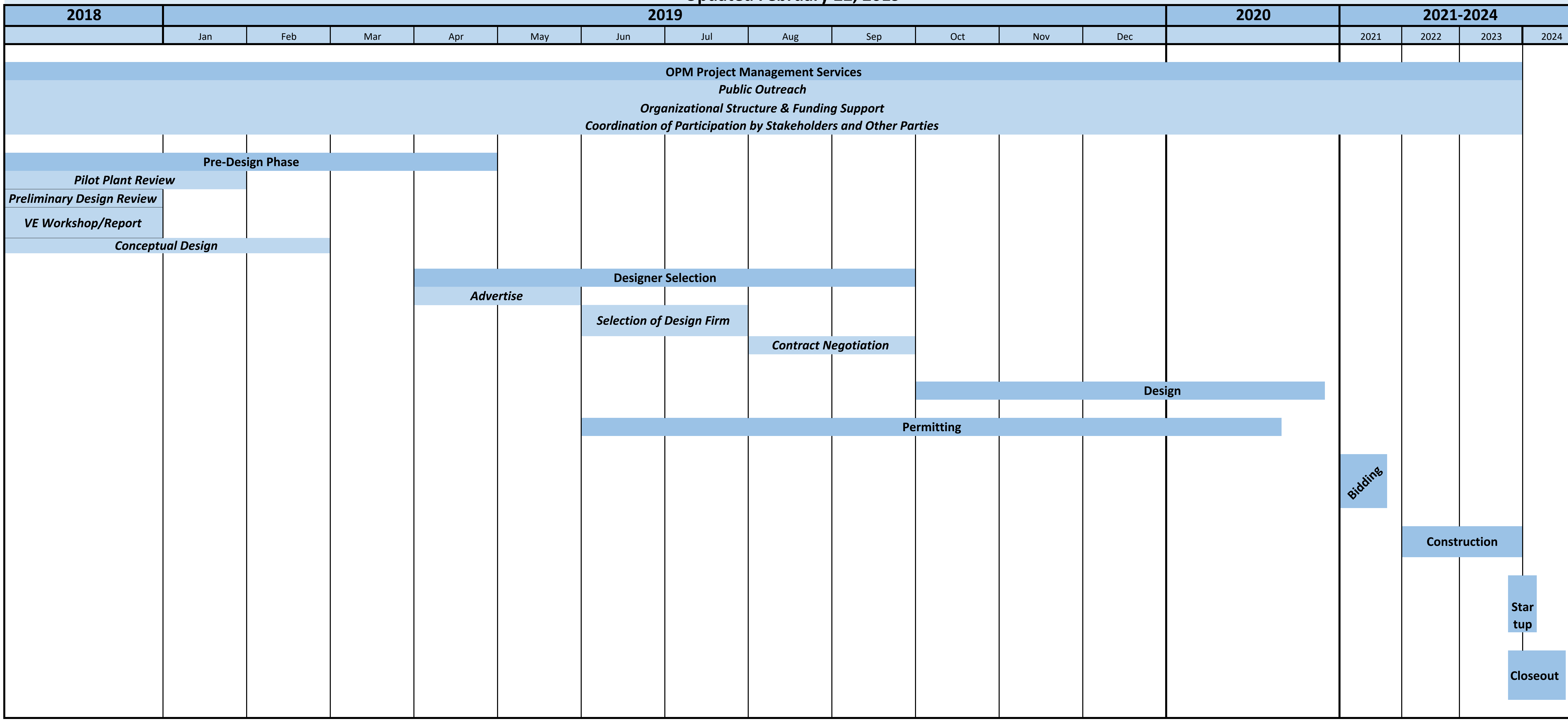
Reviewed by: **Date:** **Boring Number: CDM-9**

Appendix I – Archeological Site Map

Appendix J – Project Schedule

Tri-Town Great Pond Regional Water Treatment Plant - Project Schedule

Updated February 22, 2019



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A partnership for engineering solutions

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Celebrating
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ATTACHMENT "D" - GREAT POND PILOT PLANT STUDY 2004

FINAL REPORT

Great Pond Reservoir
Pilot Study Report

Prepared for:
Town of Braintree, Massachusetts

April 2004

Stephen C. Olson, P.E.
Sr. Project Manager

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Hingham, MA www.envpartners.com

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EXECUTIVE SUMMARY

The results of a Comprehensive Performance Evaluation of Braintree's existing Great Pond Water Treatment Plant completed in the fall of 2002 by Environmental Partners Group, Inc. indicated that it was more effective and economical to replace the existing facilities with a new water treatment plant, rather than attempt to repair/upgrade the existing facilities, given the extent and magnitude of the repairs and modifications necessary to adequately address all of the deficiencies and performance limiting factors identified. As a result, in January 2003 Environmental Partners Group, Inc. (Environmental Partners) was retained by the Town of Braintree to complete a pilot scale water treatability study and investigate treatment options for the future design and construction of a new drinking water treatment facility.

The scope of the pilot study was to evaluate two alternative high rate solids separation processes and three filtration processes for the production of high quality drinking water meeting the requirements of the Enhanced Surface Water Treatment Rule (ESWTR) and Disinfectants/Disinfection By-Product Rule as summarized in the following table.

Table E.1
Water Quality Goals

Location	Parameter	Goal
Clarified Water	Turbidity	< 0.5 NTU
Clarified Water	Color	< 5 C.U.
Filtered Water	Turbidity	< 0.1 NTU
Filtered Water	TOC Removal	> 35% when raw water TOC ≤ 4 mg/L > 45% when raw water TOC > 4 mg/L
Filtered Water	Iron	< 0.1 mg/L
Filtered Water	Manganese	< 0.03 mg/L

Based on a detailed assessment of the quality of Braintree's source water, the Great Pond reservoir system, it was determined that the new treatment facilities must be capable of meeting the following treatment requirements:

- The removal of source water iron and manganese to levels consistently below Secondary Standards.
- The removal of objectionable tastes and odors which can occur seasonally in the source water.
- The efficient removal of low density particulates (algae, and floc formed from the coagulation of low turbidity waters containing NOM), and the capability to

effectively treat source water turbidity spikes upwards of 20 NTU (compliance with the Interim Enhanced Surface Water Treatment Rule (IESWTR).

- The removal of NOM (color, TOC, and disinfection by-product precursors materials) to minimize the production of distribution system DBPs (compliance with the Disinfection/Disinfection By-Product Rule).
- Adequate disinfection for compliance with the CT requirements of the Surface Water Treatment Rule and IESWTR.
- Corrosion control for compliance with the Lead and Copper Rule.

A summary of treatment objectives and techniques which proved to be effective during the pilot study are presented below:

Iron and Manganese Oxidation

The most effective treatment method for the oxidation and removal of iron and manganese identified in the pilot study consisted of the addition of potassium permanganate prior to the coagulant. The oxidant was added at a dose of 1.5 times the theoretical stoichiometric requirement for combined iron and manganese oxidation and allowed a minimum of 5 minutes retention time. The adjustment of the treated water to a pH level greater than pH 7.0 using liquid potassium hydroxide was required for adequate oxidation during the cold water season.

Taste and Odor Control

All of the mechanisms evaluated for taste and odor control were proven to be effective: ozonation, permanganate oxidation, and carbon adsorption. In addition, there was no observable difference between the taste and odor control performance between the two oxidants: potassium permanganate and ozone. However, because of the presence of brominated trihalomethane species, and the relative differences in operation and maintenance complexity, safety, and costs, the use of potassium permanganate combined with granular activated carbon (GAC) filter adsorption is favored.

Coagulation/Flocculation/Clarification

The processes of coagulation/flocculation/clarification in this study were evaluated based on the removal of dissolved NOM and particulates. NOM removal was assessed based on treated water color, UV-254, and TOC data. Particulate removal was assessed based on clarifier turbidity and particle counts. The most effective process proved to be the dissolved air flotation using a polyaluminum chloride coagulant (PCH-180) at a dose between 65 mg/L and 75 mg/L (product dose). The use of a cationic polymer coagulant aid was required to achieve clarified water turbidities less than 0.5 NTU during the winter season.

Filtration

Two filter medias were investigated: GAC and mixed media (anthracite, filter sand, garnet). The filter performance with respect to turbidity removal was similar for both filter medias. The granular activated carbon (GAC) media filter demonstrated a higher capability of removing natural organic matter (NOM), but shorter filter run times. Although the GAC filter runs were shorter than the mixed media filter runs on average, the net water yield, using DAF clarification, still exceeded 96% at an average loading rate of 4 gpm/sf. A secondary benefit of GAC filters is the effective removal of taste and odor causing compounds.

Additional Treatment Issues

Additional treatment concerns that were not specifically piloted as part of this study, but which are incorporated into the conclusions and recommendations for a new treatment facility are summarized below:

1. Bulk source water screening.
2. Primary and secondary disinfection for compliance with the Interim Enhanced Surface Water Treatment Rule and Total Coliform Rule.
3. Corrosion control for compliance with the Lead and Copper Rule.
4. Residuals management techniques.

The raw water used during the pilot study was pre-treated by the existing intake facilities which consists of two parallel 48-inch RC pipes extending 135 feet into Lower Pond with inverts set at an elevation of 115.5 feet (USGS). Water from these two intake pipes travels into the intake building through aluminum bar racks where in enters a vault and is then screened through well screens (5'8" tall, 24" diameter). A 24-inch pipe connects the intake structure to the raw water pumps. This type of intake facility is common as it has proven to be effective for surface water treatment facilities. A detailed description and assessment of Braintree's existing intake facilities can be found in the Comprehensive Performance Evaluation engineering report prepared by Environmental Partners in September 2003. It is recommended that similar facilities, including the potential re-use of Braintree's existing facilities, be employed for physical pretreatment.

Given the effective disinfection practices demonstrated at Braintree's existing WTP, the use of free chlorine for both primary and secondary disinfection is recommended. The proposed treatment facilities are expected to result in enhanced treatment compared with the existing finished water quality (with respect to DBP precursor materials). Therefore, since the Great Pond WTP's disinfection practices currently enable the Braintree water system to meet the requirements of the IESWTR, D/DBP Rule, and TCR, it is recommended that the existing disinfection approach also be used for the proposed facility.

The Town's compliance with the Lead and Copper Rule is well documented in a number of engineering studies including the Great Pond WTP Comprehensive Performance Evaluation engineering report prepared by Environmental Partners in September 2003 and a supplemental evaluation prepared by Environmental Partners in January 2004. The supplemental corrosion control evaluation is provided in Appendix L. For the purposes of this pilot study, it is recommended that the new treatment plant include chemical storage, handling, and feed facilities for the use of 75% technical grade phosphoric acid as a corrosion inhibitor and potassium hydroxide for pH adjustment.

Although methods of residuals dewatering and handling were not evaluated as part of this pilot study, there are several acceptable technologies successfully used in Massachusetts and New England. The existing Great Pond WTP currently uses lagoons for residuals handling. Drinking water treatment plant residuals in Massachusetts are currently considered a "special waste" under the solid waste regulations (310 CMR 19, 310 CMR 30, and 310 CMR 32). As such, there are a number of alternative materials handling and disposal options. A detailed review of residuals management options for Braintree's existing Great Pond WTP are found in the Great Pond WTP Comprehensive Performance Evaluation engineering report prepared by Environmental Partners in September 2003. The Town is currently completing a permit application for the beneficial use of treatment residuals (sludge) at Massachusetts landfills. The use of dewatering lagoons for residuals management are recommended to be employed at the proposed treatment plant in Braintree.

Estimated Costs of New Facilities

Based on the recommended treatment processes of the pilot study, a conceptual design for a new 6 MGD WTP located adjacent to the existing treatment facility was prepared. In addition, cost estimates for the proposed 6.0 MGD WTP and additional facilities including a new Water & Sewer Department maintenance garage were prepared. A summary of the estimated capital and operation & maintenance costs for these facilities is presented in the following table.

Table E.2
Braintree WTP Cost Estimates

Capital Costs (6 MGD DAF WTP)	
Description	Cost
Equipment	$3,400,000.00
Equipment Installation	$1,300,000.00
Process Mechanical Piping	$1,410,000.00
SCADA Instrumentation and Control	$500,000.00
Electrical	$250,000.00
Treatment Building	$1,200,000.00
Site Work	$350,000.00
Utilities	$900,000.00
Demolition	$900,000.00
Garage	$800,000.00
Subtotal	**$11,010,000.00**
Engineering (20%)	$2,202,000.00
Contingency (20%)	$2,202,000.00
Total	**$15,414,000.00**
Annual O&M Costs (Average Annual Demand of 3.3 MGD)	
Description	Cost
Labor	$270,000
Energy	$150,000
Chemicals	$195,000
Maintenance (equipment & materials)	$50,000
Residuals (removal and disposal)	$25,000
Telemetry/Communications	$5,000
Laboratory Testing	$10,000
Emergency Fuel	$3,000
Total	**$708,000.00**

In addition to a new WTP for the Town Braintree, the potential for a new regional WTP for the Tri-Town communities of Braintree, Randolph, and Holbrook was evaluated. These three communities currently share the same water source, the Great Pond Reservoir system. Based on the nature of the recommended treatment approach and equipment for the Braintree WTP, the facility could easily be expanded to a greater capacity that is sufficient to supply water to the three communities. Preliminary estimations indicate the potential need for a 12.75 MGD Tri-Town WTP. A summary of the estimated capital and operation & maintenance costs for a Tri-Town water treatment facility is presented in the following table.

Table E.3
Tri-Town WTP Cost Estimates

Capital Costs (12.75 MGD DAF WTP)	
Description	Cost
Equipment Cost	$4,900,000.00
Equipment Installation	$2,400,000.00
Process Mechanical Piping	$2,200,000.00
SCADA Instrumentation and Control	$600,000.00
Electrical	$400,000.00
Treatment Building	$1,600,000.00
Site Work	$450,000.00
Utilities	$1,200,000.00
Demolition	$900,000.00
Garage	$800,000.00
Transmission Piping	$1,000,000.00
Subtotal	**$16,450,000.00**
Engineering (20%)	$3,290,000.00
Contingency (20%)	$3,290,000.00
Total	**$23,030,000.00**
Annual O&M Costs (Average Annual Demand of 6.8 MGD)	
Description	Cost
Labor	$340,000
Energy	$250,000
Chemicals	$400,000
Maintenance (equipment & materials)	$60,000
Residuals (removal and disposal)	$40,000
Telemetry/Communications	$7,000
Laboratory Testing	$12,000
Emergency Fuel	$5,000
Total	**$1,114,000.00**

In the current cost sharing arrangement between the three Tri-Town communities, the Town of Braintree pays for approximately 48% of all capital and operating expenses of the Tri-Town water system. If it is assumed that this same cost sharing model would be used for the capital and O&M costs for the proposed regional WTP presented in Table E.3 then the capital costs allocated to Braintree would be approximately $11,050,000, and the estimated annual O&M costs allocated to Braintree would be approximately $535,000/yr. A comparison of these allocated costs for a regional WTP with the costs presented in Table E.2 for a Braintree WTP suggests a potential cost savings of approximately 28% in capital costs ($4.4

million) and approximately 24% in annual O&M costs ($173,000/yr), if the regional WTP were to be implemented.

It is critical to note that the cost sharing model and potential implementation of a regional water treatment facility have been over simplified in this report. The feasibility and detailed requirements for implementing a regional water treatment facility for the communities of Braintree, Randolph, and Holbrook is beyond the scope of this report. A summary of key questions and issues that must be addressed in order to effectively and efficiently move forward with this alternative is presented below:

1. The identification and description of regionalization alternatives.
2. The identification and development of cost sharing alternatives.
3. The identification of infrastructure requirements (each community).
4. An assessment of the legal jurisdiction and authority of each community and Board.
5. The make up and authority of the existing or new proposed Water Board.
6. The identification and evaluation of administrative and management control and policies.
7. The identification and evaluation of staffing, operation, and maintenance alternatives.
8. The evaluation and development of a financial and billing structure.

1. INT ODUCTION

1.1 Background and Purpose

The Town of Braintree, Massachusetts has a current population of approximately 34,000 and is bordered by the communities of Quincy to the north and northwest; Weymouth to the east; Holbrook to the south; and Randolph to the west. The current average daily water demand for the Town of Braintree is approximately 3.3 MGD.

A Comprehensive Performance Evaluation (CPE) of the Great Pond WTP was conducted in the Fall of 2002, which consisted of:

- The collection and review of existing available design, construction, operation, maintenance, and water quality information.
- Physical inspections of building system components including: electrical, architectural, structural, and HVAC.
- Physical inspections of process equipment and facilities including: raw water pumping and screening; chemical storage, handling, and addition facilities; rapid mixing; coagulation/flocculation; sedimentation; filtration; disinfection; corrosion control; finished water pumping; residuals handling; metering; and instrumentation and controls.
- Evaluation of major treatment unit processes to identify peak operating flows and process effectiveness, including: chemical mixing; coagulation/flocculation; sedimentation; filtration; disinfection; corrosion control; and residuals handling.
- Various bench scale and full-scale performance tests including: bench scale jar tests; tracer studies; filter loading tests; and plant hydraulic profiling.
- The identification and prioritization of performance limiting factors.
- The development of recommended improvements and construction cost estimates including a strategic implementation plan for the recommended improvements.

The results of the CPE indicated that it was more effective and economical to replace the existing facilities with a new treatment plant, given the extent and magnitude of the repairs and modifications necessary to address the Great Pond WTP deficiencies and performance limiting factors. Therefore, in January 2003 Environmental Partners Group was retained by the Town of Braintree to complete a pilot scale water treatability study and investigate treatment options for the future design and construction of a new drinking water treatment facility.

The purpose and intent of this report is to present the findings and recommendations of the Great Pond Pilot Study and meet the requirements of DEP's Policy #90-04 "Pilot Study Requirements for Proposed Treatment".

1.2 Scope of Work

The pilot scale study scope of work was approved by DEP in a letter dated February 12, 2003. The project investigated alternative clarification and filtration technologies including dissolved air flotation, contact clarification, direct pressure filtration, mixed media filtration, and filtration using granular activated carbon (GAC). The pilot study was completed for two seasons. The cold water season (winter) was performed when water temperatures were 6°C or less, between February 28, 2003 and March 24, 2003. The warm water season (summer) was performed between July 9, 2003 and July 24, 2003.

The scope of the pilot study was to evaluate two alternative high rate solids separation processes and three filtration processes for the production of high quality drinking water meeting the requirements of the Enhanced Surface Water Treatment Rule (ESWTR) and Disinfectants/Disinfection By-Product Rule. The objectives of the pilot test were to:

- Assess the role of coagulation (coagulant, dose, and pH) on the removal of NOM, solids separation performance, and finished water quality (pH, alkalinity).
- Assess the effects of oxidation (oxidant, dose, contact time, and pH) on the removal of source water iron and manganese and examine the secondary affects on NOM removal, solids separation performance, and the control of tastes and odors.
- Assess the effectiveness of each clarification process for solids separation performance.
- Assess the effectiveness of each filtration media on solids separation performance.
- Identify process operating parameters for the design of a full scale water treatment facility and development of detailed cost estimates, including: chemical dosages, mixing, and contact times; plant and process hydraulics; process sizing and loading rates; filtration media depths and materials; process cleaning cycles; and, residuals management.

2. SU FACE WATE SUPPL

Great Pond has been used by the Town of Braintree as a water supply source for over 100 years. As a result, there is an abundance of useful available water quality information to characterize the source water. This section of the report will present and discuss source water quality information relevant to the pilot study.

2.1 Water Quality Characterization

Water quality sampling is routinely conducted on a daily, weekly, monthly, and annual basis as part of Braintree's treatment and operations program and to meet DEP sampling requirements. A summary of recent existing available source water quality information for the period January 2001 through December 2002 is presented in Table 2.1 - Great Pond Water Quality Summary. In addition, daily, weekly, and monthly source water temperature, pH, alkalinity, turbidity, color, UV absorbance at a wavelength of 254 nm (UV-254), total organic carbon (TOC), iron, and manganese data for the period January 2001 through December 2002 is presented graphically in Appendix A.

Table 2.1
Great Pond Water Quality Summary

Parameter	Average	Maximum	Minimum
Temperature (°C)	15	29 (Aug)	2 (Dec)
pH (s.u.)	7.24	7.64	6.61
Alkalinity (mg/L $CaCO_3$)	22.3	34.0	13.0
Turbidity (NTU)	2.2	19.6	0.37
Apparent Color (cu)	20	60	8
UV-254 (abs @ 254 nm)	0.110	0.228	0.077
TOC (mg/L)	4.36	5.70	2.20
SUVA (m^{-1}/mg/L)	2.7	3.9	2.0
Iron (mg/L)	0.213	0.484	0.038
Manganese (mg/L)	0.114	0.286	0.024
HPC Bacteria (CFU/100 mL)	140	620	14
Total Coliform (#/100 mL)	76	860	5
Fecal Coliforms	Present	During summer months	

The following observations are made based on a review and evaluation of the existing raw water quality information.

- The water temperature is seasonally variable reaching less than 4°C in the winter and greater than 28°C in the summer.

- The pH and alkalinity of the source water is not typical of New England surface waters. The average raw water alkalinity is greater than 20 mg/L as $CaCO_3$ and the average pH of the surface water is in the mid 7's. The variability in pH and alkalinity does not appear to be seasonal or excessive. This combination of source water alkalinity and pH is conducive to a favorable buffer intensity (the ability of a water to resist changes in pH), which is helpful in maintaining stable distribution system pH levels.
- The source water turbidity information indicates that elevated turbidities greater than 5 NTU occur during the winter months while consistently low turbidities (less than or equal to 1 NTU) are present between the late spring and late fall. Elevated turbidity levels have occurred in the recent past due to an ongoing reservoir dredging project. From late fall to early spring the Upper Great Pond has been drained and excavated to remove peat and other materials to increase its storage volume. Episodes of turbidity spikes greater than 15 NTU have occurred when siltation barriers in Lower Great Pond were breached. The Town's engineers and contractor are evaluating methods to limit the introduction of silt into Lower Great Pond during the dredging program, which is expected to continue for several more years.
- The color, TOC, and UV-254 levels found in the source water are indicative of moderate levels of natural organic matter (NOM). An average SUVA of approximately 2.7 indicates that the majority of the NOM is composed of largely non-humic materials that are less aromatic, of lower molecular weight, and hydrophilic compared with humic materials. This type of NOM is usually more difficult to remove using coagulation alone, possibly making USEPA's TOC removal requirements difficult to achieve. Optimizing the removal of NOM is essential for controlling the formation of disinfection by-products (DBPs) for water systems using free chlorine for disinfection.
- The majority of the source water iron results were less than the Secondary Standard of 0.3 mg/L. However, iron levels greater than the Secondary Standard have been detected, especially during the winter of 2001. These elevated iron levels coincide with the Upper Reservoir dredging project. The presence of iron in the finished water can consume free available chlorine and contribute to aesthetically displeasing colored water.
- Manganese levels detected in the source water are consistently greater than the Secondary Standard of 0.05 mg/L. Similar to the iron results, manganese levels were reported to be especially high during the winter of 2001 during the dredging program. The presence of

manganese in the finished water above the Secondary Standard of 0.05 mg/L can consume free available chlorine and contribute to aesthetically displeasing colored water.

In addition to the water quality information presented and discussed above, there is a significant amount of water quality information not submitted as part of this report. For instance, although there is limited water quality data relative to algae, tastes, and odors, there is sufficient historic water quality information, operational records, and engineering studies to indicate the occurrence of seasonal algal blooms as well as episodes of objectionable tastes and odors. An engineering study completed in the early 1980's indicated that the Great Pond Reservoir system is susceptible to eutrophication, including algal blooms and the presence of nuisance aquatic vegetation due to elevated levels of phosphorus and nitrogen. A review of historic water quality sampling information and operating logs indicate the occurrence of seasonal algal blooms resulting in decreased water productivity due to increased filter washing and episodes of objectionable tastes and odors. One source water sample from September 1974 indicated the presence of *aphanizomenon* (8,850 per mL), which is a species of algae in the class Cyanophyceae, and which exhibits a grassy/musty odor. The following algal genera were detected in a sample collected on July 28, 2003: Synedra, Navicula, Cyclotella, Cryptomonas, and Chroccoccus. In addition, operating records dating back to the 1940's indicate distinct earthy/musty odors in the source water. Although there is no specific recent source water quality information regarding tastes and odors, it is clear that both have occurred and were an important consideration for the pilot study.

In 1996 the Town of Braintree completed supplemental sampling for *Giardia* and *Cryptosporidium* in both their raw water and finished water a the Great Pond WTP. The test method used was ASTM Method P229 in which 259 gallons of raw water and 650 gallons of finished water was collected, filtered, and tested for both *Giardia* Cysts and *Cryptosporidium* Oocysts. The sampling results indicated that neither protozoa was detected.

2.2 Water Quality and Treatment Requirements

This section describes the requirements of several drinking water quality regulations as they relate to the scope and objectives of the pilot study.

2.2.1 Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) was promulgated by the United States Environmental Protection Agency (USEPA) in 1989 to protect public drinking water from waterborne microbiological pollutants such as *Giardia* and viruses. Under the provisions of the SWTR, all public water systems using surface water supplies or groundwater supplies under the direct influence of surface water must provide disinfection. In addition, unless the water meets strict water quality criteria, filtration is required to physically remove waterborne microorganisms that are resistant to conventional disinfection practices (chlorination) and may be present in the water. For water systems in the Commonwealth of Massachusetts, detailed requirements of the SWTR are defined in 310 CMR 22.20A.

Approved filtration technologies include conventional filtration, direct filtration, diatomaceous earth filtration, slow sand filtration, and membrane filtration. Combined filtration and disinfection must achieve 99.9% (3-log) removal/inactivation of *Giardia* and 99.99% (4-log) removal/inactivation of viruses. Removal credits are achieved for several water treatment processes such as sedimentation (2.5-log), dissolved air flotation (2.5-log), and direct filtration (2-log). Under the rule, 95% of monthly filtered water turbidity samples must be less than 0.5 NTU, and the maximum allowable filtered water turbidity is 5 NTU. Inactivation credits are achieved based on the type, concentration, and dose of disinfectant, water temperature and pH, and the contact time between the disinfectant and the water.

2.2.2 Enhanced Surface Water Treatment Rule

Under the 1996 amendments to the Safe Drinking Water Act (SDWA), improvements to the SWTR were proposed by the USEPA in the form of an Enhanced Surface Water Treatment Rule (ESWTR). These changes address increased removal/inactivation requirements for poorer quality source waters and propose treatment requirements for the removal/inactivation of *Cryptosporidium*, which has been found to be highly resistant to standard disinfection practices. The ESWTR applies to water systems currently regulated by the SWTR.

Implementation of the ESWTR is currently proceeding based on USEPA’s promulgation and enactment of four major provisions:

1. The Interim Enhanced Surface Water Treatment Rule (IESWTR),
2. The Long Term 1 – Enhanced Surface Water Treatment Rule (LT1ESWTR),
3. The Long Term 2 – Enhanced Surface Water Treatment Rule (LT2ESWTR), and
4. The Filter Backwash Recycling Rule (FBRR).

2.2.2.1 The Interim Enhanced Sur ace Water Treatment ule (IESWT)

The IESWTR was promulgated in December 1998 and only applies to water systems serving a population greater than 10,000. The main purpose of the IESWTR is to provide increased protection against *Cryptosporidium* and to guard against increases in microbial risk that might otherwise occur when systems implement the Stage 1 Disinfectants/Disinfection By-Products Rule (D/DBPR). The IESWTR requires that all large systems (serving > 10,000) that are required to filter under the SWTR provide 2-log (99%) removal of *Cryptosporidium*. Physical removal of *Cryptosporidium* is required under the IESWTR due to the fact that *Cryptosporidium* is highly resistant to standard disinfectant practices. For water systems in the Commonwealth of Massachusetts, detailed requirements of the IESWTR are defined in 310 CMR 22.20D.

The IESWTR also provides more stringent turbidity standards and requires: individual filter monitoring; the establishment of a disinfection benchmark; and a requirement for covering new water storage reservoirs. Under the IESWTR the required 2-log *Cryptosporidium* removal is accomplished as long as the new turbidity standards are met. The rule also requires additional watershed control measures for systems with a filtration avoidance waiver. Large systems were required to be in compliance with the requirements of the IESWTR by December 2001. A summary of turbidity and filter monitoring requirements for conventional filtration is provided below:

- The average Combined Filter Effluent (CFE) Turbidity must be $\leq$ 0.3 NTU in 95% of monthly samples.
- The maximum CFE turbidity must be < 1.0 NTU.
- Individual turbidity monitors required for each filter.
- If the turbidity of an individual filter exceeds 0.5 NTU after 4 hours of operation following a backwash or being off-line in two consecutive measurements taken 15 minutes apart, then a filter turbidity profile must be completed within 7 days.
- If the turbidity of an individual filter exceeds 1.0 NTU in two consecutive measurements taken 15 minutes apart in three consecutive months, then a self assessment of the filter must be completed within 14 days.
- If the turbidity of an individual filter exceeds 2.0 NTU in two consecutive measurements taken 15 minutes apart in two consecutive months, then a Comprehensive Performance Evaluation must be completed.

2.2.2.2 The Long Term 1 Enhanced Sur ace Water Treatment ule (LT1ESWT)

The Long-term 1 ESWTR (LT1ESWTR) was promulgated by USEPA in April 2000 (Federal Register, April 10, 2000) to extend the provisions of the IESWTR to systems serving populations less than 10,000. The rule was finalized in January 2002 (Federal Register, January 14, 2002). Under the LT1ESWTR all of the provisions of the IESWTR are extended to small systems required to filter under the SWTR. Systems will have three years to come into compliance with the final rule and may request an additional two year extension if capital improvements are required. For water systems in the Commonwealth of Massachusetts, detailed requirements of the LT1ESWTR are defined in 310 CMR 22.20F.

2.2.2.3 The Long Term 2 Enhanced Sur ace Water Treatment ule (LT2ESWT)

The Long-term 2 ESWTR (LT2ESWTR) was proposed by USEPA in August 2003 (Federal Register, August 11, 2003) to reduce disease incidence associated with Cryptosporidium and other pathogenic microorganisms in drinking water and to supplement existing regulations by targeting additional Cryptosporidium treatment requirements to higher risk systems. This proposed regulation also contains provisions to mitigate risks from uncovered finished water storage facilities and to ensure that systems maintain microbial protection as they take steps to reduce the formation of disinfection byproducts. The LT2ESWTR will apply to all systems that use surface water or ground water under the direct influence of surface water. The LT2ESWTR will be implemented concurrently with Stage 2 D/DBP Rule in order that systems not jeopardize DBP levels as a result of meeting the requirements of LT2ESWTR.

Under the LT2ESWTR, systems currently regulated under the SWTR will be assigned into bins based on source water *Cryptosporidium* monitoring. Additional treatment requirements will then be required based on the bin assignment. Available treatment technologies for systems to utilize in order to comply with the rule, will be available from a “tool box”, which includes watershed controls, alternative sources, pretreatment, improved treatment, improved disinfection, and peer review performance testing. Large systems will be required to complete 2 years of *Cryptosporidium* monitoring, while small systems will be allowed to use *E. coli* as a surrogate to *Cryptosporidium* monitoring as long as *E. coli* concentrations are below an established level. *Cryptosporidium* removal requirements under the LT2ESWTR are summarized in Table 2.2.

Table 2.2
Cryptosporidium Removal Requirements

Source Water *Cryptosporidium* Level (Bin)	Log Removal Requirement	Additional Requirements
Cryptosporidium ≤ 0.075/L	No Action Required	None
0.075/L ≤ *Cryptosporidium* ≤ 1.0/L	1-log	Any technology from tool box
1.0/L ≤ *Cryptosporidium* ≤ 3.0/L	2-log	At least 1-log removal from ozone, ClO_2, UV, membranes, bag/cartridge filters
Cryptosporidium ≥ 3.0/L	2.5-log	At least 1-log removal from ozone, ClO_2, UV, membranes, bag/cartridge filters

2.2.3 Disinfectants/Disinfection By-Product Rule

Chemical reactions between natural organic matter (NOM) and the disinfectant chlorine can produce regulated organo-chlorine compounds called disinfection-by-products (DBPs). A group of four DBPs (chloroform, bromoform, bromodichloromethane and dibromochloromethane) referred to as total trihalomethanes (TTHMs), are regulated under the SDWA. The MCL for TTHMs under the SDWA of 1986 is 100 µg/L, based on a running annual average (RAA) of quarterly distribution system THM sampling results. This MCL for TTHMs applies only to community water systems serving a population of 10,000 or more and use a disinfectant in any part of their drinking water treatment process. Detailed requirements of the TTHM Rule are provided in 310 CMR 22.07.

A new Disinfectants/Disinfection-by-Product (D/DBPR) was promulgated by the USEPA in December 1998 (Federal Register December 16, 1998), and applies to all water systems that utilize a disinfectant. Under the Stage 1 D/DBPR the current TTHM MCL was lowered to 80 µg/L, and MCLs were established for a group of five haloacetic acids (HAA5: mono-chloroacetic acid, di-chloroacetic acid, tri-chloroacetic acid, mono-acetic acid, and di-acetic acid) 60 µg/L, bromate 100 µg/L, and chlorite 1 mg/L. Compliance is determined based on a RAA of samples taken quarterly, where the number of samples taken depends on system size (Large surface water systems - 4 samples per quarter per water treatment plant [WTP]; Groundwater systems serving more than 10,000 and surface water systems serving between 500 and 9,999 – one sample per quarter per WTP; Groundwater systems serving less than 10,000 and surface water systems serving fewer than 500 – one sample per year per WTP).

Maximum residual disinfectant levels (MRDLs) for chlorine, chloramines, and chlorine dioxide are also established at 4 mg/L as free chlorine, 4 mg/L as total chlorine, and 0.8 mg/L as ClO_2, respectively. In addition, the rule establishes DBP precursor removal requirements based on source and treated water quality characteristics unless strict water quality criteria are met (see Table 2.3). Large surface water systems (serving > 10,000) must have been in compliance with the new requirements by January 2002. Small surface water systems and ground water systems must be in compliance with the new regulation by January 2004. For water systems in the Commonwealth of Massachusetts, detailed requirements of the D/DBP Rule are defined in 310 CMR 22.07E.

Table 2.3
TOC Removal Requirements

Source Water TOC (mg/L)	Source Water Alkalinity (mg/L as $CaCO_3$)		
	0-60	>60 - 120	> 120
>2.0 – 4.0	35%	25%	15%
>4.0 – 8.0	45%	35%	25%
>8.0	50%	40%	30%

The Stage 2 Disinfectants/Disinfection-by-Product Rule (D/DBPR) was proposed by USEPA in August 2003 (Federal Register, August 18, 2003). The Stage 2 D/DBPR will apply to all water systems using a disinfectant and establishes more stringent TTHM and HAA5 standards. Through the FACA process, the new TTHM and HAA5 standards are proposed to be implemented in two phases:

Phase I Under Phase I, all systems are required to meet running annual averages (RAAs) of 80 µg/L for TTHMs and 60 µg/L for HAA5s and locational running annual averages (LRAA) of 120 µg/L for TTHMs and 100 µg/L for HAA5s. Systems must comply with the Phase I levels three years after the rule is promulgated, except that an additional two-year extension is available for systems requiring capital improvements.

Phase II Under Phase II, all systems are required to conduct an initial distribution system evaluation (IDSE), based on system size and source water type, to determine new DBP monitoring sites which represent maximum DBP formation sites, unless historic monitoring results indicate TTHM levels less than 40 µg/L and HAA5 levels less than 30 µg/L. In addition the LRAA levels for TTHMs and HAA5s are lowered to 80 µg/L and 60 µg/L, respectively. Compliance scheduling depends on system size: large and medium sized systems must be in compliance within 6 years of the final rule; small systems required to do *Cryptosporidium* monitoring under the ESWTR must be in compliance within 8.5 years of the final rule; and all other small systems must be in compliance within 7.5 years of the final rule; except that an additional two year extension is available for systems requiring capital improvements.

Compliance with the D/DBPR is a delicate balance between achieving compliance with the ESWTR and the Total Coliform Rule (see below), since all of the rules relate to the use and application of disinfectants. Although disinfection is required to ensure the protection against waterborne pathogens, the misuse of disinfectants can result in unallowable levels of disinfection by-products.

2.2.4 Total Coliform Rule

While the SWTR/ESWTR addresses source water microbiological pollutants, the Total Coliform Rule (TCR) addresses the protection against waterborne bacteria in drinking water distribution systems. Compliance with the TCR is based on distribution system sampling results and the detection of total Coliforms. Coliforms are a collective group of microorganisms that typically originate from the intestines of warm-blooded animals, but which may also occur naturally in the environment. Therefore, a subset of the total Coliform group (*E. coli* or fecal Coliforms) is used to identify fecal contamination.

Water systems must collect a minimum number of distribution system samples per month based on the population served. Compliance with the TCR is based on the presence or absence of total Coliforms. For water systems collecting less than 40 distribution system samples per month, no more than one sample per month can be positive for total Coliforms. For water systems collecting more than 40 distribution system samples per month, compliance with the TCR is achieved if no more than 5% of the samples are positive. Any positive Coliform sample must be re-sampled within 24-hours, and two additional samples taken (upstream and downstream of the site). A system is out of compliance if the results of repeat sampling are positive for fecal Coliforms or *E. coli*, in which case the water system must contact the DEP within 24-hours and perform public notification. Best available treatment techniques for compliance with the TCR include source water protection, filtration, primary disinfection, and secondary disinfection. Detailed requirements of the TCR are provided in 310 CMR 22.05.

2.2.5 Lead and Copper Rule

The Lead and Copper Rule (LCR) was promulgated by USEPA on June 6, 1991 based on the requirements of the 1986 Amendments to the SDWA. The objective of the LCR is to reduce consumer exposure to lead and copper resulting from the corrosion of drinking water piping and plumbing systems. Unlike other drinking water regulations that establish maximum contaminant levels (MCLs), the LCR requires various treatment techniques including: optimal corrosion control treatment; source water treatment; public education; and lead service line replacement, which are triggered by lead and copper action levels (AL's) measured at the consumer's tap. USEPA has set AL's at a 90th percentile concentration of 0.015 mg/L for lead and 1.3 mg/L for copper, respectively.

Water systems must sample tap water distribution system sites for lead and copper and for corrosion control water quality parameters based on service population. Sampling sites are selected based on an inventory of distribution system materials (lead services) and residential house age (homes built just prior to the USEPA lead ban, between 1982 and 1986). Systems that comply with the 90th percentile Action Levels are eligible for reduced monitoring. Systems exceeding the lead Action Level must install optimal corrosion control, replace lead service lines, and complete a lead public education program annually.

Under the 1996 amendments to the SDWA, USEPA provided several revisions to the LCR (Federal Register, January 12, 2000) including changes or additions in requirements for: the demonstration of optimal corrosion control, lead service line replacement, public education, monitoring, analytical methods, reporting and record keeping, and special primacy considerations. Detailed requirements of the LCR are provided in 310 CMR 22.06B.

3. PILOT TESTING P OG AM

3.1 General

Based upon the Pilot Test Proposal approved by DEP, the pilot study consisted of two seasons of testing, a cold water season and a warm water season. The cold water testing was conducted between February 28, 2003 and March 24, 2003 and the warm water testing was conducted between July 9, 2003 and July 24, 2003. DEP required the water temperature not to exceed 6° C to qualify as cold water testing and be greater than 20°C to qualify as warm water testing.

A total of 33 filter runs were conducted with different treatment technologies, two alternative high rate clarification processes (dissolved air flotation and contact clarification) and three alternative filtration methods (mixed media filtration, granular activated carbon (GAC) filtration, and direct pressure filtration). All of the treatment technologies except direct pressure filtration were piloted for both seasons. The direct pressure filtration process was not piloted during the warm water period due to the poor results obtained during the cold water study period.

A site layout diagram for the pilot facilities is presented in Figure 3-1. Manufacturer's representatives and Environmental Partners' staff shared in the operation of the pilot facilities. The services of F.B. Leopold Company were used for the dissolved air flotation pilot unit, the services of US Filter Corporation were used for the contact clarification pilot unit, and the services of Kinetico Incorporated were used for the direct pressure filtration pilot unit.

3.2 Pilot Plant Description

3.2.1 Dissolved Air Flotation

Dissolved air flotation is a high rate clarification process suitable for the treatment of low turbidity waters, naturally colored waters, and algal laden waters. Flotation as a clarification process involves the introduction of air at the head of the flotation tank and the attachment of particulates to the rising air bubbles. In drinking water applications, the most suitable flotation process is accurately described as pressurized recycle flow dissolved air flotation (hereupon referred to as DAF). In DAF a percentage of the treated flow is saturated with air under pressure and recycled back to the head of the flotation basin. The recycle stream is injected through either specially designed nozzles or needle valves resulting in the formation of bubbles with diameters between 10 µm and 120 µm (40 µm average). Successful particle-bubble attachments resulting in efficient flotation performance relies on properly destabilized particles controlled by coagulant dose, pH and raw water quality conditions. Therefore, coagulation and

Figure 3-1 Pilot Plant Site Layout

flocculation are essential pretreatment processes for the successful application of DAF. A process flow schematic of a typical DAF system is presented in Figure 3-2.

A detailed description of the DAF pilot testing equipment and operating procedures are included in a report prepared by the F.B. Leopold Company entitled, "Leopold DAF Pilot Plant Report." This report is provided in Appendix B. A schematic diagram of the DAF pilot unit is presented in Figure 3-3.

3.2.2 Contact Clarification

Contact clarification (CC) is a high rate solids separation process in which the processes of coagulation, flocculation, and clarification occur in one combined process. The process is generally suited for low turbidity waters containing moderate levels of color and NOM. The most popular drinking water application of contact clarification in the United States is the use of up-flow clarifiers followed by down flow mixed media filtration. The up-flow clarifier is designed to mix, flocculate, and clarify chemically treated water. The process flow is passed up through a coarse media that acts similar to a roughing filter. Destabilized floc and particulates are attached to the clarifier media and removed. The clarifier media is flushed on a regular basis using a combination of air and water, and the solids are removed to waste. A schematic flow diagram of a proprietary contact clarification system, known as the Trident system, is presented in Figure 3-4.

A detailed description of the contact clarification pilot testing equipment and operating procedures are included in two reports prepared by US Filter entitled, "Pilot Study Report – Trident Water Treatment System." Both of these reports are provided in Appendix C. A schematic diagram of the Trident pilot unit is presented in Figure 3-5.

3.2.3 Direct Pressure Filtration

A proprietary direct pressure filtration (DPF) system applicable for the treatment of high quality surface waters has recently been developed by Kinetico Inc. The technology utilizes spherical ceramic media (Macrolite) manufactured by 3M, with a mesh size of 70. The media is contained in pressure vessels and is operated in an up-flow filtration mode and down-flow cleaning mode. A process flow schematic of a typical Kinetico DPF system is presented in Figure 3-6.

The technology is suitable for low turbidity, low color surface water supplies, and can achieve USEPA Giardia lamblia cyst and Cryptosporidium oocyst removals without the use of chemical coagulants. A detailed description of the pilot testing equipment and operating procedures used for this study are contained in a pilot proposal prepared by Kinetico entitled, "Pilot Proposal 05560-A." This report and

Figure 3-2 Dissolved Air Flotation Process Flow Schematic

Figure 3-3 Dissolved Air Flotation Pilot Unit Schematic

Figure 3-4 Trident Contact Clarification Process Flow Schematic

Figure 3-5 Trident Contact Clarification Pilot Unit Schematic

Figure 3-6 Kinetico Direct Pressure Filtration Process Flow Schematic and a summary memorandum is provided in Appendix D. A schematic diagram of the Kinetico DPF pilot treatment unit is presented in Figure 3-7.

Both of the alternative clarification pilot systems were equipped with two types of filters: a mixed media filter (MMF) and a granular activated carbon (GAC) filter. Also, as previously stated, the DPF filter unit used ceramic media manufactured by 3M. Various technical specifications describing the pilot filter media are presented in Table 3.1.

Table 3.1
Pilot Filter Media

	Filter #1	Filter #2	Pressure Filter
Description	Mixed Media	GAC	Macrolite
Media Type	Anthracite	Calgon Filtrasorb 8x30	70/80 Mesh Ceramic
Media Depth	18”	48”	30”
Effective Size	1.0 – 1.1 mm	0.8 – 1.0 mm	0.18 - 0.2 mm
Uniformity Coefficient	< 1.7	2.1	1.15
Media Type	Filter Sand	Filter Sand	NA
Media Depth	9”	6”	NA
Effective Size	0.35 – 0.45 mm	0.35 – 0.45 mm	NA
Uniformity Coefficient	< 1.4	< 1.4	NA
Media Type	Garnet	NA	NA
Media Depth	3”	NA	NA
Effective Size	0.2 – 0.32 mm	NA	NA
Uniformity Coefficient	< 2.2	NA	NA

3.2.4 Chemical Treatment

A summary of the chemical treatment applications and dosages for each pilot filter run are provided in Appendix E. The selection of treatment chemicals for the pilot study was partially based on the results of bench scale jar testing completed in August 2002 and November 2002. The use of alternative coagulants for turbidity, UV-254, and TOC removal were investigated as part of the August 2002 warm water study. A detailed description of the August 2002 study is provided in Appendix F. In addition, alternative coagulants and the use of potassium permanganate for the oxidation of source water iron and manganese was investigated as part of the November 2002 cold water jar test study. Results for the November 2002 cold water jar test study are provided in Appendix G.

3.2. .1 Pre-oxidation

Pre-oxidation is used as a primary treatment or treatment aid for: NOM and color removal; taste and odor reduction; metal precipitation; and coagulation/flocculation enhancement. Two alternative oxidants were

Figure 3-7 Kinetico Direct Pressure Filtration Pilot Unit Schematic tested during this study, potassium permanganate and ozone. Oxidant dosages were applied based on an assessment of the theoretical stoichiometric requirements of the raw water. In addition, liquid potassium hydroxide (KOH) was added for pH adjustment to aid the oxidation process during the winter season. Due to several difficulties with the ozone generator, there were no definitive results of its efficiency for oxidation during the warm water period.

3.2. .2 Coagulation

There are two objectives of the coagulation process: the creation of destabilized particles to aid in the agglomeration of floc particles; and the adsorption of NOM onto the freshly precipitated metallic hydroxide floc. A polyaluminum chloride coagulant was used for coagulation in this pilot study. The product dose used for both piloting seasons varied between 60 mg/L and 75 mg/L (wet). The product used was Holland PCH-180, which has an approximate aluminum content of 5.5%, a density of 10.51 lb/gal, and a product strength of 33.3%. In the winter season, it was found that the use of a cationic polymer aided the coagulation/flocculation process and resulted in increased turbidity performance of the clarified water, especially during high raw water turbidity events.

3.3 Pilot Testing Procedures

Although the pilot clarifiers ran continuously for the entire duration of the study, the discreet time period used for assessing process variables during the pilot study is referred to as a “Filter Run”. Filter run times were determined based on the length of time required for a clean filter to achieve either terminal head loss (~8 feet) or filter effluent turbidity breakthrough (0.3 NTU). Each individual filter column was backwashed to define and assign a starting point for the beginning of each filter run.

Filter runs were monitored by field staff and on-line instrumentation for the collection of water quality and operational data. This information was used to evaluate: chemical type; chemical dosage; media performance; and overall process effectiveness and efficiency. The following online instrumentation was used to operate, monitor, and record treatment performance during automated operations: flow meters; flow rate controllers including chemical pacing; pressure transmitters; pH analyzers; turbidimeters; particle counters; and temperature probes. With the exception of the direct pressure filter system, all systems were operated for both the cold water and warm water seasons.

3.3.1 Pilot Unit Operations

A summary of typical operating parameters for each pilot unit are presented in Table 3.2. Detailed operating parameters for each individual filter run are provided in Appendix H.

Table 3.2
Typical Operating Parameters

	Dissolved Air Flotation	Contact Clarification	Direct Pressure Filtration
Schedule (cold)	2/28/03 – 3/14/03	3/14/03 – 3/21/03	2/28/03 – 3/13/03
Schedule (warm)	7/10/03 – 7/19/03	7/18/03 – 7/24/03	NA
Flocculation Period (Design)	10 min	6 min[1]	NA
Flocculation Period (Peak)	7.5 min	5 min[1]	NA
Clarifier Design Loading Rate	6 gpm/sf	10 gpm/sf	NA
Clarifier Peak Loading Rate	8 gpm/sf	12 gpm/sf	NA
Recycle Rate	11%	NA	NA
Saturation Pressure	80 psi	NA	NA
Filter Design Loading Rate	4 gpm/sf	4 gpm/sf	10 gpm/sf
Filter Peak Loading Rate	5 gpm/sf	5 gpm/sf	

[1]Detention time for upflow flocculation/clarification

3.3.2 Water Quality Tests

Routine water quality analyses (temperature, pH, alkalinity, turbidity, color, UV-254, iron, manganese, and aluminum) were completed by the pilot operations staff and Environmental Partners Group. The bench top laboratory instruments used to complete water quality testing included: a HACH ratio turbidimeter; HACH spectrophotometers (DR 2010 and HACH DR 4000); Fischer Scientific pH analyzer; and a HACH digital titrator. All bench top laboratory equipment was calibrated on a daily basis.

Supplemental water quality samples were sent to an independent laboratory certified in Massachusetts, GeoLabs (Braintree, MA). GeoLabs completed the following additional water quality tests: Total Organic Carbon (TOC), odor, volatile organic compounds (VOC), sanitary chemicals (Na, Ca, Mg, K, SO_4, NO_3, NO_2, NH_3), inorganic chemicals (As, Ba, Cd, Cr, Pb, Hg, Se, Cu, Fl), and total and fecal Coliform. In addition, during the summer pilot season, water samples were sent to Morrell Associates (Marshfield, MA) for algae identification and enumeration. Raw water and filtered water particle counting was performed on-site using each pilot unit's on-line instrumentation. Each particle counter was calibrated according to the manufacturer's recommendations. The sample locations and testing frequency for each water quality parameter conducted during the pilot study is presented in Table 3-3, Water Quality Testing Program.

Table 3.3
Water Quality Testing Program

Parameter	Sample Location	Testing Frequency
Temperature	Raw	Once during each filter run
Turbidity	Raw, Clarified, Filtered	Once manually during each filter run & continuous on-line instrumentation
Particle Counts 2–5 μm & 5-15 μm	Raw & Filtered	Continuous on-line instrumentation
Color	Raw, Clarified, Filtered	Once during each filter run
UV-254	Raw, Clarified, Filtered	Once during each filter run
TOC	Raw, Clarified, Filtered	Once during each filter run
Alkalinity	Raw & Filtered	Once during each filter run
pH	Raw & Filtered	Once during each filter run
Odor	Raw & Filtered	Once during each filter run
Aluminum	Raw, Clarified, Filtered	Once during each filter run
Iron	Raw, Clarified, Filtered	Once during each filter run
Manganese	Raw, Clarified, Filtered	Once during each filter run
Total Coliform	Raw & Filtered	Once during each filter run
Fecal Coliform	Raw & Filtered	Once during each filter run
SDS THMs	Finished	Once during select filter runs
SDS HAA5s	Finished	Once during select filter runs
VOCs	Raw & Filtered	One filter run each season
Sanitary Group (Na, Ca, Mg, K, SO_4, NO_3, NO_2, NH_4, Hardness)	Raw & Filtered	One filter run each season
IOCs (As, Ba, Cd, Cr, Pb, Hg, Se, Cu, F)	Raw, Filtered, Clarifier Sludge, Filter Backwash Residuals	One filter run each season
TSS	Clarifier Sludge & Filter Backwash Residuals	Once for each filter run

The formation of simulated distribution system (SDS) THMs and HAA5s was assessed by dosing treated water samples with appropriate amounts of KOH, phosphate, and chlorine to match the full scale facility's target water quality parameters of pH 7.5, orthophosphate 0.5 mg/L, and chlorine residual of 1 mg/L. The SDS-DBP samples were stored for 5 days in amber glass containers with no head space, in the dark, at a temperature of 5° C. At the end of the 5 day reaction period, the samples were tested for pH, chlorine and phosphate before being sent to an independent laboratory for DBP testing.

3.3.3 Clarifier Residuals

Residuals from the DAF clarifier accumulate at the water surface and are collected by a chain and flight skimmer. A rubber blade attached to the skimmer pushed the sludge from the surface of the tank into a collection trough. Operation of the skimmer was automatic once the time intervals were selected by the operator. During the Great Pond pilot study, the skimmer was pre-programmed to run for 10 continuous minutes every 50 minutes at a speed of approximately 1.0 foot per second.

Residuals from the contact clarifier accumulate in the upflow zone and attach to the buoyant media. A clarifier media wash cycle is initiated when the loss of head across the clarifier exceeds 8.0 feet. The steps and duration of the clarifier wash cycle for the Trident pilot unit are described in Table 3.4.

Table 3.4
Clarifier Backwash Cycle

Cycle	Duration (min)
1. Air Scour	1
2. Air Scour/ Water (10 gpm/sf)	3
3. Media Settling	1
4. Treat to Waste	7

3.3.4 Filter Backwashing

The pilot filters were backwashed with either clarified water or filtered water. The backwash steps and duration of each pilot filter tested are presented in Table 3.5.

Table 3.5
Filter Backwash Cycle Description

Cycle	Rate	Duration (min)
Leopold Mixed Media Filter and GAC Filter		
1. Air Scour	4 SCFM	1
2. Low Wash	5 gpm/sf	1
3. High Wash	20 gpm/sf	5
4. Low Wash	5 gpm/sf	1
US Filter Mixed Media Filter		
1. Surface Wash	2 gpm/sf	1.5
2. Surface Wash & Backwash	15-20 gpm/sf	2
3. Backwash	15-20 gpm/sf	4.5
US Filter GAC Filter		
1. Low Wash	5 gpm/sf	1
2. High Wash	20 gpm/sf	5
3. Low Wash	5 gpm/sf	1
Kinetico Direct Pressure Filter		
1. Air Scour		1
2. Rinse	8 gpm/sf	5
3. Backwash	8 gpm/sf	20

Backwash samples were collected to measure Total Suspended Solids (TSS) at different phases throughout the backwash cycle. Records were also kept of media bed expansion where possible.

3.4 Pilot Testing Water Quality Results

Water quality performance goals based on DEP's regulatory requirements for the pilot study are presented in Table 3.6.

Table 3.6
Water Quality Goals

Parameter	Location	Goal
Iron	Filtered Water	< 0.1 mg/L
Manganese	Filtered Water	< 0.03 mg/L
Color	Clarified Water	< 5 C.U.
TOC Removal	Filtered Water	> 35% when raw water TOC ≤ 4 mg/L > 45% when raw water TOC > 4 mg/L
Turbidity	Clarified Water	<0.5 NTU
Turbidity	Filtered Water	<0.1 NTU

Water quality results obtained from the manufacturer's representatives operating the pilot equipment are provided in the attached appendices (Leopold: Appendix B, US Filter: Appendix C; Kinetico: Appendix D). The water quality results obtained using Environmental Partners' staff and laboratory equipment are provided in Appendix I. In addition, the water quality results from the sampling collected by Environmental Partners and sent to an independent certified laboratory for testing are provided in Appendix J. A review and summary of key water quality parameters is presented in the sections that follow:

3.4.1 Iron

The iron content of the raw water, clarified water, and filtered water samples were measured by Environmental Partners once during each filter run. The results of these measurements are provided in Appendix I. The average total iron levels measured in the raw water during the winter season and summer seasons were 0.18 mg/L and 0.5 mg/L, respectively. The results of filtering the samples through a 0.2 µm filter indicated that between 55% and 75% of the iron in the raw water was particulate and the remaining 45% to 25% was dissolved. The pilot study results suggested that the dissolved iron present was easily oxidized using potassium permanganate in the DAF and CC pilot units. Iron oxidation for the direct pressure treatment unit was more difficult due to chemical dosing problems. However, a review of all the pilot study iron results indicate that once the iron was successfully oxidized, all three pilot systems easily achieved the filtered water quality goal of <0.1 mg/L iron.

3.4.2 Manganese

The manganese content of the raw water, clarified water, and filtered water samples were measured once during each filter run by EPG staff. These manganese levels are presented in Appendix I. The raw water average total manganese levels during the winter season and summer seasons were 0.15 mg/L and 0.09 mg/L, respectively. The results of filtering the samples through a 0.2 µm filter indicated that between 60% and 80% of the manganese present in the raw water was dissolved. A review of the pilot study results indicate that a potassium permanganate dose 1.5 times greater than the theoretical stoichiometric requirement for combined iron and manganese oxidation was adequate for oxidizing the manganese present, resulting in levels less than 0.05 mg/L after filtration. However, the pH of oxidation was found to be important, especially under cold water conditions. In the winter season, the raw water pH needed to be adjusted to a pH of at least 7.0 using potassium hydroxide (KOH) to effectively achieve manganese oxidation with potassium permanganate. Finished water manganese levels less than the water quality goal of 0.03 mg/L were achieved.

3.4.3 Natural Organic Matter

Two of the simplest methods for indirectly quantifying a water's natural organic matter (NOM) content is by measuring its ability to absorb light. Color is measured at a wavelength of 465 nm, while the absorption of ultraviolet light at a wavelength of 254 nm is referred to as UV-254. Both measurements rely on the aromatic structure of the dissolved organic matter within the water for light absorption. In the absence of a strong oxidant, generally the higher the absorbance measured, the higher the NOM content of the water.

Color levels of the raw water, clarified water, and filtered water samples were generally measured once during each filter run by Environmental Partners. The results of these measurements can be found in Appendix I. On average, the color of the raw water samples during the winter season and summer seasons were 101 C.U. (color units) and 18 C.U., respectively. The average treated water color achieved from the DAF and Trident clarifiers was 22 C.U. and 45 C.U., respectively in the winter season; and 6 C.U. and 15 C.U., respectively in the summer season. The pilot filters produced filter effluent color between 10 C.U. and 1 C.U., with the GAC filters yielding slightly lower results. The performance of the Kinetico DPF filter was less successful with respect to color. The pressure filter only achieved an average filtered water color of 37 C.U for the winter season.

Similarly, UV-254 was measured at least once from raw water, clarified water, and filtered water grab samples. UV-254 results from samples collected and tested by Environmental Partners are provided in Appendix I. The average percent reduction in UV-254 for each clarification method piloted is summarized below in Table 3.7.

Table 3.7
UV Percent Removal

Pilot Unit	Average % Reduction Winter Season	Average % Reduction Summer Season
DAF	74.8%	65.2%
CC	70.2%	63.2%
DPF	23.3%	-

The data shown in Table 3.7 represents a coagulant product dose between 65 mg/L and 75 mg/L. UV-254 removals were slightly higher for greater coagulant dosages. In addition, UV removal was slightly less for the CC system during higher loading rates, but showed no effects on the DAF system with increased loading rates. The average reduction in UV-254 for the DPF system (winter season) was 23.3%, which is significantly less than the other two pilot treatment units.

A gross measurement of the NOM content in drinking water is total organic carbon (TOC). TOC concentrations for raw water, clarified water, and filtered water samples were measured once during each filter run by an independent laboratory. TOC results are provided in Appendix J. The average percent removal of TOC for each pilot system at a coagulant dose between 65 mg/L and 75 mg/L is summarized below in Table 3.8:

Table 3.8
TOC Percent Removal

Pilot Unit	Average % Removal Winter Season	Average % Removal Summer Season
DAF Clarifier	39%	42%
DAF & MMF	43%	44%
DAF & GACF	78%	88%
CC Clarifier	28%	22%
CC & MMF	40%	42%
CC & GAC	84%	86%
DPF	27%	-

Based on raw water alkalinity and TOC levels measured taken during the pilot study, acceptable TOC removals for compliance with the D/DBP Rule varied between 35% and 45%. However, compliance with the D/DBP TOC removal requirement is based on a quarterly review of the running annual average of monthly results. A review of the information presented in Table 3.8 suggests that the DAF clarifier performed better than the CC clarifier, the GAC filters performed better than the mixed media filters, and that the filters performed equally well with respect to TOC regardless of the preceding clarification step.

Also, a review of individual TOC results and operating information indicates that the DAF process observed no reduction in TOC removal with increased clarifier loading rates. However, the removal of TOC for the CC system was significantly decreased for the higher loading rates. Lastly, TOC removals for the DPF system were poor.

The removal of NOM is important in water treatment because chemical reactions between NOM and the disinfectant chlorine can produce regulated organo-chlorine compounds or disinfection-by-products (DBPs). Detailed SDS DBP (TTHMs and HAA5s) results are provided in Appendix J. The average values are summarized in Table 3.9.

Table 3.9
Average DBPs (TTHMs and HAA5s) Results

Filter Media	TTHMs (μg/L)	HAA5s (μg/L)
Winter Season		
DAF Mixed Media Filter	33.1	17.0
DAF Granular Activated Carbon	12.7	8.2
CC Mixed Media Filter	31.3	15.2
CC Granular Activated Carbon	11.0	6.6
Direct Pressure Filter	32.9	24.3
Summer Season		
DAF Mixed Media Filter	36.9	21.8
DAF Granular Activated Carbon	5.8	4.1
CC Mixed Media Filter	35.8	22.3
CC Granular Activated Carbon	1.4	1.9

A review of the information found in Table 3.9 and Appendix J indicates that all three pilot units may be expected to meet DBP compliance limits. As expected, the results of the GAC media filters were significantly more effective at removing DBP precursor materials than the mixed media filters. However, elevated DBP precursor material and TOC removals are typical for the first several weeks or months of service based on the adsorption capacity of fresh carbon. These levels would be expected to decline as the adsorption capacity of the GAC media is expended..

3.4.4 Turbidity and Particulates

The raw water turbidity during the pilot study is presented in Figure 3-8. A review of the information shown on Figure 3-8 indicates that raw water turbidity was significantly greater during the cold water season compared to the warm water season. Raw water turbidities were greater than 10 NTU during the winter season and consistently less than 1.0 NTU during the summer season. The ongoing reservoir dredging program contributed to the elevated turbidities during the winter period.

Figure 3-8 Raw Water Turbidity

Clarifier effluent turbidity and filter effluent turbidity were measured with on-line turbidimeters for each pilot process. Detailed results including graphical representations of the data for each filter run are provided in Appendix B, Appendix C, and Appendix K. Clarified water turbidities for the DAF system and CC system are presented graphically in Figures 3-9 and 3-10, respectively. Filter effluent turbidities for the DPF system are shown on Figure 3-11. In addition, average raw water, clarified water, and filtered water turbidity information is summarized below in Table 3.10.

Table 3.10
Turbidity Results

Process	Average Raw Water Turbidity (NTU)	Average Clarified Water Turbidity (NTU)	Average Filtered Water Turbidity[1] (NTU)
Winter Season			
DAF & MMF	8.5	0.9	0.04
DAF & GAC filter	8.5	0.9	0.045
CC & MMF	8.4	4.2	0.10
CC & GAC filter	8.4	4.2	0.20
DPF	10.5	NA	1.85
Summer Season			
DAF & MMF	0.60	0.26	0.031
DAF & GAC filter	0.60	0.26	0.029
CC & MMF	0.71	0.77	0.037
CC & GAC filter	0.71	0.77	0.046

1 – note, average for the first eight hours of filter operation.

The following conclusions are made after a review and evaluation of the effluent turbidity information provided in the appendices and presented in Table 3.10 and Figures 3-9 through 3-11:

- Only the DAF clarifier was able to achieve effluent turbidities less than 0.5 NTU during the cold water season. However, this goal was achieved only 21% of the time. However, DAF clarifier turbidities were less than 1 NTU 71% of the time during the cold water season while CC clarifier turbidities were only less than 1 NTU 1% of the time.

- During the summer season the DAF clarifier was able to achieve effluent turbidities less than 0.5 NTU 99% of the time, while the CC clarifier was only able to produce effluent turbidities less than 0.5 NTU 17% of the time. In addition, the DAF clarifier turbidities were not affected by increased loading rates.

- The DPF system was only able to achieve filter effluent turbidities less than 0.5 NTU 28% of the time, and less than 0.1 NTU 10% of the time. These results usually occurred during the first half hour of operation following a filter backwash.

Figure 3-9 Dissolved Air Flotation Clarifier Effluent Turbidity

Figure 3-10 Contact Clarification Clarifier Effluent Turbidity

Figure 3-11 Direct Pressure Filter Effluent Turbidity

- Both filter medias were able to achieve effluent turbidities less than 0.1 NTU on a consistent basis. The mixed media filters and GAC media filters performed equally well with respect to effluent turbidity performance regardless of the clarification step preceding the filters.

Raw water and filtered water particles were counted for each pilot process using on-line instrumentation. Detailed particle count results are provided in Appendix B for the DAF system, Appendix C for the CC system, and Appendix D for the DPF system. A summary of raw water particle count results and filtered water log reduction results is presented in Table 3.11.

Table 3.11
Particle Count Results

Process	Average Raw Water Particles		Average Log Reduction	
	2 µm to 5 µm (#/mL)	5 µm to 15 µm (#/mL)	2 µm to 5 µm	5 µm to 15 µm
Winter Season				
DAF & MMF	13,831	3,441	2.2	1.9
DAF & GAC filter	13,831	3,441	3.3	2.8
CC & MMF	10,277	2,480	2.5	2.1
CC & GAC filter	10,277	2,480	NA	NA
DPF	17,746	3,977	1.6	0.8
Summer Season				
DAF & MMF	4,257[1]	385	3.3	2.7
DAF & GAC filter	4,257[1]	385	2.8	2.6
CC & MMF	1,760	503	1.2	1.3
CC & GAC filter	1,760	503	NA	NA

1 – note, decimal error in raw water particle counter. Data from Appendix B corrected.

The following conclusions are made after a review and evaluation of the particle count information provided in the appendices and presented in Table 3.11:

- There was approximately 3 times as many particles in the raw water during the winter season compared to the summer season. The majority of the particles present in the raw water are in the size range of 2 µm to 5 µm.

- The granular media filters performed similarly with respect to particulate removal. Both the GAC and mixed media filters achieved between 2 log and 3 log reductions in particles (based on raw water particle counts) in the size ranges of 2 µm to 15 µm. Greater log reductions were achieved for the smaller particle size range 2 µm to 5 µm.

- The direct pressure filter system only achieved between 0.8 and 1.2 log reductions in particles (based on raw water particle counts).

3.5 Pilot Testing Operational Results

3.5.1 Filter Run Times

Filter runs times were calculated as the duration of time for each filter to reach terminal head loss (~8 feet) or turbidity breakthrough (0.3 NTU). If neither terminal head loss nor turbidity breakthrough occurred the filter run time was estimated based on the rate of head loss accumulation. Filter turbidity and head loss were measured with on-line instrumentation when available. Where on-line turbidimeters were unavailable, measurements were taken periodically throughout the filter run using grab samples. Where on-line head loss meters were unavailable, measurements were taken periodically using manometers. Detailed graphical head loss and turbidity results for each pilot unit filter run are provided in Appendix K. The average filter run time for each pilot unit is presented in Table 3.12.

Table 3.12
Average Filter Run Times (hours)

Filter Loading Rate (gpm/sf)	DAF Mixed Media	DAF GAC	CC Mixed Media	CC GAC	Pressure Filter
Winter Season					
4	24	12	11	7	
5	16	7	6	2	
10					2
Summer Season					
4	47	25	9	6	
5	29	12	5	9	

In general, the DAF pilot unit filters (mixed media and GAC) reached terminal head loss before reaching turbidity breakthrough. The CC pilot unit filters reached terminal head loss prior to turbidity breakthrough in the summer season but reached turbidity breakthrough prior to terminal head loss during the winter season. The direct pressure filters could only maintain filter effluent turbidities less than 0.3 NTU for three out of the seven runs when raw water turbidities were less than 9 NTU.

The filter run times of the DAF pretreated filters were longer than the CC pretreated filters. The data discussed in the previous section illustrates that the DAF pretreatment process was more effective in turbidity and particulate removal, resulting in a lower solids loading rates to the filters, and hence longer filter run times.

3.5.2 Net Water Production

Net water production is defined as the ratio of total volume of treated water produced for distribution divided by the total volume of raw water used. Each process consumes treated water for cleaning and backwashing purposes. The calculated net water yield for each treatment system evaluated during the pilot study is presented in Table 3.13.

Table 3.13
Net Water Production

Pilot Unit	Loading Rate (gpm/sf)	Net Water Yield
Winter Season		
Dissolved Air Flotation		
Mixed Media	4	98.0%
Mixed Media	5	97.5%
GAC	4	96.6%
GAC	5	94.8%
Contact Clarification		
Mixed Media	4	92.2%
Mixed Media	5	90.0%
GAC	4	88.2%
GAC	5	84.7%
Pressure Filtration	10	88.2%
Summer Season		
Dissolved Air Flotation		
Mixed Media	4	99.0%
Mixed Media	5	98.7%
GAC	4	98.2%
GAC	5	97.0%
Contact Clarification		
Mixed Media	4	87.0%
Mixed Media	5	93.5%
GAC	4	92.6%
GAC	5	96.1%

A review of the information presented in Table 3.13 indicates that the DAF system was the most efficient treatment process in terms of net water yield (water produced versus water sent to waste) for both seasons of this study. Average net water productions were greater than 95% for the DAF system and greater than 85% for the CC system. In general the mixed media filters demonstrated higher net water yields than the GAC filters. The DPF system resulted in a net water production of 88%.

3.6 Conclusions and Recommendations

Based on a review of Braintree's source water quality information and consideration of existing and future proposed drinking water standards, a new treatment facility that treats water from the Great Pond reservoir system must be capable of the following treatment requirements under both cold water (< 4°C) and warm water (> 20°C) conditions:

- The removal of source water iron and manganese to levels consistently below Secondary Standards.
- The removal of objectionable tastes and odors which can occur seasonally in the source water.
- The efficient removal of low density particulates (algae, and floc formed from the coagulation of low turbidity waters containing NOM), and the capability to effectively treat source water turbidity spikes upwards of 20 NTU (compliance with the Interim Enhanced Surface Water Treatment Rule (IESWTR).
- The removal of NOM (color, TOC, and disinfection by-product precursors materials) to minimize the production of distribution system DBPs (compliance with the Disinfection/Disinfection By-Product Rule).
- Adequate disinfection for compliance with the CT requirements of the Surface Water Treatment Rule and IESWTR.
- Corrosion control for compliance with the Lead and Copper Rule.

3.6.1 Iron and Manganese Oxidation

The most effective treatment method for the oxidation and removal of iron and manganese identified in the pilot study consisted of the addition of potassium permanganate prior to the coagulant. The oxidant was added at a dose of 1.5 times the theoretical stoichiometric requirement for combined iron and manganese oxidation and allowed a minimum of 5 minutes retention time. The adjustment of the treated water to a pH level greater than pH 7.0 using liquid potassium hydroxide was required for adequate oxidation during the cold water season.

3.6.2 Taste and Odor Control

All of the mechanisms evaluated for taste and odor control were proven to be effective: ozonation, permanganate oxidation, and carbon adsorption. In addition, there was no observable difference between the taste and odor control performance between the two oxidants: potassium permanganate and ozone. However, because of the presence of brominated trihalomethane species, and the relative differences in operation and maintenance complexity, safety, and costs, the use of potassium permanganate combined with granular activated carbon (GAC) filter adsorption is favored.

3.6.3 Coagulation/Flocculation/Clarification

The processes of coagulation/flocculation/clarification in this study were evaluated based on the removal of dissolved NOM and particulates. NOM removal was assessed based on treated water color, UV-254, and TOC data. Particulate removal was assessed based on clarifier turbidity and particle counts. The most effective process proved to be the dissolved air flotation using a polyaluminum chloride coagulant (PCH-180) at a dose between 65 mg/L and 75 mg/L (product dose). The use of a cationic polymer coagulant aid was required to achieve clarified water turbidities less than 0.5 NTU during the winter season.

3.6.4 Filtration

Filtered water turbidity and particulate results were similar with respect to the two filter medias (GAC versus mixed media). The mixed media filters resulted in longer filter run times, however the net water yield of the GAC filters (preceded by DAF) still exceeded 96% at an average loading rate of 4 gpm/sf. The granular activated carbon (GAC) filters demonstrated a higher capability for the removal of NOM. A secondary benefit of GAC filters is the effective removal of taste and odor causing compounds.

3.6.5 Additional Treatment Issues

Additional treatment concerns that were not specifically piloted as part of this study, but which are incorporated into the conclusions and recommendations for a new treatment facility are summarized below:

5. Bulk source water screening.
6. Primary and secondary disinfection for compliance with the Interim Enhanced Surface Water Treatment Rule and Total Coliform Rule.
7. Corrosion control for compliance with the Lead and Copper Rule.
8. Residuals management techniques.

The raw water used during the pilot study was pre-treated by the existing intake facilities which consists of two parallel 48-inch RC pipes extending 135 feet into Lower Pond with inverts set at an elevation of 115.5 feet (USGS). Water from these two intake pipes travels into the intake building through aluminum bar racks where it enters a vault and is then screened through well screens (5’8” tall, 24” diameter). A 24-inch pipe connects the intake structure to the raw water pumps. This type of intake facility is common as it has proven to be effective for surface water treatment facilities. A detailed description and assessment of Braintree's existing intake facilities can be found in the Comprehensive Performance Evaluation engineering report prepared by Environmental Partners in September 2003. It is recommended that similar facilities, including the potential re-use of Braintree's existing facilities, be employed for physical pretreatment.

Given the effective disinfection practices demonstrated at Braintree's existing WTP, the use of free chlorine for both primary and secondary disinfection is recommended. The proposed treatment facilities are expected to result in enhanced treatment compared with the existing finished water quality (with respect to DBP precursor materials). Therefore, since the Great Pond WTP's disinfection practices currently enable the Braintree water system to meet the requirements of the IESWTR, D/DBP Rule, and TCR, it is recommended that the existing disinfection approach also be used for the proposed facility.

The Town's compliance with the Lead and Copper Rule is well documented in a number of engineering studies including the Great Pond WTP Comprehensive Performance Evaluation engineering report prepared by Environmental Partners in September 2003 and a supplemental evaluation prepared by Environmental Partners in January 2004. The supplemental corrosion control evaluation is provided in Appendix L. For the purposes of this pilot study, it is recommended that the new treatment plant include chemical storage, handling, and feed facilities for the use of 75% technical grade phosphoric acid as a corrosion inhibitor and potassium hydroxide for pH adjustment.

Although methods of residuals dewatering and handling were not evaluated as part of this pilot study, there are several acceptable technologies successfully used in Massachusetts and New England. The existing Great Pond WTP currently uses lagoons for residuals handling. Drinking water treatment plant residuals in Massachusetts are currently considered a "special waste" under the solid waste regulations (310 CMR 19, 310 CMR 30, and 310 CMR 32). As such, there are a number of alternative materials handling and disposal options. A detailed review of residuals management options for Braintree's existing Great Pond WTP are found in the Great Pond WTP Comprehensive Performance Evaluation engineering report prepared by Environmental Partners in September 2003. The Town is currently completing a permit application for the beneficial use of treatment residuals (sludge) at Massachusetts landfills. The use of dewatering lagoons for residuals management are recommended to be employed at the proposed treatment plant in Braintree.

. P OPOSED P ELIMINA DESIGN OF T EATMENT FACILIT

4.1 General

The design capacity of a drinking water treatment facility must ensure that the future maximum day demand can be met. A review of the June 2002 Water System Master Plan indicates that the projected maximum day demand for the year 2020 is 5.4 MGD. Prior engineering studies and estimates prepared by the Department of Environmental Management suggest future peak day demands of 5.72 MGD and 10.25 MGD, respectively. An examination of the past 12 years of water demand information indicates that the highest average annual demand during this period was 3.9 MGD and the highest peak day factor during this period was 1.53. Using these recent historic maximums, an alternative estimate of the future maximum day demand is 6.0 MGD. However, using an average industry peaking factor of 2.0 and an annual average demand of 3.9 MGD, a more conservative estimate of the future maximum day demand potential is 8.0 MGD. Based on this information, it is recommended that the proposed facilities be designed with a dependable capacity of 6 MGD, with provisions that make it easily expandable in the future.

4.2 Recommended Design Criteria

Based on a review and evaluation of the pilot study results, a summary of recommended design criteria for the proposed facilities to treat water from the Great Pond reservoir system is presented below:

Plant Capacity:	6.0 MGD (design for future expansion up to 9 MGD)
Raw Water Pumping:	3 pumps, each rated at 3,200 gpm (2 duty, 1 standby)
In-Line Mixing:	Static Mixer – 1 to 2 seconds (for pre-oxidant)
Pre-Oxidation:	Contact Tank – 5 minute detention time
Rapid Mixing:	30 seconds (for coagulant)
Flocculation:	20 minutes (dual stage, variable speed)
Dissolved Air Flotation:	Loading Rate: 8 gpm/sf; Recycle Flow 12%
Granular Activated Carbon Filters:	Loading Rate: 5 gpm/sf 4 feet of 8x30 mesh carbon and 6 inches of filter sand
Filter Clearwell/CT Basin:	Detention Time – 42 mg/L • min (CT required)
Finished Water Pumping:	3 pumps, each rated at 3,000 gpm (2 duty, 1 standby)

The chemicals and recommended design dosages are summarized below:

Chemical Treatment	Chemical	Design Dosage
Primary Coagulant	Polyaluminum Chloride	65-75 mg/L (as product) [2.7 mg/L to 3.7 mg/L as Al^{+3}]
Coagulant Aid	Cationic Polymer	0.2 mg/L (winter only)
pH Adjustment (raw water) pH Adjustment (finished water)	Potassium Hydroxide	9.0 mg/L (winter only) 10.0 mg/L (year round)
Pre-oxidation	Potassium Permanganate	1.5 mg/L
Disinfection	Chlorine (gas)	3.5 mg/L
Corrosion Inhibitor	Orthophosphate	4.0 mg/L (as orthophosphate)

4.3 Facility Layout

Braintree's existing treatment plant lies on a lot of approximately 14.5 acres owned by the Braintree Water & Sewer Department. The existing facilities, including an intake building, pump station building, filter building, flocculation basins, sedimentation basins, clearwell, lagoons, and washwater tank, are spread across approximately 4 acres of this land.

The proposed location of the new treatment facility is adjacent to the existing water treatment plant as shown on Figure 4-1. A process schematic of the proposed water treatment facility is presented in Figure 4-2. The proposed treatment building size is approximately 1,800 feet by 1,400 feet. The building would house the raw water pumps, pre-oxidation contact tanks, rapid mixers, flocculation basins, DAF clarification treatment units, GAC filters, finished water pumps, wash water storage basin, wash water pumps, and all of the chemical storage, handling, and feed equipment. Additional space is provided for offices, a control room, a meeting/conference room, a laboratory, sanitary facilities with showers and lockers, a breakroom, maintenance area, and storage area. A separate building is also shown on the proposed site layout (Figure 4-1) for a 14 bay vehicle garage for vehicle storage and maintenance.

Based on an assessment of future projected water demands, it is recommended that the new treatment facility be designed for a capacity of 6 MGD, with the ability to expand. The type of equipment recommended is modular, thus allowing a floor plan and facility layout that is readily and efficiently expandable. Given DEP's requirements for redundancy, as shown on Figure 4-2 the facility will consist of 3 raw water pumps, two pre-oxidation trains, three flocculation trains, three DAF trains, four filters, a chlorine contact tank, three finished water pumps, and three lined lagoons. The DAF units are packaged, and therefore each of the flocculation/DAF treatment trains will be sized for 3 MGD, allowing a dependable maximum treated water flow of 6 MGD (with one unit off-line) and an instantaneous treated water flow capability of 9 MGD with all three units operating. Similarly, the dependable filtration flow is 6 MGD with one filter off-line or 8 MGD with all 4 filters operating.

Figure 4-1 Proposed Site Layout

Figure 4-2 Conceptual Design: Braintree Water Treatment Facility

4.4 Raw Water Intake

The proposed intake structure consists of two chambers. Raw water enters the intake structure by gravity flow from the reservoir through one of two intake pipelines. When the raw water reaches the intake structure, the flow is divided in to the two chambers where the water passes through a screen to remove large debris and aquatic life. Each chamber is capable of being taken off line for maintenance and repair. The reuse of the existing facilities should be investigated.

4.5 Chemical Feed Systems

The new facility shall be equipped with separate bulk chemical storage areas: one for dry chemicals, potassium permanganate and copper sulfate; one for liquid chemicals, polyaluminum chloride, potassium hydroxide, phosphoric acid, and polymer; and an isolated room for chlorine gas. Each chemical feed system shall consist of bulk storage, handling, and containment; a day tank with containment, two chemical feed pumps (one spare), and all of the necessary appurtenances for proper chemical handling, storage, containment, mixing, monitoring, and injection.

4.6 Pre-oxidation

The water is pumped from the intake structure to a contact chamber by a set of raw water pumps located in the treatment building. There are three (3) 3,200 gpm pumps (2 duty, 1 standby). Prior to the contact tank, potassium permanganate is injected into the raw water line for oxidation of iron, manganese, and tastes and odors. If necessary, liquid potassium hydroxide is injected to raise the pH to a target of 7.0 for more effective oxidation. There are two proposed basins sized for five minutes of detention time (each, at max day) and which are aligned in parallel.

4.7 Coagulation/Flocculation

After pre-oxidation, the coagulant (polyaluminum chloride) is added prior to two rapid mixing chambers aligned in parallel, allowing a minimum mixing time of 30 seconds (or a G value of 1,000 fps/ft). Here the flow divides into three equal trains for coagulation/flocculation and clarification. The flocculation basins are sized for a minimum 20 minute detention time at peak flow. The proposed dimensions of the flocculation basins are 20' wide by 28' long. Flocculated water will flow uniformly into the bottom of the dissolved air flotation units.

4.8 Clarification

The DAF units are sized for a maximum loading rate of 8 gpm/sf, resulting in three (3) 3.0 MGD basins, each with dimension of 14' wide x 18' long. DEP guidelines require the ability to treat maximum day demand with one unit off-line. Each DAF unit comes equipped with a chain-and-flight skimmer for the removal of floated solids. Floated solids are dragged across the beach into a hopper from which they will flow by gravity to the proposed sludge lagoons. The DAF system will also be equipped with two recycle systems including air saturators, recycle pumps, and flow meters. The saturation and recycle system shall be sized to handle a maximum recycle flow of 15%.

4.9 Filtration

Four filters with 48” of 8x30 mesh GAC media are proposed. The filters shall also include a minimum of 6-inches of filter sand and IMS cap for media support atop the underdrain. The filters shall be designed for a loading rate of 5 gpm/sf. The proposed filter dimensions are 15.5’ wide by 18’ long each, to maintain a treated water capacity of 6.0 MGD with one filter off-line. The filters shall be backwashed by direct pumping from a below ground clearwell. The clearwell will be sized to hold a minimum of 150,000 gallons. The backwash system shall also consist of air scour equipment. The target backwash cycle will consist of a 1 minute air scour (4 SCFM), followed by a 1 minute low wash rate (5 gpm/sf), followed by a 5 minute high wash rate (20 gpm/sf), ending with a 1 minute low wash rate (5 gpm/sf). The backwash rate shall be adequate to fluidize and expand the media a minimum of 50% under cold water (1°C) and warm water (25°C) conditions.

4.10 Disinfection

Disinfection will be achieved using chlorine gas. The disinfection system must be designed to provide a 0.5 log inactivation/removal for Giardia. Using the CT table found in the USEPA SWTR Guidance Manual, for a water temperature less than or equal to 0.5 °C, a pH of 7.5, and a free chlorine residual of 1.0 mg/L, the required CT for 0.5 log inactivation of Giardia is 42 (mg/L)•min. Therefore, considering a proposed design to achieve superior baffling, indicating a contact time efficiency of 70%, the CT tank should be designed to achieve a contact time of 60 minutes at the design flow rate of 6 MGD.

Based on the information provided above, the minimum volume required for CT is 250,000 gallons. However, in order to easily incorporate the expansion for up to 9 MGD, a 375,000 gallon CT basin is required. The chlorine shall be injected into the combined filter effluent line prior to entering the circular clearwell for CT. The finished water pumps shall pump the water from the CT-basin into the distribution system. Three finished water pumps are proposed, each rated at 3,000 gpm (2 duty, 1 standby).

4.11 Corrosion Control

Corrosion control shall include chemical storage, handling, and feed equipment for the addition of potassium hydroxide for pH adjustment and a liquid phosphate inhibitor (75% technical grade phosphoric acid). The facilities shall be designed to achieve a target finished water pH of 7.5 and an orthophosphate dose of 3.5 mg/L.

4.12 Residuals

Lined lagoons are proposed for sludge handling. The proposed lagoons are sized to handle the projected waste streams from the new water treatment plant, including clarifier sludge and spent filter backwash waste. A review of the net water production (discussed in Section 3.5.2) indicates that the finished flow, during the worst water quality conditions, is 95% of the raw water flow, indicating a residuals discharge stream of approximately 5%. The average day demand of new plant is 3.9 MGD. Therefore, given a finished water production of 3.9 MGD, and a net water production of 95%, the corresponding raw water withdrawal requirement from Great Pond is 4.1 MGD

4.12.1 Clarifier Sludge

The generation of sludge from the DAF basins was estimated based on average daily flow, water quality, and coagulant dosing. When the application of aluminum coagulants is used for water treatment, the amount of solids produced can be estimated based on the generation of aluminum hydroxide precipitate $Al(OH)_3 \bullet 3H_2O$, and the aluminum concentration of the coagulant. Based on an aluminum concentration of 5.5% for PCH-180, every 1 mg/L of PCH-180 will generate approximately 0.27 mg/L of dry solids (or 2.25 pounds of dry solids for every million gallons of water treated). Therefore, based on a treated water flow of 4.1 MGD, and an average PCH-180 dosage of 70 mg/L (wet) or 23.3 mg/L (dry), the projected coagulation solids generation is 215 lb/day (dry). In addition, based on a flow of 4.1 MGD, an average raw water turbidity of 2.2 NTU, and an assumed ratio of 1.75 mg/L per NTU, the estimated generation of inert solids at the Great Pond WTP is 132 lb/day (dry). Therefore, the future total estimated solids production at the Great Pond WTP is estimated to be approximately 347 lb/day (dry).

4.12.2 Filter Backwash

Based on the proposed filter backwash cycles and the filter dimensions, the back wash volume per filter is estimated to be approximately 40,000 gallons. As reported in the lab results, provided in Appendix J, the average solids concentration for the DAF pretreated GAC filter backwash water is approximately 320 mg/L, which results in a solids loading of approximately 107 lb per backwash (dry).

4.12.3 Lagoon Sizing

The lagoons should be designed based on a conservative residuals stream of 200,000 gpd based on net yield production of 95% for an average daily flow of 3.9 MG. Therefore, based on the requirement for a total lagoon volume equal to ten times the total volume of wash water discharged, the lagoons will require a total volume of 2.0 MG. The three proposed lagoons will have 5.5 feet of useable depth with a total surface area of approximately 48,600 sf, providing a total volume of 2.0 MG.

4.13 Process Instrumentation and Controls

The proposed treatment plant shall be operated and monitored by a fully automated PLC-based supervisory control and data acquisition (SCADA) system. The treatment plant's instrumentation and controls shall meet the requirements of 310 CMR 22.11B(5)d, thereby enabling the facility to qualify for reduced staffing, or a minimum of 16 manned hours for every 24 hours of operation.

4.14 Additional Facilities

In addition to the treatment plant, the proposed conceptual design includes facilities for the storage of water system vehicles and equipment. The facilities include a 14-bay garage for vehicle storage and maintenance. The proposed location of these proposed facilities is shown on Figure 4-1.

4.15 Regional Tri-Town Facility

During the course of this study, a proposal for the construction of a regional water treatment facility to provide potable water to the communities of Braintree, Randolph, and Holbrook was introduced. A summary of supporting factors for this approach is provided below:

- The three communities currently share a drinking water supply source called the Great Pond reservoir system under the management of the Tri-Town Board of Water Commissioners.
- The Randolph/Holbrook Joint Water Board currently operates and maintains a separate treatment facility located on the opposite shore of the Lower Reservoir, across from Braintree's existing Great Pond WTP.
- The age and condition of both treatment facilities is similar, manifesting the future need for their replacement to efficiently and effectively maintain the communities ability to meet drinking water regulations.

- The potential for cost savings (both capital and operation/maintenance) is highly likely when building one combined facility for all three communities rather than two separate treatment facilities due to economies of scale.

As outlined in DEP's Guidelines and Policies for Public Water Systems, the pilot study conducted for the community of Braintree as presented herein, is applicable and can be used for the design and construction of a new regional treatment facility since the same source is used. Therefore, the proposed facilities for a regional Tri-Town Water Treatment Plant would incorporate the same design recommendations previously discussed, with the exception of having a larger capacity.

The average annual water demand for the Joint Water Board (Randolph/Holbrook) during the past four years is 3.5 MGD. If it is assumed that future water demands for the Joint Water Board will change uniformly with those of Braintree, then a reasonable estimate for the average annual water demand in the year 2020 is 8.1 MGD, for the three communities. Similarly, a reasonable estimate for the future potential maximum day demand in the year 2020 is 12.5 MGD. Therefore, the proposed hydraulic capacity for a regional water treatment facility should be at least 12.5 MGD. In addition, as with the proposed Braintree water treatment facility, the proposed facility would incorporate a modular design approach that is easily expandable.

A summary of proposed design criteria for a new regional water treatment facility to provide potable water to the communities of Braintree, Randolph, and Holbrook is presented below:

Plant Capacity:	12.75 MGD (design for future expansion)
Raw Water Pumping:	4 pumps, each rated at 3,400 gpm (2 duty, 1 standby)
In-Line Mixing:	Static Mixer – 1 to 2 seconds (for pre-oxidant)
Pre-Oxidation:	Contact Tank – 5 minute detention time
Rapid Mixing:	30 seconds (for coagulant)
Flocculation:	20 minutes (dual stage, variable speed)
Dissolved Air Flotation:	Loading Rate: 8 gpm/sf; Recycle Flow 12% 4 DAF trains each at 4.25 MGD
Granular Activated Carbon Filters:	Loading Rate: 5 gpm/sf 4 feet of 8x30 mesh carbon and 6 inches of filter sand
Filter Clearwell/CT Basin:	Detention Time – 42 mg/L • min (CT Required)
Finished Water Pumping:	4 pumps, each rated at 3,200 gpm (2 duty, 1 standby)

The chemicals and recommended design dosages are summarized below:

Chemical Treatment	Chemical	Design Dosage
Primary Coagulant	Polyaluminum Chloride	65-75 mg/L (as product) [2.7 mg/L to 3.7 mg/L as Al^{+3}]
Coagulant Aid	Cationic Polymer	0.2 mg/L (winter only)
pH Adjustment (raw water) pH Adjustment (finished water)	Potassium Hydroxide	9.0 mg/L (winter only) 10.0 mg/L (year round)
Pre-oxidation	Potassium Permanganate	1.5 mg/L
Disinfection	Chlorine (gas)	3.5 mg/L
Corrosion Inhibitor	Orthophosphate	4.0 mg/L (as orthophosphate)

A conceptual layout for these facilities is presented in Figure 4-3. The overall footprint of these facilities will be incrementally larger than the 6.0 MGD Braintree WTP, but located in the same general location and layout as shown on Figure 4-1. The siting of a new Tri-Town water treatment facility at this location would require minimal new piping to deliver finished water to the Braintree water system. However, approximately 5,000 feet of new piping would be required to deliver finished water to the existing Joint Randolph/Holbrook water treatment facility. An assessment of the Braintree water system indicates that the easiest finished water piping route involves connecting the new piping the Braintree's existing 24-inch water main along West Street. This scenario would require approximately 5,000 feet of new 24-inch pipe. A schematic diagram of Braintree's existing water system in this area is shown on Sheet 32 of the Braintree Water Atlas (attached).

Figure 4-3 Conceptual Design: Tri-Town Water Treatment Facility

Braintree Water Atlas: Sheet 32

. ESTIMATED COSTS AND CONCLUSIONS

5.1 General

This section of the report presents the estimated capital, operational, and maintenance costs for the proposed water treatment facilities presented in Section 4. Capital costs are presented first, following by annual operation and maintenance costs. Finally, a review and comparison of the potential costs for a new Braintree water treatment plant versus a regional treatment facility are presented.

5.2 Estimated Capital Costs

The estimated probable capital costs for a 6 MGD DAF WTP located in Braintree are presented in Table 5.1. The capital costs shown in Table 5.1 include the costs for construction of the new facilities, demolition of the old facilities, contingencies, and engineering services (design, permitting, bidding assistance, and construction management and inspection). All of these costs are current as of January 2004, using an ENR Construction Cost Index of 6825. Future use of this cost data must be adjusted accordingly.

Table 5.1
Capital Costs

Description	Cost
Equipment	$3,400,000.00
Equipment Installation	$1,300,000.00
Process Mechanical Piping	$1,410,000.00
SCADA Instrumentation and Control	$500,000.00
Electrical	$250,000.00
Treatment Building	$1,200,000.00
Site Work	$350,000.00
Utilities	$900,000.00
Demolition	$900,000.00
Garage	$800,000.00
Subtotal	**$11,010,000.00**
Engineering (20%)	$2,202,000.00
Contingency (20%)	$2,202,000.00
Total	**$15,414,000.00**

Equipment costs include the purchase of all equipment associated with the following items: raw water intake, raw water pumps, chemical feed systems ($KMnO_4$, KOH, PACl, Polymer, Cl_2, and PO_4), static mixers, rapid mixer system, oxidation basins, DAF units (including flocculators, recycle system, and air saturators), filters (including GAC media, underdrain, and air scour system), wash water basin, wash water pumps, CT basin, finished water pumps, emergency generator, residuals lagoons, and all related peripheral equipment and appurtenances. Related equipment including process and mechanical piping, electrical, and SCADA equipment (including PLCs, RTUs, computers, printers, etc.) are included separately. A review of the cost information provided in Table 5.1 indicates a total estimated capital cost of approximately $15.4 million for a new 6.0 MGD DAF WTP as described in Section 4.0.

5.3 Estimated Operational Costs

Estimated probable annual operation and maintenance (O&M) costs for the proposed Braintree WTP are summarized in Table 5.2. Based on an average daily demand of 3.3 MGD, the estimated annual O&M costs for the proposed Braintree WTP are $708,000.

Table 5.2
Operational Costs

Description	Cost
Labor	$270,000
Energy	$150,000
Chemicals	$195,000
Maintenance (equipment & materials)	$50,000
Residuals (removal and disposal)	$25,000
Telemetry/Communications	$5,000
Laboratory Testing	$10,000
Emergency Fuel	$3,000
Total	**$708,000.00**

The labor estimates consider average annual salaries for management and union employed skilled laborers working for a municipal Water Department. The staffing level includes a Plant Manager, a Chief Operator/Laboratory Supervisor, 3 operators, and 1 maintenance mechanic. The labor cost estimates correspond to an ENR Skilled Labor Index value of 6644.23 (January 2004). Energy costs were developed for both process and building-related power requirements. Estimates for maintenance materials include the costs of periodic replacement of equipment parts and components including valves, motors, and miscellaneous instrumentation and control equipment. The chemical cost estimates are based on the recommended dosages, an average day demand of 3.3 MGD, and recent chemical pricing in for the New England area. The costs for residuals includes removal, hauling and disposal at an off-site location based on the average annual solids generation rate presented in Section 4.12, and considering that the material could be used beneficially at Massachusetts landfills. Laboratory testing includes equipment and materials for both on-site and off-site testing associated with process control. The costs for emergency fuel consider monthly testing and operation of emergency generators.

5.4 Regional Tri-Town Facility

As discussed in Section 4.0, the preliminary sizing of a new regional treatment facility incorporates a hydraulic capacity of 12.75 MGD, with the ability to easily expand to 17.0 MGD. Capital cost estimates are presented in Table 5.3 below for a new 12.75 MGD regional water treatment facility which uses the same treatment technologies as those proposed for the Town of Braintree treatment facility described in Section 4.0 An additional capital cost component for the regional treatment facility alternative includes approximately 5,000 feet of new 24-inch water main along West St. Operation and maintenance costs for a proposed regional water treatment facility are presented in Table 5.4, based on an average daily demand of 6.8 MGD. The costs presented in Tables 5.3 and 5.4 are based on January 2004 ENR cost indices.

Table 5.3
Capital Costs

Description	Cost
Equipment Cost	$4,900,000.00
Equipment Installation	$2,400,000.00
Process Mechanical Piping	$2,200,000.00
SCADA Instrumentation and Control	$600,000.00
Electrical	$400,000.00
Treatment Building	$1,600,000.00
Site Work	$450,000.00
Utilities	$1,200,000.00
Demolition	$900,000.00
Garage	$800,000.00
Transmission Piping	$1,000,000.00
Subtotal	**$16,450,000.00**
Engineering (20%)	$3,290,000.00
Contingency (20%)	$3,290,000.00
Total	**$23,030,000.00**

Table 5.4
Operational Costs

Description	Cost
Labor	$340,000
Energy	$250,000
Chemicals	$400,000
Maintenance (equipment & materials)	$60,000
Residuals (removal and disposal)	$40,000
Telemetry/Communications	$7,000
Laboratory Testing	$12,000
Emergency Fuel	$5,000
Total	**$1,114,000.00**

As previously discussed, the Town of Braintree is currently a member of the Tri-Town Board of Water Commissioners. In the current cost sharing arrangement between the three communities, the Town of Braintree pays for approximately 48% of all capital and operating expenses of the Tri-Town water system. If it is assumed that this same cost sharing model would be used for the capital and O&M costs for the proposed regional WTP presented in Tables 5.4 and 5.5, then the capital costs allocated to Braintree would be approximately $11,050,000, and the estimated annual O&M costs allocated to Braintree would be approximately $535,000/yr. A comparison of these allocated costs for a regional WTP with the costs presented in Table 5.1 and 5.2 for a Braintree WTP suggests a potential cost savings of approximately 28% in capital costs ($4.4 million) and approximately 24% in annual O&M costs ($173,000/yr), if the regional WTP were to be implemented.

It is critical to note that the cost sharing model and potential implementation of a regional water treatment facility have been over simplified in this report. The feasibility and detailed requirements for implementing a regional water treatment facility for the communities of Braintree, Randolph, and Holbrook is beyond the scope of this report. A summary of key questions and issues that must be addressed in order to effectively and efficiently move forward with this alternative is presented below:

1. The identification and description of regionalization alternatives.
2. The identification and development of cost sharing alternatives.
3. The identification of infrastructure requirements (each community).
4. An assessment of the legal jurisdiction and authority of each community and Board.
5. The make up and authority of the existing or new proposed Water Board.
6. The identification and evaluation of administrative and management control and policies.
7. The identification and evaluation of staffing, operation, and maintenance alternatives.
8. The evaluation and development of a financial and billing structure.

This report has identified a simple idea that suggests that if the Town of Braintree were to receive finished water from a new regional water treatment facility located adjacent to the site of their existing Great Pond WTP, then a savings in both capital and O&M costs would be achieved compared with constructing and operating a water treatment facility solely for the use of the Town of Braintree. Although on the surface it appears that this approach could be highly effective for solving water supply and treatment issues associated with the three communities of Braintree, Randolph, and Holbrook, there are many issues that need to be resolved before a definitive recommendation for the implementation of a regional water treatment facility can be made. Several key issues have been identified above, however other factors that may contribute to the debate and evaluation of a regional water treatment alternative include: the possibility of grants and loans; public/political acceptance; land ownership and control; or other legal, technical, or political issues that have yet to be determined.

ATTACHMENT "E" - BORING LOGS CDM 2010

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-1

Client: Tri-Town Water Board
Project Location: Braintree, MA

Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Walter Hoeckele
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/15/2008 **End:** 8/18/2008

Surface Elevation (ft.): 143
Total Depth (ft.): 31
Depth to Initial Water Level (ft):
Depth Date Time

Abandonment Method: Backfill with Cutting
Logged By: M. Cronin

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
143.0 / 0	SS	S-1	24	2 4 5 18	6			TOPSOIL	Dry, loose, brown, SILT, little medium to fine sand	
138.0 / 5	SS	S-2	5	100/5"	5			GLACIAL TILL	Dry, very dense, light brown, SILT, little fine sand Boulder Encountered, 4.5'-5.5'	
133.0 / 10	SS	S-3	9	48 100/3"	8				Wet, very dense, brown SILT, little coarse to fine sand, little fine gravel	
									Boulder Encountered, 12'-13'	
128.0 / 15	SS	S-4	10	108 100/4"	3				Wet, very dense, brown, SILT, little coarse to fine sand, trace fine gravel	
123.0	SS	S-5	8	104 100/2"	5				Wet, very dense, brown, SILT, little coarse to fine sand, trace fine gravel	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-1**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-1

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
123.0 / 20	SS	S-5	8		5			GLACIAL TILL		
118.0 / 25	SS	S-6	7	144 100/1"	6				Wet, very dense, brown, SILT, little coarse to fine sand, trace fine gravel Boulder Encountered, 24.5'-25.5'	
113.0 / 30	SS	S-7	5	150/5"	0				No Recovery - Rock in Spoon	
									B.O.E. = 31'	
108.0 / 35										
103.0 / 40										
98.0 / 45										

CAMP DRESSER & McKEE
CDM

Boring Number: CDM-2

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Walter Hoeckele
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/18/2008 **End:** 8/18/2008

Surface Elevation (ft.): 147
Total Depth (ft.): 36
Depth to Initial Water Level (ft):
Depth Date Time
Abandonment Method: Backfill with Cutting
Logged By: M. Cornin

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
147.0 / 0	SS	S-1	24	19 22 20 19	2			TOPSOIL	Dry, dense, brown, medium to fine SAND, trace silt	
142.0 / 5	SS	S-2	11	78 100/5	8			GLACIAL TILL	Moist, hard, brown, SILT, some coarse to fine sand, trace fine gravel	
137.0 / 10										
132.0 / 15	SS	S-3	4	100"/4	4				Wet, very dense, brown, coarse to fine SAND, some coarse to fine gravel, little silt Boulder Encountered,15'-17'	
127.0										

Sample Types
AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):			
V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):			
V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-2**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-2

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
127.0 / 20								GLACIAL TILL	Boulder Encountered, 20'-21'	
122.0 / 25	SS	S-4	7	130 100/1"	4				Wet, very dense, brown, coarse to fine SAND, some fine gravel, trace silt Boulder Encountered, 25'-26'	
117.0 / 30										
112.0 / 35	SS	S-5	7	160 100/1"	7				Wet, very dense, gray-brown SILT, little coarse to fine sand, trace fine gravel	
									B.O.E. = 36'	
107.0 / 40										
102.0 / 45										

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-5

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Walter Hoeckele
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/19/2008 **End:** 8/19/2008

Surface Elevation (ft.): 142
Total Depth (ft.): 27
Depth to Initial Water Level (ft):
Depth **Date** **Time**
Abandonment Method: Backfill with Cutting
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
142.0 / 0	SS	S-1	24	5 10 8 6	14			TOPSOIL	Dry, medium dense, dark brown, SAND, some silt, little organic roots	
137.0 / 5	SS	S-2	24	35 63 65 93	17			GLACIAL TILL	Wet, very dense, light brown, coarse to fine SAND and SILT, little medium to fine gravel	
132.0 / 10	SS	S-3	5	100/5"	4				Wet, very dense, light brown, coarse to fine SAND and SILT, little medium to fine gravel Boulder Encontered, 9.5'-11'	
127.0 / 15	SS	S-4	5	100/5"	5				Wet, very dense, light brown, coarse to fine SAND and SILT, little medium to fine gravel	
122.0	SS	S-5	24	62 83	17				Wet, very dense, light brown, coarse to fine SAND and SILT, little fine gravel	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):			
V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):			
V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-5**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-5

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Elev. / Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
122.0 / 20	SS	S-5	24	66 51	17			GLACIAL TILL		
117.0 / 25	SS	S-6	5	100/5"	0				No Recovery - Rock in Spoon	
	SS	S-7	5	100/6"	5				Wet, very dense, light brown, coarse to fine SAND, some silt, trace fine gravel Boulder Encountered at 27' B.O.E. = 27'	
112.0 / 30										
107.0 / 35										
102.0 / 40										
97.0 / 45										

BL LOGS.GPJ - 8/21/08

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-6

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Walter Hoeckele
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/14/2008 **End:** 8/15/2008

Surface Elevation (ft.): 147
Total Depth (ft.): 35
Depth to Initial Water Level (ft):
Depth Date Time

Abandonment Method: Backfill with Cutting
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
147.0 / 0	SS	S-1	24	7, 12, 7, 14	24			TOPSOIL	Moist, medium dense, brown, coarse to fine SAND, some silt, little medium to fine gravel	
142.0 / 5	SS	S-2	24	86, 55, 53, 63	24			GLACIAL TILL	Wet, hard, brown, SILT, some coarse to fine sand, little medium to fine gravel	
137.0 / 10	SS	S-3	9	74, 100/3"	6			GLACIAL TILL	Wet, hard, brown, SILT and medium to fine GRAVEL, some coarse to fine sand	
	Core	C-1	8		8			GLACIAL TILL	Boulder Encountered, 11-11.8'	
132.0 / 15	SS	S-4	12	80, 12/6"	3			GLACIAL TILL	Wet, brown, hard, SILT and medium to fine GRAVEL, some coarse to fine sand	
	SS	S-5	10	32, 100/4"	10			GLACIAL TILL	Wet, hard, brown, SILT and coarse to fine SAND, little medium to fine gravel	
127.0										

Sample Types
AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):				Fine Grained (Clay):			
V. Loose:	0-4	Dense:	30-50	V. Soft:	<2	Stiff:	8-15
Loose:	4-10	V. Dense:	>50	Soft:	2-4	V. Stiff:	15-30
M. Dense:	10-30			M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-6**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-6

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
127.0 / 20								GLACIAL TILL		
	SS	S-6	9	95 100/3"	9				Wet, very dense, brown, fine to medium SAND, little silt	
122.0 / 25										
	SS	S-7	6	120/6"	6				Wet, very dense, brown fine SAND and SILT	
117.0 / 30										
	SS	S-8	9	135 103/3"	9				Wet, very dense, brown, SILT, some coarse to fine gravel, little coarse to fine sand	
112.0 / 35									B.O.E. = 36'	
107.0 / 40										
102.0 / 45										

BL LOGS.GPJ - 8/21/08

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-7

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Walter Hoeckele
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/13/2008 **End:** 8/14/2008

Surface Elevation (ft.): 144
Total Depth (ft.): 25
Depth to Initial Water Level (ft):
Depth Date Time
Abandonment Method: Backfill with Cutting
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
144.0 / 0	SS	S-1	24	2 6 4 2	12			TOPSOIL	Moist, loose, dark brown, silty peat	
139.0 / 5	SS	S-2	4	100/4"	4			GLACIAL TILL	Wet, hard, brown, SILT and medium to fine GRAVEL, some coarse to fine sand	
	SS	S-3	10	61 100/4"	8			GLACIAL TILL	Wet, hard, brown, SILT, little fine sand	
134.0 / 10										
129.0 / 15	SS	S-4	4	100/4"	3			GLACIAL TILL	Wet, hard, brown, SILT and medium to fine GRAVEL, some coarse to fine sand	
	SS	S-5	10	51 100/4"	10			GLACIAL TILL	Wet, hard, brown, SILT, some coarse to fine sand, trace fine gravel	
124.0										

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):			
V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):			
V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-7**

CAMP DRESSER & McKEE
CDM

Boring Number: CDM-7

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
124.0 / 20										
	Core	C-1	7		7			GLACIAL TILL	Boulder Encountered, 21'-21.6'	
	SS	S-6	9	75 100/3"	9			GLACIAL TILL	Wet, hard, brown, SILT and coarse to fine SAND, little fine gravel	
119.0 / 25									B.O.E. = 25'	
114.0 / 30										
109.0 / 35										
104.0 / 40										
99.0 / 45										

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-9

Client: Tri-Town Water Board
Project Location: Braintree, MA
Project Name: Tri-Town WTP
Project Number: 01920-65292

Drilling Contractor/Driller: NH Boring / Don Pamer
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4"/ -
Hammer Weight/Drop Height/ Spoon Size: 140 lb / 30 in /2 in O.D.
Bore Hole Location:
See Boring Plan
N: E:
Drilling Date: Start: 8/13/2008 **End:** 8/13/2008

Surface Elevation (ft.): 145
Total Depth (ft.): 19
Depth to Initial Water Level (ft):
Depth Date Time
Abandonment Method: Backfill with Cutting
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Org. Vap. (ppm)	Graphic Log	Strata	Material Description	Remarks
145.0 / 0	SS	S-1	24	6 10 16 29	12			TOPSOIL	Moist, dark brown, medium dense, medium to fine SAND, some silt, little coarse to fine gravel.	
	SS	S-2	24	60 44 46 45	8			GLACIAL TILL	Moist, dark brown, very dense, coarse to fine GRAVEL, some medium to fine sand, little silt.	
140.0 / 5										
	SS	S-3	5	100/5"	0				No Recovery - Rock in Spoon	
135.0 / 10	SS	S-4	24	28 34 70 67	17				Wet, brown, very dense, medium to fine GRAVEL, little silt, little medium to fine sand.	
									Wet, brown, hard, SILT, little medium to fine sand.	
130.0 / 15	SS	S-5	12	102 103	6				Wet, brown, very dense, coarse to fine SAND, some silt, little fine gravel.	
	SS	S-6	12	73 115	12				Wet, brown, very dense, coarse to fine SAND, some silt, trace fine gravel.	
125.0									B.O.E. = 19'	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

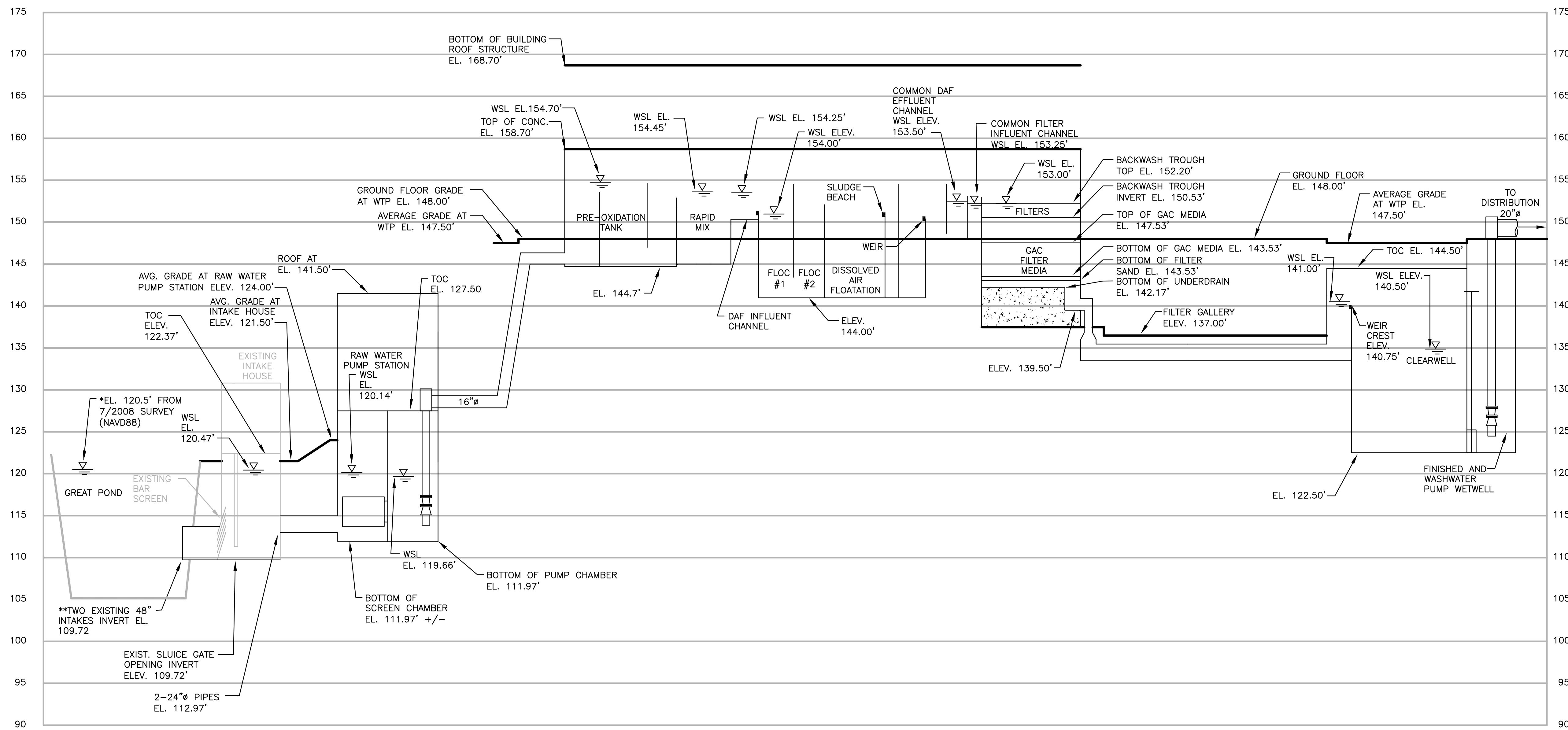
Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-9**

ATTACHMENT "F" - PRELIMINARY CONCEPT PLANS



*NORMAL HIGH WATER ELEV. 121.3' (TAKEN FROM EP FIRM YIELD STUDY)

**TAKEN FROM 1971 SEA PLANS FOR INTAKE STRUCTURE

NOTES:
1. ALL ELEVATIONS ARE NAVD88 DATUM.

BASIS OF HYDRAULIC PROFILE

FLOW DESCRIPTION	FLOW (MGD)	NUMBER OF UNITS IN SERVICE
MAXIMUM DESIGN	12.5	3 – RAW WATER PUMPS 2 – PRE-OXIDATION 1 – RAPID MIX 3 – FLOCCULATION / DAF 4 – FILTERS 1 – CLEARWELL 6 – FINISHED WATER PUMPS

NOTE: MINIMUM DESIGN FLOW: 2.8 MGD

Environmental Partners GROUP
A partnership for engineering solutions.

MARK	DATE	DESCRIPTION

Scale	N.T.S.
Date	APRIL 2019
Job No.	181-1801
Designed by	DNRP
Drawn by	AJR
Checked by	DNRP
Approved by	HTG

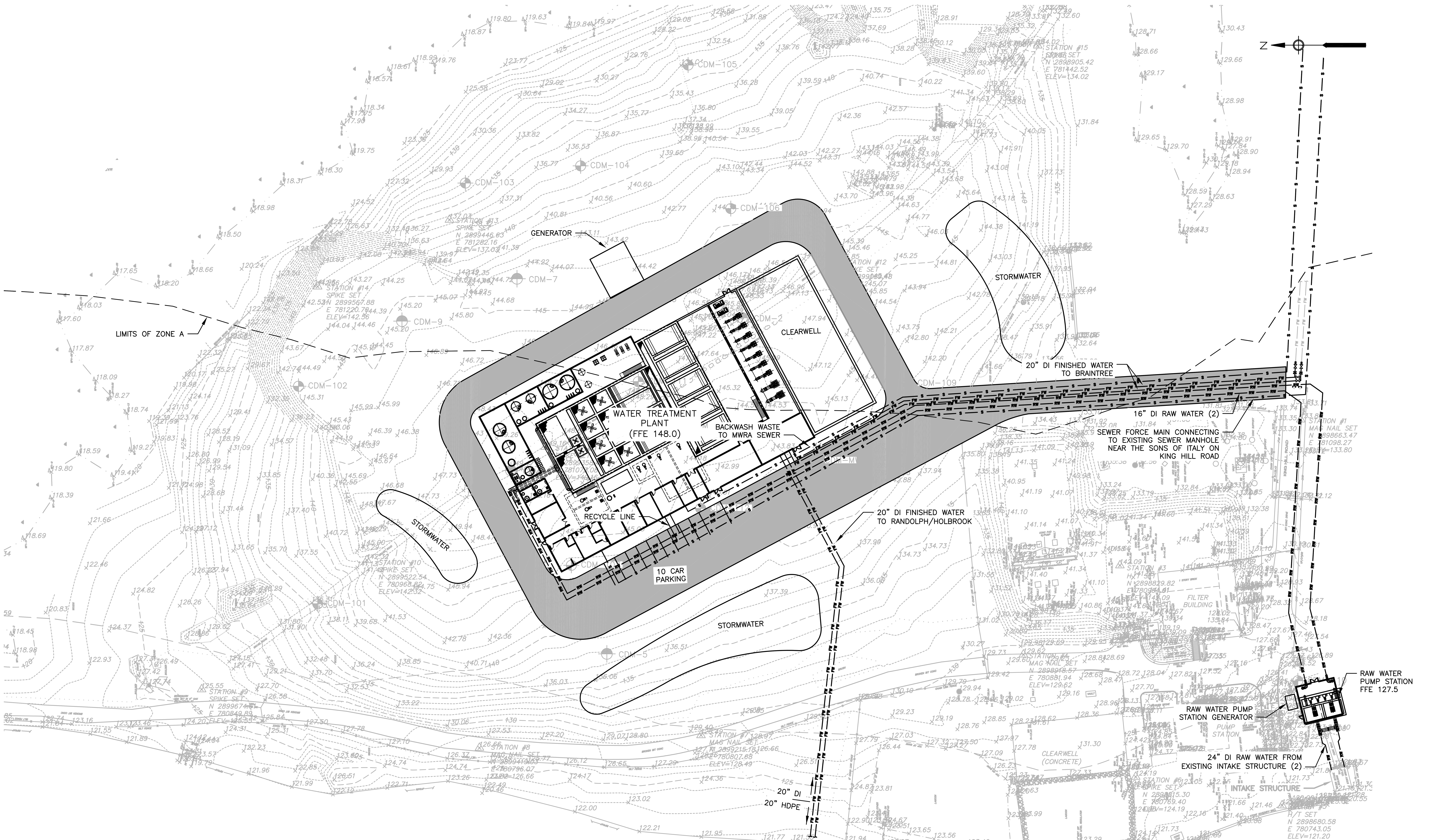
THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

HYDRAULIC PROFILE

NOT FOR CONSTRUCTION

Sheet No.
G-2



SITE LAYOUT AND GRADING PLAN

SCALE: 1"=40'-0"

Environmental Partners GROUP

A partnership for engineering solutions.

MARK	DATE	DESCRIPTION

Scale	AS SHOWN
Date	APRIL 2019
Job No.	181-1801
Designed by	AJL
Drawn by	AJL
Checked by	AJR
Approved by	HTG

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

CONCEPTUAL SITE PLAN

NOT FOR CONSTRUCTION

Sheet No.

C-1

Drawing file: I:\Tri-Town (Brain,Rand,Holb) 181\181-1801 OPM Services WTP\Phase I - Value Engineering, Schematic Prep, Designer selection\06. Concept\Civil Site\Civil Sheets.dwg Plot Date: Apr 23,2019-12:39pm

NOTES:
1. ALL CHEMICAL FEED POINTS LISTED AS DRY DOSE.

Environmental Partners GROUP
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MARK	DATE	DESCRIPTION

Scale	AS SHOWN
Date	APRIL 2019
Job No.	181-1801
Designed by	DNRP
Drawn by	AJR
Checked by	DNRP
Approved by	HTG

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

PROCESS FLOW DIAGRAM

NOT FOR CONSTRUCTION

Sheet No.

G-1

GROUND LEVEL PLAN

SCALE: 3/32"=1'-0"

Environmental Partners GROUP
A partnership for engineering solutions.

MARK	DATE	DESCRIPTION

Scale	AS SHOWN
Date	APRIL 2019
Job No.	181-1801
Designed by	AJL
Drawn by	AJL
Checked by	AJR
Approved by	HTG

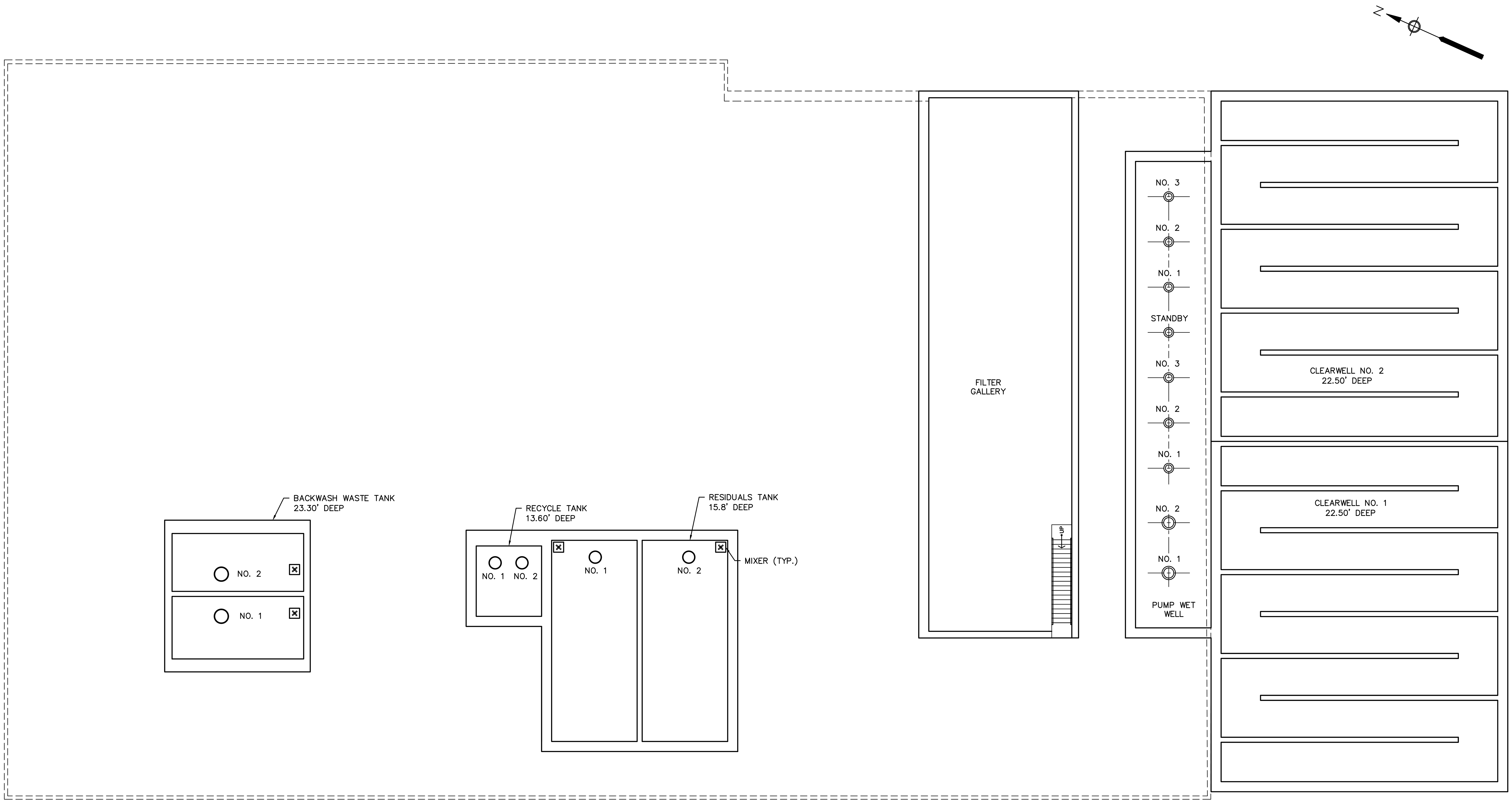
THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

GROUND LEVEL PLAN

NOT FOR CONSTRUCTION

Sheet No.
M-1



BELOW GRADE TANK PLAN

SCALE: 3/32"=1'-0"

Drawing file: C:\Users\a\appdata\local\temp\AcPublish\16336\M-Sheets.dwg Plot Date: Apr 02,2019-7:18pm

Environmental Partners GROUP
A partnership for engineering solutions.

MARK	DATE	DESCRIPTION

Scale	AS SHOWN
Date	APRIL 2019
Job No.	181-1801
Designed by	AJL
Drawn by	AJL
Checked by	AJR
Approved by	DNRP

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

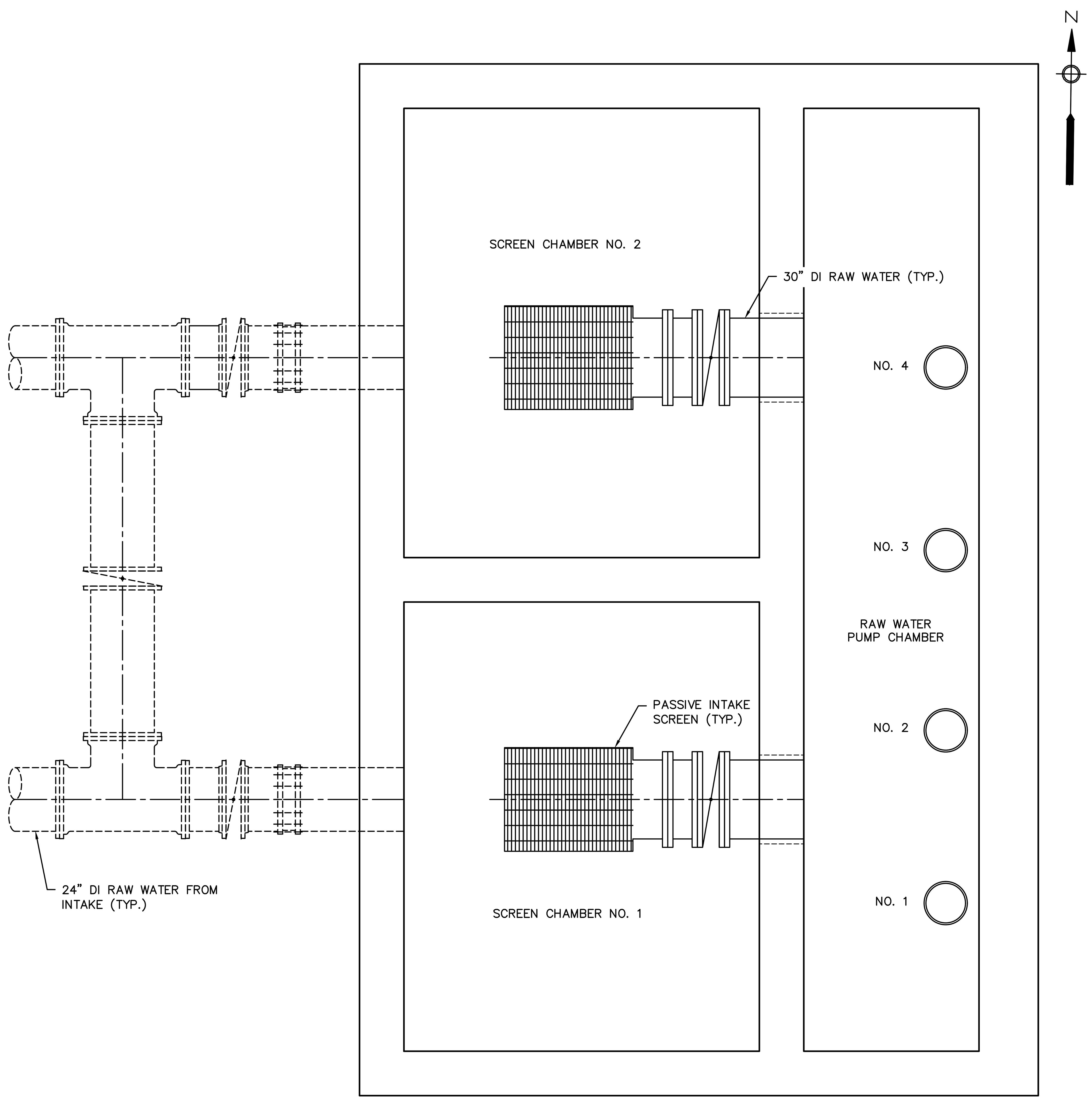
TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

BELOW GRADE TANK PLAN

NOT FOR CONSTRUCTION

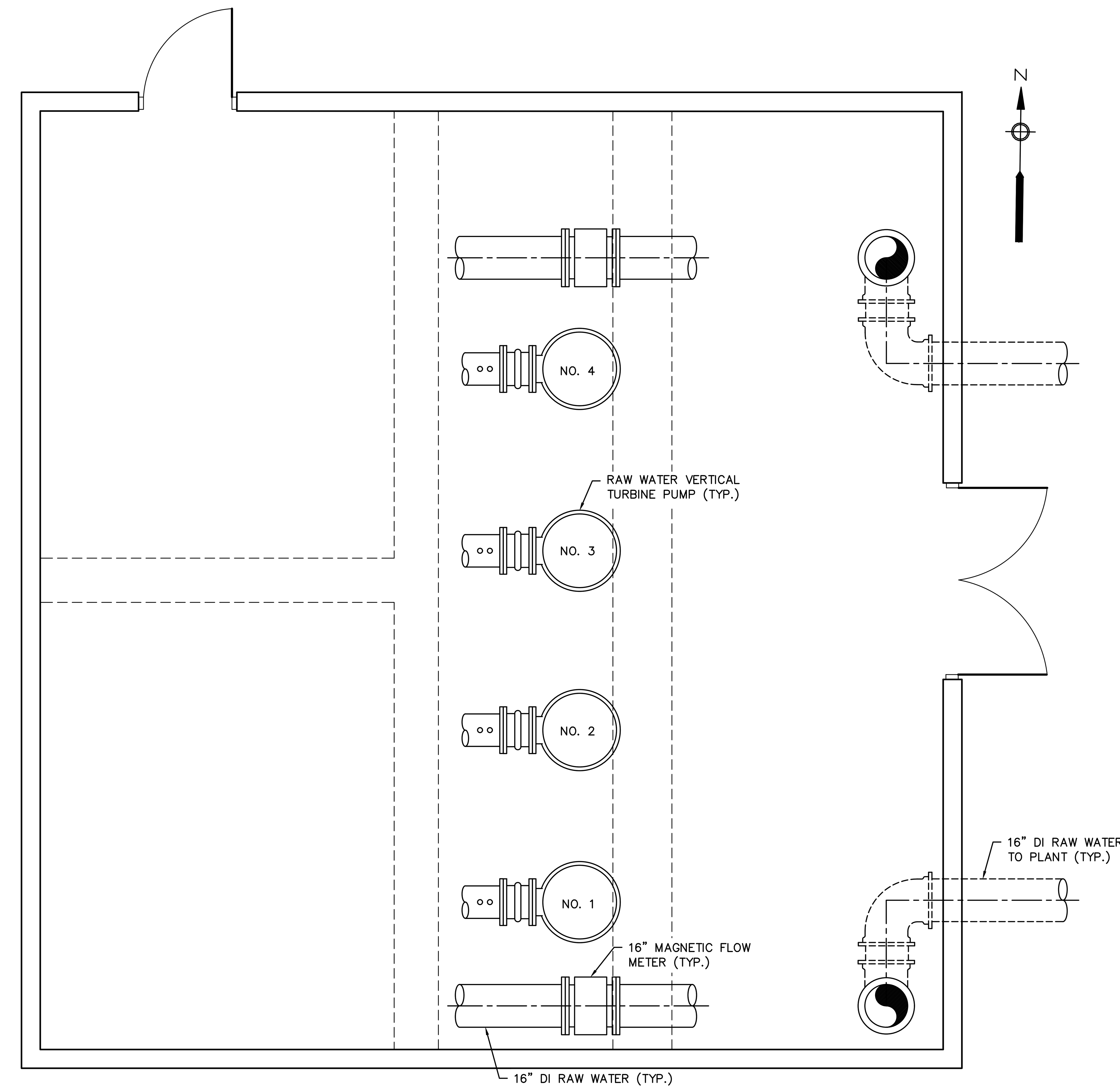
Sheet No.

M-2



RAW WATER PUMP STATION BELOW GRADE FLOOR PLAN

SCALE: 3/8"=1'-0"



RAW WATER PUMP STATION GROUND FLOOR PLAN

SCALE: 3/8"=1'-0"

Drawing file: C:\Users\a\fappdata\local\temp\AcPublish_16336\M-Sheets.dwg Plot Date: Apr 02,2019-7:18pm

Environmental Partners GROUP

A partnership for engineering solutions.

MARK	DATE	DESCRIPTION

Scale	AS SHOWN
Date	APRIL 2019
Job No.	181-1801
Designed by	AJL
Drawn by	AJL
Checked by	AJR
Approved by	DNRP

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

TRI-TOWN REGIONAL WATER TREATMENT PLANT
CONCEPTUAL DESIGN
TRI-TOWN BOARD OF WATER COMMISSIONERS

RAW WATER PUMP STATION

NOT FOR CONSTRUCTION

Sheet No.

M-3

ATTACHMENT "G" - FORMS

Standard DSB Application Form

Reference Forms

Conflict of Interest Statement

Certification of Authorization

Non-Collusion Statement

Tax Compliance Certificate

Designer Certifications

W-9 Form

STANDARD DESIGNER SELECTION BOARD
APPLICATION FORMS

DOWNLOAD FORMS FROM COMMONWEALTH OF MASSACHUSETTS WEBSITE
WWW.Mass.gov
LINK PROVIDED BELOW

https://www.mass.gov/service-details/dsb-forms

REFERENCE FORM

1. Have you ever failed to complete a contract awarded to you?______yes _
_no

2. If yes, where and why?

____

3. Have you ever failed to complete a contract awarded to you?______yes _
_no If yes, where and why?

____

____

4. Please attach **CURRENT** contact information from three recent projects (last five years) for the Principal-in-Charge and for the Project Manager, even if this information appears in your proposal. This should, of course, be someone who is specifically familiar with each individual's work. Include the following information for each listing:

Project Name
Nature of Work Completed by
Firm Owner
Location
Dollar Amount of Designer's Fee
Date Completed
Contact Person's Name & Relationship to Project
Contact Person's CURRENT employer:
Contact Person CURRENT Telephone
Contact Person CURRENT Email

CONFLICT OF INTEREST STATEMENT

The undersigned certifies under penalties of perjury that no official or employee of the governmental body for which the attached solicitation is proposed has a pecuniary interest in this proposal or in the contract which it offers to execute or in expected profits to arise therefrom; and, further that no official or employee of said governmental body will receive any commission, discount, bonus, gift, contribution, or reward from or share in the profits of any person making or performing such a contract. As used in this certification, the word "person" shall mean any natural person, business, partnership, corporation, union, committee, club, or other organization, entity, or group of individuals.

__________________________ ____________________

(Signature) (Date)

____

(Print Name)

____

(Name of Business)

Does your firm or any of the employees proposed for this work or who may work on this project have an interest, directly or indirectly, that may lead to a conflict or the appearance of a conflict in the performance of work as proposed herein?

_______Yes ______No

CERTIFICATE OF AUTHORIZATION

(NOTE: A certified vote of the corporation may be substituted for this form.)

The Vendor,____is: (CHECK ONE)
(Name of Company/Designer/Corporation)

_______ A. a corporation formed and existing under the laws of the state of ____________________________________, and pursuant to the corporate by-laws, _

____
(Insert Name and Title of Authorized Representative)

is authorized to execute contracts in the name of said corporation. Such execution of any contract or obligation in this corporation's name on its behalf by such duly authorized individual shall be valid and binding upon the corporation.

_______ B. a limited liability company or a partnership formed and existing under the laws of the state of________________________________, and pursuant to the limited liability company agreement or partnership agreement,

____
(Insert Name and Title of Authorized Representative)

is authorized to execute contracts in the name of said company or partnership. Such execution of any contract or obligation in this company or partnership's name on its behalf by such duly authorized individual shall be valid and binding upon the company or partnership.

_______ C. is a sole proprietorship owned an operated exclusively by the undersigned.

____
(Insert Name and Title of Authorized Representative)

Execution of any contract or obligation in this sole proprietorship's name by such duly authorized individual shall be valid and binding.

____
Signature:
(Must be signed by Corporate Officer, Partner, or Sole Proprietor)

____
Print Name of Above

____
Title

____
Date

CERTIFICATION OF NON-COLLUSION

The undersigned certifies under penalties of perjury that this Response or Response has been submitted in good faith and without collusion or fraud with any other person. As used in this certification, the work "person" shall mean any natural person, business, partnership, corporation, union committee, club or other organization, entity or group of individuals.

For (Vendor/Company) *

____
Signature

Printed Name: ____

Title: ____

Date: ____________________________________

*Must be signed by the person signing the Response, Response, or contract.

CERTIFICATION OF TAX COMPLIANCE

I,____, for__________________________, (Name of representative, position/title) (Company / Designer)

a Company, Designer or Corporation existing or formed under the laws of the

_______________________________________, having a principal place of business at (state)

____, hereby certify that the
(Company/Designer/Corporation Business Address)

Company/Designer/Corporation is in full compliance with all laws of the Commonwealth of Massachusetts relating to taxes, as required by Massachusetts General Laws, Chapter 62C, Section 49A.

Signed under pains and penalties of perjury this______________________day of

_____________, 20___.

____
(signature of representative/position/title)

____
(print name of person signing above)

Date: __________________________________

DESIGNER CERTIFICATIONS

[Required by MGL Chapter 7C, Section 51(d)]

The undersigned certifies under the penalties of perjury:

1. That the DESIGNER has not given, offered or agreed to give any person, corporation or other entity any gift, contribution or offer of employment as an inducement for, or in connection with, the award of the Contract for design services; and

2. That no Designer to or subcontractor for the DESIGNER has given, offered or agreed to give any gift, contribution or offer of employment to the DESIGNER, or to any other person, corporation, or entity as an inducement for, or in connection with, the award to the Designer or sub-contractor of an Contract by the DESIGNER; and

3. That no person, corporation or other entity, other than a bona fide full time employee of the DESIGNER, has been retained or hired by the DESIGNER to solicit for or in any way assist the DESIGNER in obtaining the Contract for design services upon an Contract or understanding that such person, corporation or other entity be paid a fee or other consideration contingent upon the award of the Contract to the DESIGNER; and

4. That with respect to contracts which exceed ten thousand dollars or which are for the design of a building for which the budgeted or estimated construction costs exceed one hundred thousand dollars that the DESIGNER has internal accounting controls as required by MGL Chapter 30 Section 39R (c), and that the DESIGNER has filed and will continue to file an audited financial statement as required by MGL Chapter 30 Section 39R (d).

Firm______________________________ **Signature**_________________________

Address____________________________ **Name (print)**_______________________

Title ______________________________ _________________________

Telephone__________________________ **Date** _________________________

Form **W-9**
(Rev. December 2011)
Department of the Treasury
Internal Revenue Service

Request for Taxpayer Identification Number and Certification

Give Form to the requester. Do not send to the IRS.

Print or type
See Specific Instructions on page 2

Name (as shown on your income tax return)
Town of Braintree

Business name/disregarded entity name, if different from above

Check appropriate box for federal tax classification:
☐ Individual/sole proprietor ☑ C Corporation ☐ S Corporation ☐ Partnership ☐ Trust/estate

☐ Limited liability company. Enter the tax classification (C=C corporation, S=S corporation, P=partnership) ▶

☐ Exempt payee

☐ Other (see instructions) ▶

Address (number, street, and apt. or suite no.)
One JFK Memorial Drive

Requester's name and address (optional)

City, state, and ZIP code
Braintree, MA 02184

List account number(s) here (optional)

Part I **Taxpayer Identification Number (TIN)**

Enter your TIN in the appropriate box. The TIN provided must match the name given on the "Name" line to avoid backup withholding. For individuals, this is your social security number (SSN). However, for a resident alien, sole proprietor, or disregarded entity, see the Part I instructions on page 3. For other entities, it is your employer identification number (EIN). If you do not have a number, see *How to get a TIN* on page 3.

Note. If the account is in more than one name, see the chart on page 4 for guidelines on whose number to enter.

Social security number
_ _ _ - _ _ - _ _ _ _

Employer identification number
0 4 - 6 0 0 1 0 9 7

Part II **Certification**

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me), and
2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding, and
3. I am a U.S. citizen or other U.S. person (defined below).

Certification instructions. You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the certification, but you must provide your correct TIN. See the instructions on page 4.

Sign Here Signature of U.S. person ▶ Date ▶

General Instructions

Section references are to the Internal Revenue Code unless otherwise noted.

Purpose of Form

A person who is required to file an information return with the IRS must obtain your correct taxpayer identification number (TIN) to report, for example, income paid to you, real estate transactions, mortgage interest you paid, acquisition or abandonment of secured property, cancellation of debt, or contributions you made to an IRA.

Use Form W-9 only if you are a U.S. person (including a resident alien), to provide your correct TIN to the person requesting it (the requester) and, when applicable, to:

1. Certify that the TIN you are giving is correct (or you are waiting for a number to be issued),

2. Certify that you are not subject to backup withholding, or

3. Claim exemption from backup withholding if you are a U.S. exempt payee. If applicable, you are also certifying that as a U.S. person, your allocable share of any partnership income from a U.S. trade or business is not subject to the withholding tax on foreign partners' share of effectively connected income.

Note. If a requester gives you a form other than Form W-9 to request your TIN, you must use the requester's form if it is substantially similar to this Form W-9.

Definition of a U.S. person. For federal tax purposes, you are considered a U.S. person if you are:

- An individual who is a U.S. citizen or U.S. resident alien,
- A partnership, corporation, company, or association created or organized in the United States or under the laws of the United States,
- An estate (other than a foreign estate), or
- A domestic trust (as defined in Regulations section 301.7701-7).

Special rules for partnerships. Partnerships that conduct a trade or business in the United States are generally required to pay a withholding tax on any foreign partners' share of income from such business. Further, in certain cases where a Form W-9 has not been received, a partnership is required to presume that a partner is a foreign person, and pay the withholding tax. Therefore, if you are a U.S. person that is a partner in a partnership conducting a trade or business in the United States, provide Form W-9 to the partnership to establish your U.S. status and avoid withholding on your share of partnership income.

Cat. No. 10231X Form **W-9** (Rev. 12-2011)