Tri-Town Board of Water Commissioners

Regional Water Treatment Plant

September 2008

Final Draft Preliminary Design Report

Section 1
Introduction

1.1 General

The Tri-Town Water Commission (Town's of Braintree, Randolph and Holbrook) maintains three water supply reservoirs yielding 100 percent of the three town's total supply. In order to maintain this system, which has served the towns for over 100 years, a new treatment facility must be constructed to replace the aging, existing separate Braintree and Randolph/Holbrook Water Treatment Plants. Camp Dresser & McKee Inc. (CDM) conducted a study for the Town of Braintree entitled "Evaluation of the Safe Yield of the Great Pond Reservoir System – January 1989" which shows the safe yield of the active system to be 5.6 million gallons per day (mgd). The registered withdrawal for the three Towns is a combined total of 7.14 mgd (Braintree 3.87 mgd and Randolph/Holbrook 3.27 mgd), which exceeds the safe yield of the system. The Tri-Town has undertaken a reservoir storage capacity increase program which is an integral part of the overall water supply and treatment plan for the three communities. The Tri-Town system will still have to implement water restrictions until this program is completed.

The Massachusetts Department of Environmental Protection (MassDEP) and the Tri-Town Water Commission have entered into past Consent Orders to provide increased safe yield to the system and MassDEP has suggested the construction of a Regional WTP to replace the existing 1930's facilities.

1.2 Scope of Preliminary Design

The goal of the Preliminary Design Report is to document and develop plans of the site, filtration, and storage with other water system improvements to be used in final design. The Preliminary Design Report incorporates the results of treatment performance obtained during pilot testing and detailed in Environmental Partner's "Great Pond Reservoir Pilot Study Report dated April 2004.

The specific objectives of the Preliminary Design Report include:

1. Review the pilot study and recommended improvements contained in the "Great Pond Reservoir Pilot Study."

2 Preliminary field investigations, including survey and soils. (Braintree site)

3. Evaluation for pumping to the Randolph/Holbrook distribution system.

4. Water treatment plant, finished water storage, lagoons and pumping layout and descriptions.

5. Permits required for construction of facilities.

6. Prepare estimate of probable cost for facilities, including WTP construction costs and storage tank cost.

The Preliminary Design Report has been prepared to address these objectives and become a blueprint for final design.

Section 2
Water Treatment

2.1 General

The proposed Tri-Town water treatment plant/tank site is located on Braintree-owned property that is adjacent to the existing Braintree WTP located on the eastern shore of the Lower Great Pond. (Refer to Preliminary Site Plan and Yard Piping, Sheet 1 of 2, Appendix A).

- Existing traffic access by the Water Department is via short access route off King Hill Road.
- Existing 24-inch water main effluent line from the Braintree WTP runs through the site with connection to the distribution system on King Hill Road and also along a northerly connection to West Street.
- All proposed structures to be located on Braintree property (refer to Water Treatment Facility Layout and Yard Piping Plan, Sheet 1 of 2, Appendix A).

  1. Water Treatment Plant
  2. Two 2-Million Gallon Tanks
  3. Lagoons
  4. Raw Water Pumping Station
  5. Backwash Water Tank

- Upgrade power to water treatment plant facility — eastern and/or northern access.
- Provide access improvements to service water treatment plant facility, including chemical tank trucks— eastern and/or northern access.
- Possible route for finish water effluent water main, gas line, and future water treatment plant sewer via existing forcemain eastern access.

2.1.1 Treatment Building Layout

The preliminary layout seeks to minimize overall building footprint by wrapping the support functions around the core treatment process structure. Figures SK-A-1, 2, and 3 illustrate the four major components of the treatment facility; treatment units, chemical feed area, pump room, and administrative and support areas.

The overall building dimensions are approximately 240 feet by 140 feet, two stories 28 feet tall above grade with lower level pipe gallery. Total building area is approximately 56,800 square feet. Finished water pump room, lobby, garage and chemical storage will be two stories high. First floor non-process areas will house mechanical, electrical and employee locker rooms. Second floor non-process areas will house Administration offices, conference room, control room, laboratory, lunch, storage and support spaces. A hydraulic elevator will connect the first and second floors.

Envelop - The building skin will be a combination of insulated masonry cavity wall - (exterior wythe of brick, CMU, precast or combination), insulated foam metal panels, metal panels, and glazed curtainwall. The building envelop will meet or exceed the requirements of the energy code.

Roof - insulated "flat" fully adhered membrane roof, either EPDM or thermoplastic, light color for energy efficiency. Roof structure will slope to drains to minimize tapered insulation thickness. The skylight will be translucent insulated panels structure running in a single spine centered over the process treatment room

Interior Finishes - the design will minimize applied finishes to reduce capital and long-term maintenance costs.

- Interior Walls - Exposed CMU will be factory glazed. Gypsum board walls in Admin Areas will be painted with latex paint. Concrete walls will not be painted. Exposed common "wet" walls will be covered with masonry in ‘public’ areas.

- Interior Floors - Concrete floors will receive hardener except as noted: Lobby floor will be polished or acid stained concrete; Chemical room floors and containment areas will receive chemical resistant resinous coatings. Admin area floors will be carpeting (offices, conference room), resilient tile (storage, lunch), ceramic tile (toilets, lockers, showers), and chemical resistant safety floor (laboratory and lab office)

- Ceilings - most ceilings will be painted exposed structure with acoustic absorptive treatment in lobby and pump room. Admin areas will have suspended acoustical ceilings. Cast-in-place and precast concrete will not be painted

- Doors - Exterior doors will be aluminum. Interior doors in process areas will be painted steel or stainless for corrosive areas. Interior doors in Admin areas will be wood. Service doors will be motorized, insulated aluminum overhead type.

- Windows and Glazing - Insulated, energy efficient glass will be used throughout. Tinted or ceramic coated glass and roof overhangs will be used to shade sunlight and minimize heat gain. Exterior framing will be aluminum curtainwall, storefront or windows with operable vents. Interior framing will be hollow metal (steel). Corrosive areas will employ aluminum or stainless steel.

- Louvers - extruded aluminum storm-proof louver will be used where required and will be located so as not to detract from building aesthetics.

- Paint - epoxy coatings will be applied to piping, conduit, surfaces and materials subject to corrosion. Stainless steel and factory finished items will not be painted. Concrete will typically not be painted. Labeling for chemical piping will be via applied banding

- Stairs - painted steel stairs with concrete infill will be used in the egress stair towers. Aluminum or concrete stairs will be used in pipe gallery. Lobby monumental stair will be custom steel design. Stair and railing design will assume at least one publicly accessible 'tour' route.

Accessibility - Except for certain mechanical and service areas the building and site will be substantially handicap accessible, in compliance with Mass State Code and ADA.

Sustainability - energy and environmentally conscious design ideas will be incorporated without incurring substantial additional cost. LEED certification will not be pursued although the project may have accumulated enough points to support LEED level certification at a future time.

Ground floor level support areas include employee locker/shower/toilet facilities as well as main electrical and building mechanical rooms.

- The Electrical room will house the motor control center equipment required to distribute the incoming power throughout the plant. This space will have dedicated temperature and humidity controls.

- Mechanical rooms will contain the equipment required to provide heat and hot water to the building. A forced hot water natural gas boiler is recommended for the building. A two-zone heating system will allow the administration area of the building — where the personnel will work — to be kept at a higher temperature, while the chemical area and process area of the building can be maintained at lower temperatures. This system will help to minimize the operating costs of the plant.

The Main Lobby provide an ‘public’ access and security control point immediately adjacent to the administration and control areas.

Upper floor administration area includes employee lunch room, public toilet rooms and storage spaces in addition to the following key areas:

Offices and Conference Room

This area will contain the office for the plant manager and for the chief operator. The reception and clerical areas are adjacent to the office, conference room and the control room. The process area, pump room and main entrance can be viewed from this space.

Control Room

This area will contain the main WTP control panels and visual display for the operator plant operation. The operator has views of the process and pump room as well as lobby and site approach.

The proposed Instrument and Control (I&C) system is a distributed type with a computerized central operating station located in the control room with remote stations configured in a distributed network throughout the plant and communicating over a dual-high speed data highway. The system is designed for maximum central monitoring and control with minimum installed wiring costs and maximum security.

Laboratory

This area provides for routine testing of operational parameters for the WTP as well as regulatory compliance and water quality testing.

2.1.2 Building Superstructure

The building that will house the water treatment facilities should have the following characteristics:

- Require low maintenance.
- Be constructed of durable material tolerant of aggressive environments and chemicals in the plant.
- Be visually attractive on the reservoir site.

The core of the building will be cast in place concrete, with the roof over the DAF and filters utilizing precast prestressed concrete roof double tees. Structural steel framing will be used for the chemical area, administrative areas, and finished water pumping area.

Second floor will be cast in place concrete on steel deck, supported by steel beams and columns. The roof framing will be steel deck and steel joists, supported on steel beams and columns. A bridge crane in the finished water pump room and a monorail in the treatment process areas will be provided for handling heavy equipment.

2.1.3 Standby Power

Standby power is provided for the treatment of average day flow and pumping plus building service. A standby diesel engine-driven generator is recommended with a sound attenuating enclosure and double walled fuel storage.

2.1.4 Wastewaters

Wastewater is generated during DAF skimming and filter backwashing. Volumes of wastewater for each are presented in the Basic Design Data and are based upon intermittent skimming and a filter run length of 30 hours. The daily volumes of DAF skim and spent filtered backwash water are 100,000 gallons and 150,000 gallons (recycled), respectively at a 7.2-mgd WTP flow rate. The total solids is estimated to be 375 lb/d (pounds per day) (as dry solids), or approximately 137,000lb/yr (pounds per year). The estimated volume of the dry solids is 15,500 ft^3/yr (cubic feet per year).

The spent backwash water will flow by gravity to a 100,000-gallon tank from which it will be pumped back to the WTP influent. The lagoons have been sized to store a 1-year accumulation of solids within one lagoon. Under this operational approach, two lagoons will be in operation during a given year and one lagoon will be off-line to dewater the stored sludge. Dewatering of the sludge will occur due to evaporation, freezing, and thawing. Dewatered sludge is anticipated to be greater than 30-percent solids. The dewatered sludge cake can then be trucked for ultimate land disposal.

Domestic sanitary wastewater will be pumped directly into the existing force main. Chemical wastes from the laboratory will be neutralized prior to disposal.

2.1.5 Future Treatment Facilities

Results of piloting indicated the distribution system local average THM and PAH value should remain at or below approximately 80 micrograms per liter (mcg/1) and 60 mcg/l, respectively using chlorine as primary disinfectant. Should new regulations be more stringent than 80 mcg/1 and 60 mcg/l, it may be necessary to add ammonia. Should chloramination be required to meet more stringent future THM and PHA regulations, space for the added chemical feed system will be provided.

2.1.6 Basic Performance Criteria Data

The performance criteria for the treatment units will be included in the specification for the treatment facility. Two separate trains of three basins each are included, each rated at 2.5 mgd, five basins for a total capacity of 12.5 mgd and one standby basin. The criteria are summarized in Table 2-1.

Table 2-1
Design Criteria
Tri-Town
Regional Water Treatment Plant

Plant Design Criteria

Plant Capacity

Normal Design/Average Day	7.2 mgd
Maximum Design/Maximum Day	12.5 mgd

Raw Water Pumps

Number	3
Type (VFD)	vertical turbine
Motor	100 hp
Volts/pH/Hz	460/3/60
Capacity of Each Pump	4,600 gpm

Raw Water Transmission Pipe

Diameter	36 inches
Length (approximately)	800 feet
Material	Ductile Iron, Class 52
Working Pressure (psi)	20
Test Pressure (psi)	150
Depth of Bury	60 inches, nominal

Raw Water Venturi

Number	2
Size	2-16 inches
Material	Cast iron
Throat Diameter	12 inches

Clari-DAF System Design Criteria

Total number of trains	2
Number of Basins per Train	3
Total Number of Basins	6 (1 basin Standby)

Loading Rate Based on Basin Area at Design Flow	8 gpm/sf
Loading Rate Based on Basin Area at Minimum Flow	7.20 gpm/sf
Loading Rate Based on basin Area at Maximum Flow	9.60 gpm/sf
Number of Rapid mixers per Train	1 total 2
Type (VFD)	Axial IMP
Motor	5 hp
Volts/pH/H_2	460/3/60
Rapid Mix Retention Time	30 sec
Number of Flocculation Stages per Basin	2 total 12
Flocculation Retention Time per Basin at Design Flow	13.5 mim
Flocculation Retention Time per Basin at Minimum Flow	15.0 min
Flocculation Retention Time per Basin at Maximum Flow	11.25 min
Type (VFD)	Axial IMP
Motor	5 hp
Volts/pH/H_2	460/3/60

Air Compressors

Type (VFD)	Rotary Screw
Total Number	4
Number in Standby	2
Flow Capacity per compressor	10.9 scfm
HP	15

Recycle Pumps

Type (VFD)	End Suction
Total Number	8
Number in Standby	2
Flow Capacity per Pump	174 gpm
Total Dynamic Head Requirement	217 ft
HP	20

Filters (GAC)

Total Number	6 (1 filter standby)
Size	384 ft^2
Filter Depth	60 inches
Media Type	Dual media
Media Material	Coarse – GAC Fine – silica sand

Hydraulic Flows	1.0 to 2.5 mgd
Underdrain	Stainless steel laterals with media retaining screen

Chemical Feed Systems

Sodium Hypochlorite (12.5-15%)

Number of Pumps	4 (2 spare)
Type	Loss of motion positive displacement, hydraulic diaphragm proportioning
Adjustments	Micrometer control, speed adjustable 80 to 150 spm
Pumping Rates	1.65 to 16.5 gph
Bulk Storage	2-4,000-gallon, high density cross-linked polyethylene tank
Piping	2-inch schedule 80 CPVC with a 2-inch BV at the tank. 3/4-inch schedule 80 CPVC suction and discharge piping for pump. 3/4-inch BV on suction and discharge

Sodium Hydroxide

Number of Pumps	4 (2 spare)
Type	Loss of motion positive displacement, hydraulic diaphragm proportioning
Adjustments	Micrometer control, speed adjustable 80 to 150 spm
Pumping Rates	1.65 to 16.5 gph
Bulk Storage	2-6,000-gallon, high density cross-linked polyethylene tank
Piping	2-inch schedule 80 CPVC with a 2-inch BV at the tank. 3/4-inch schedule 80 CPVC

	suction and discharge piping for pump. 3/4-inch BV on suction and discharge

PACl

Number of Pumps	4 (2 spare)
Type	Loss of motion positive displacement, hydraulic diaphragm proportioning
Adjustments	Micrometer control, speed adjustable 80 to 150 spm
Pumping Rates	3.5 to 35 gph
Bulk Storage	2-8,000-gallon, high density cross-linked polyethylene tank
Piping	2-inch schedule 80 CPVC with a 2-inch BV at the tank. 3/4-inch schedule 80 CPVC suction and discharge piping for pump. 3/4-inch BV on suction and discharge

Cationic Polymer

Poly Blend Type Mixer & Transfer Pump

Rotameter	0 to 40 gph
Transfer Pump Range	0.04 to 1.0 gph
Piping	1/2-inch flexible suction hose; 1/2-inch schedule; 80 CPVC inlet and discharge; 1/2-inch CPVC; BVs on suction and discharge piping

Anionic/Nonionic Polymer

Drum Pump Output	0.5 gpm
Polymer Solution Day Tank	30-gallon polyethylene
Mixer Manufacturer	Neptune
Model	GM-2.0
Input, RPM	1,725
Output, RPM	288
hp	1/3
Shaft and Impeller Material	316 stainless steel
Batch Water Meter	5/8-inch resettable counters
Number of Pumps	2 (1 installed; 1 spare)

Type	Electronic/magnetic diaphragm proportioning
Adjustments	Micrometer stroke control, frequency adjustable
Piping	1.2-inch CPVC suction and discharge with 1/2-inch CPVC. BVs discharge piping increases to 3/4-inch CPVC

Finished Water Pumps (2 sets)

Number	3 each
Type (VFD)	vertical turbine
Motor	250 hp
Volts/pH/Hz	460/3/60
Capacity	500 to 2,300 gpm

Finished Water Venturis

Number	2
Size	20 inches
Material	Cast iron
Throat Diameter	14 inches

Finished Water Storage Tanks

Number	2
Capacity Each	2 MG
Material	Precast, prestressed concrete
Inside Diameter	150 feet
Sidewall Height	15 feet
Inlet and Drain Sizes	24 inches
Outlet Size	24 inches
Cover	Domed top with vent and access hatch

Backwash System

Air Scour Blower

Number	2
Type	Rotary lobe
Motor	20 hp
Volts/Phase/Hz	460/3/60
rpm	1,100
Capacity	560 scfm

Backwash Water Supply

Transmission Pipe	20 inches

Supply	Finished water storage tank/backwash pump

Backwash Pump

Number	2
Type	Vertical, centrifugal
Motor	125 hp
Volts/Phase/Hz	460/3/60
Capacity	7,700 gpm at 40 feet TDH

Backwash Water Collection

Waste Water Header	24 inches
Sludge Discharge Collection	50,000-gallon receiving
Sludge Lines	tank 24-inch ductile iron

Sludge Lagoons

Number	3
Approximate Maximum Capacity Each Pond	1-40,000ft3 or 300,000 gallons/Pond Total 3 ponds 120,000 ft^3 or 900,000 gallons

2.2 Description of Treatment Facilities

Raw water taken from Great Pond Reservoir flows by gravity through an existing intake structure to the existing WTP. New raw water pumps will be installed in a new facility to pump water to the treatment facility. The raw water flows will be metered by new venturi flowmeters and be monitored by a continuous sampling turbidimeter. Potassium permanganate will be added at the raw water pump station to oxdize iron and managanese.

At the treatment facility, the raw water flows through two rapid mix chambers. The mixing chambers are outfitted with multiple diffusion points for addition of the following chemicals:

1. Polyaluminum chloride (PACl) - coagulant
2. Cationic Polymer – coagulant aid
3. Anionic Polymer – filter aid

The chemically treated water is then directed via sluice gates to the six (6) flocculation chambers. Equalization of flow to each basin is accomplished by manual actuator.

The chemically treated water passes through the tapered floc zone. In an upflow mode, the water is combined with dissolved air to float the formed particles. A reciprocating skimmer system is designed to optimize the removal of coagulated particles (floc) the clarified water then under flows to a weir into the GAC/sand gravity filter unit.

The filter bed is 60 inches deep GAC/sand type. The media is composed of two materials, each of different size and specific gravity, providing uniform distribution from coarse to fine in the direction of flow. The water flows by gravity (in a downflow mode) through the filter media.

The flow rate of each filter is governed by a probe-type electronic level controller which modulates the motor operated effluent BFV to match effluent flow to influent flow.

The water (after leaving each filtration chamber, but prior to each effluent butterfly valve) is sampled by means of a sampling pump. The samples are directed toward a single turbidimeter. A microprocessor controls the selection of sample points by selective operation of the sample pumps and their related solenoid valves.

The data (turbidity) generated by this sampling is electronically fed back to the microprocessor, which in turn will vary the speed of the coagulant (PACl) pump to adjust dosages as required to maintain the effluent turbidity goal.

The filtered water is then collected in a common 24-inch effluent pipe. The water flows by gravity through the effluent pipe to the two 2 mgd baffeled finished water tanks. Sodium hyochlorite is injected prior to the tank for disinfection.

The water flows by gravity to the pump room wet well. Variable speed, finished water pumps convey the water to the distribution systems. The pumping rate of the finished water pumps is controlled by each distribution system tank level telemetry.

The finished water is monitored as it leaves the pump room gallery, but before it enters the distribution system, for chlorine residual and pH. A sample line is brought into the plant to the chlorine and pH analyzers. Chlorine is added if the residual is below required levels. Caustic soda is added to the tank discharge for pH adjustment. A venturi flow measuring device will provide pacing of the caustic soda and chlorine.

Provision will be made for a polyphosphate to be injected into the filtered water pump discharge line paced to finish water flow.

The backwash water is piped to the holding tank from which it is pumped to the plant influent.

Three residual lagoons will receive the DAF skimming residuals. Solids are directed toward one lagoon at a time for a year. Excess water which is relatively clean will overflow a weir into a 12-inch pipe and be directed to the reservoir or reclamation.

After approximately one year, the first lagoon will be taken out-of-service, allowed to decant and dewater. The second lagoon will be used while the sludge in the first lagoon is allowed to dry. After drying, the sludge will be removed and the lagoon cleaned and readied for reuse. A third lagoon is available to aid in solids management.

Reclamation of the washwater will be by one of two methods. The normal mode of operation will be by gravity discharge of clarified top water to Great Pond Reservoir. Provisions will also be made for recycle to the treatment plant influent.

2.2.1 System Capacity

The water treatment facility is necessary to provide filtered water meeting the requirements of the SDWA to Braintree and Randolph/Holbrook.

This treatment plant with a capacity of 12.5 million gallons per day (mgd) will enable the Tri-Town to maximize the use of its supplies. It should be noted that the surface water supplies that feed this facility will not have enough safe yield during drought years to meet the 7.2-mgd average capacity. During these periods, each town will need to impose restrictions. The regional WTP capacity is equal to the combined capacity of the two existing water treatment plants. The new facility has a standby basin and filter which may be also used in a pilot plant application.

2.2.2 Intake Structure and Pumping

Water flows by gravity through an existing intake structure and 24-inch supply main to a new raw water pump station.

The existing screens are made up of two 24-inch diameter stainless steel well screens. The screens are manually cleaned. The screen maintenance system may be modified.

After screening, the water flows through the 24-inch pipe to the existing Braintree WTP. A section of the existing 24-inch line will be tied into and connections made to new raw water pump station.

The pumping system is comprised of three variable speed, 100 hp vertical turbine pumps. The pumps have a maximum capacity of 4,600 gpm each. The system is designed so that any combination of pumps can operate at a time. The raw water pumps have VFD controlled motors that are paced by plant flow settings.

2.2.3 Raw Water Metering

Pumped raw water to the plant passes through two primary venturi meters. The venturis are used in metering the volume of water pumped to each process train. In addition, signals are sent from a flow indicting recorders (FIR) to a flow indicating controller (FIC). The FIC, in turn, retransmits a signal to pace the pretreatment chemical feed pumps (PACL, anionic polymer and cationic polymer). The standby basin (pilot train) will have independent flow measurement and chemical feed provided.

The FIC also is used to control the raw water pumps when they are placed in the "remote" position.

2.2.4 Chemical Addition and Mixing

Raw water is pumped from the raw water pumping station to the water treatment facility. After entering the treatment facility, the raw water is directed to two rapid mixers ahead of each process train. Chemical diffusers will be strategically designed into the mixer chambers. The three chemical diffusers provided are:

1. PACL
2. Cationic Polymer
3. Anionic Polymer

Potassuim Permaganate will be injected at the raw water P.S. The oxidation process for iron and manganese will occur in the 36-inch raw water pipeline feeding the WTP.

PACL is the primary coagulant added and may be injected before the mechanical rapid mix process. Coagulation takes place in the mixer and after the water leaves the rapid mixer prior to dissolved air flotation (DAF) units.

Sodium hypochlorite may be used to oxidize organic matter and iron or manganese. Hypochlorite may also be added to disinfect the DAF and filter media.

Sodium hydroxide may be used to adjust the pH of the water, if required to optimize to coagulation process.

Cationic polymer can be used as a primary coagulant, although it is intended in this application to be a coagulant aid to PACL. The use of this polymer will enhance the formation of floc. Cationic polymer will also toughen the floc — that is — make it more resistant to shearing or tearing in the DAF units.

Anionic polymer is the last chemical added. This chemical may be used as a filter aid. It conditions the filter bed surface and improves the filter adsorption.

Chemical requirements are defined in Table 2-1 and includes: dose in mg/1, chemical use in lb/day, form of delivered chemical and 30-day requirement, and storage requirements.

2.2.5 Dissolved Air Floatation

After being chemically treated the water flows to a manifold, where it is equally split and directed toward the two treatment trains. Each train of three basins each is then clarified through the DAF process at a high rate. A portion of the clarified water is recirculated through the system to provide a large amount of 30 to 100 micron sized bubbles. The recycled water is pressurized with 75 to 90 psig air and delivered to a saturation vessel where it is distributed across the entire surface area. Once the water passes through the plastic packing media, it pools on the bottom of the vessel for a period of time to "off-gas" the excess air entrained. The recycle is then injected back into the basin through a recycle injection header equipped with a series of dispersion nozzles. The nozzles in the header provide a dramatic pressure drop from 75 to 90 psig down to the static water pressure in the DAF cell. This sudden pressure drop reverses the physical laws that dissolved the air into the stream and creates a cloud of 30 to 100 micron bubbles.

The bubbles created by the recycle then attach themselves to the flocculated particle in the water. The bubble attachment decreases the specific gravity of the particle and forces it to rise to the top of the basin where a sludge layer is formed. This sludge layer is supported by an excessive number of bubbles created by the dispersion system. As the sludge layer increases, the sludge is forced to float above the water level, allowing it to slightly dewater and thicken. After a period of time, a mechanical skimmer removes the sludge layer into the sludge effluent trough.

The entire process is a balance between pressure and flow. The fixed orifice nozzle assembly provided on the dispersion header fixes the pressure in the system. Each nozzle is sized for a specific flow and pressure. The system will therefore only operate at one pressure and one flow. Therefore, in the case plant flow must be adjusted the recycle flow percentage shall be adjusted in lieu of the actual recycle flow.

2.2.6 Filters

A total of six (6) two component GAC/sand media filters have been provided (one standby). Media materials of differing size and specific gravity result in a filter that hydraulically grades coarse to fine in the direction of flow. This configuration provides series of progressively finer materials which remove increasingly smaller particles throughout the entire depth of the filter bed. This results in an ability to accept higher solids loadings, slower headloss buildup, and a consistent filtered water quality.

A lateral underdrain system lays on the floor of the filter box. The underdrains collect filtered water and introduce backwash water. Over the underdrains is placed a layer of supportive silica gravel.

The filter bed is comprised of a silica sand on the bottom and GAC on the top. The particle sizes range from 1.2 millimeters (mm) down to 0.3 mm. The filter bed is 60 inches deep.

As water passes through the filter bed, solids are captured resulting in a headloss buildup. At a predetermined headloss, a "backwash" cycle is initiated. Upon activation, the backwash cycle closes the filter effluent valve and allows the water level to reach a predetermined level. A level probe senses the predetermined level and closes the influent valve and allows the backwash process to proceed.

The first portion of the filter backwash consists of an air scour. Air is introduced to the bottom of the filter and as the air escapes through the media, the agitation effectively causes the media to scrub itself and release the embedded particulate matter. The air scour lasts for about 2 minutes. This is followed by a water wash.

Pumped water passes through a venturi meter before being directed toward the filter that is being backwashed. The venturi measures the flow of the washwater and, via a flow indicating transmitter, signals the filter control cabinet. The filter control cabinet, in turn, controls the motorized butterfly valve on the washwater header. In this manner, the backwash rate is kept consistently at a preset backwash rate. A maximum rate of 7,700 gpm is provided.

The washwater is directed in through the underdrain system, up through the media, and carried out through the washwater trough for discharge to the waste washwater holding tank.

After a predetermined time period the cycle automatically will end. The valving will automatically be rearranged for filtering to waste and then to resume normal treatment.

2.2.7 Finished Water Tanks and Finished Water Pumps

The effluent from the filters is collected in a common 36-inch ductile iron pipe. The filtered water then flows by gravity to the tanks. The filtered water is treated with sodium hypochlorite for disinfection. Phosphates and hydroxide be added for corrosion control as the water flows from the Tanks to the Finished Water Pump Wells.

Two sets of three variable speed, 2,300 gpm, vertical turbine pumps are installed in the pump room. The pumping rate normally is paced by the distribution system tank water levels in each of the respective systems.

A level indicating transmitter (LIT) senses the actual level of water in the well. The signal from the LIT is fed to a level indicating controller (LIC). The LIC, in turn, varies the speed of the operating pump to maintain the water level in a preset range.

Post-treated water is pumped and passes through two venturis. The signal from the venturi is used to measure and record flow and totals the gallons being pumped. The signal from the venturis is used to pace the hypochlorite, and phosphate chemical additions for corrosion control.

2.2.8 Finished Water Storage

Two two-million gallon precast, prestressed concrete tanks have been provided for the storage of finished water. The concept of finished water storage is based on three considerations:

The storage tanks ensure an ample capacity of water to meet high demand periods. These demands, at times, may be greater than the maximum output of the treatment facility (10,500 gpm). Causes of these demands are peak hourly consumption or emergency situations (e.g., fire flows or broken water mains).

The second consideration is that storage minimizes plant operating time. Through experience and proper scheduling, the plant may be operated during times of normal high demand (during the day), and shut down during the times of very low demand (nights). Before shutting down, the tanks will be full. The distribution system will draw down the storage tanks at a very slow rate during the late night, early morning hours. The plant will be restarted very early in the day and begin refilling the tanks. Storage also serves as a buffer in the event the treatment facility needs to be shut down for emergencies.

The third consideration and perhaps most important is that the storage tank provides the detention time necessary to ensure complete disinfection (CT) with chlorine before the water enters the distribution system. The total combined detention time, including the 24-inch transmission main, is approximately 100 minutes at 10,500 gpm flow rate. The chlorine residual requirement can be as low as 0.6 mg/1.

2.2.9 PACL Sludge Disposal Lagoons

Water containing PACL residual solids is collected after DAF skimming. The materials are direct gravity flow to the lagoons.

Waste skimwater will normally be directed to only one lagoon at a time. In this manner, another lagoon can be dewatered and the sludge allowed to freeze, dry, and be removed and disposed.

As the washwater enters the lagoon, the lagoon's water level rises and the excess water may be decanted to vary the lagoon water level as much a s 4 feet. The clarified effluent is either discharged to the Great Pond Reservoir or reclaimed.

The lagoon decant to Reservoir requires a National Pollution Discharge Elimination Systems (NPDES) permit. The permit should be closely examined by all operating personnel. All of the parameters of the discharge will be called out in the permit. Standards, including volumes and chemical concentrations, must be monitored and must comply with those described in the permit.

2.2.10 Washwater Reclamation

The reclaimed water is pumped into the water treatment plant influent line. Two constant speed submersible pumps have been installed in the backwash tank. The pumps are separately controlled by the water level. The reclaimed water is pumped through a 12-inch pipe to the raw water line. The reclaimed water then mixes with the raw water at the treatment plant for processing.

2.2.11 Telemetry

The RTUs' locations are as follows:

1. Braintree Distribution Storage Tanks
2. Randolph Distribution Storage Tanks
3. Holbrook Distribution Storage Tanks
4. Holbrook Pumping Station
5. Braintree Booster Pumping Station
6. Water Treatment Plant

The information that is transmitted is received at the Master Control Station (MCS) located at the WTP building.

The system is used to collect status and/or alarm information from each RTU. These conditions are visually displayed on a panel at the MCS. An ongoing record of these conditions, once received at the MCS, is recorded on the system's computer software.

The information may also be displayed on the computer's monitor (CRT) and/or be printed out as a hard copy.

This system will initially be used for status indication, but it may be expanded in the future to include remote operation.

The Tri-Town SCADA system will be controlled by a computer master station. The master station calls each RTU in sequence after which each RTU responds with all of its data. Each RTU will not transmit unless requested by the master station.

The following is a typical list of information that may be supplied by each RTU:

1. Booster Pumping Stations
   a) Low room temperature/intrusion (common alarm)
   b) Pump No. 1 run
   c) Pump No. 2 run
   d) Tank low/high pressure alarm
   e) Pump No. 1/No. 2 low flow
   f) Primary power fail
2. Distribution System Storage Tanks
   a) Tank level
   b) Power fail
3. Water Treatment Plant
   a) Raw Water Pump No. 1 fail
   b) Raw Water Pump No. 2 fail
   c) Raw Water Pump No. 3 fail
   d) Finished Water Pump No. 3 fail (Braintree and Randolph/Holbrook)
   e) Finished Water Pump No. 2 fail (Braintree and Randolph/Holbrook)
   f) Finished Water Pump No. 3 fail (Braintree and Randolph/Holbrook)
   g) Raw Water Pump No. 1 run
   h) Raw Water Pump No. 2 run
   i) Raw Water Pump No. 3 run
   j) Finished Water Pump No. 1 run (Braintree and Randolph/Holbrook)

k) Finished Water Pump No. 2 run (Braintree and Randolph/Holbrook)

l) Finished Water Pump No. 3 run (Braintree and Randolph/Holbrook)

m) Low finished water residual chlorine

n) Low filtered water residual chlorine

o) High finished water pH

p) Raw water flows

q) Raw water turbidity

r) Raw water pump discharge pressure

s) Filtered water turbiditys

t) Finished Water Pressures (Braintree and Randolph/Holbrook)

Each RTU has a 12-volt battery for backup power. The batteries are trickle charged by an on board battery charger during normal operation. Power failure conditions are reported to the MCS.

An automated telephone dialer has been interfaced with this system. This unit will be used to notify the emergency duty person of critical alarms during periods that the MCS is unmanned.

Several telephone numbers will be programmed into the dialer. If an alarm that has been programmed as critical is received, the dialer will be activated. The telephone dialer will continuously dial the programmed telephone numbers until a connection is made. When a connection is made, a voice synthesized message will be delivered describing the alarm

Loss of chlorine residual and high filtered water turbidity will shut the plant down as will high raw water discharge pressure and full storage tank. Other alarm situations may be considered for triggering plant shutdown.

All alarms will require that an operator go to the plant to physically check the situation.

2.3 Staffing

It is anticipated that the water treatment facility will be in operation for 24 hours per day, except during periodic maintenance and will be staffed at all times.

A Grade IV Massachusetts certified operator must be responsible for the facility. The operator must oversee the treatment process, maintenance, chemical inventories, and preparation. He/she prepares all reporting data for recordkeeping and MassDEP, as may be required.

The water treatment plant staff would serve under the overall direction of the Plant Manager. The Chief Operator would also serve as the overall Laboratory Supervisor. The staff would include three additional Certified Operators, a Head Maintenance Mechanic and Mechanic/Laborer.