DRAFT
PRELIMINARY DESIGN REPORT

PFAS REMOVAL AND RELATED UPGRADES
D'ANGELIS WATER TREATMENT FACILITY

MILLIS, MA WATER DEPARTMENT
PWSID 2187000
TOWN OF MILLIS, MA

JUNE 2021

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A Report Prepared for:

Mr. James McKay
Director of Public Works
Town of Millis, MA
900 Main Street
Millis, MA 02054

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Prepared by:

Alexander B. Bishop, P.E.
Project Professional

Reviewed by:

Felipe S. Contreras, P.E., C.M.E., C.F.M.
Principal Engineer

KLEINFELDER
One Beacon Street, Suite 8100
Boston, MA 02108
Phone: 617.497.7800

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1 INTRODUCTION

1.1 PROJECT BACKGROUND AND SUMMARY

The Millis Water Department (PWS -2187000) currently operates six supply wells and four treatment plants. In April and May of 2020, Millis began voluntarily sampling all of its wells for per- and poly-fluoroalkyl substances (PFAS) in anticipation of the MassDEP promulgating new drinking water regulations for PFAS. Millis' initial supply well sampling results for PFAS-6[1] were below the Office of Research and Standards Guidelines (ORSG) of 20 nanograms per liter (ng/L) or parts per trillion (ppt) in place at that time. The D'Angelis Water Treatment Plant (DWTP) results from the April and May PFAS-6 sampling were 17.6 and 17.1 ng/L, respectively. These results represent a blend of water from Well 1 and Well 2, which are treated at the DWTP. Additional samples collected at the DWTP in August 2020 were 20.9 and 21.6 ng/L and the treatment facility was immediately taken offline. On October 2, 2021, the MassDEP published a new Massachusetts Maximum Contaminant Level (MCL) for PFAS6 of 20ng/L. Millis is therefore seeking to upgrade the treatment system at the DWTP to continue providing consumers with high quality safe drinking water which consistently complies with Massachusetts Maximum Contaminant Levels and Office of Research and Standards Guidelines

In March 2021, Millis was awarded a MassDEP PFAS Treatment Grant which will fund pilot testing through 30% design of upgrades to the D'Angelis WTP. The deliverable result of the grant is this Preliminary Design Report (PDR), which will be used to develop a final design and construction plans and specifications.

The main objective of the proposed treatment plant will be to effectively remove PFAS-6 compounds using filtration granular activated carbon (GAC) to below regulatory limits with a goal of non-detect (by current laboratory standards). Removal of PFAS-6 from raw water at the DWTP will bring this treatment location into compliance with current Massachusetts PFAS MCLs. The proposed building is being sized to accommodate the possibility of future treatment upstream of the GAC contactors to adapt to changes in water quality or meet future regulatory requirements.

[1] *PFAS6 represents the combined concentration of six regulated PFAS compounds: PFOS,PFOA, PFHxS, PFNA, PFHpA, PFDA).*

The expanded building size will allow the Millis Water Department to be able to cost effectively and readily add treatment such as filters for iron and manganese removal.

1.2 PROJECT SCOPE

This Preliminary Design Report (PDR) was developed to evaluate PFAS removal options, and to recommend a single design concept so that the subsequent design phase may proceed to advance the selected concept to completion for bidding. This PDR will provide a brief overview and evaluation of PFAS removal and treatment options for Wells 1 and 2 at the DWTP, which treats these sources. Both wells have been found to contain levels of PFAS above the MassDEP's recently published MCL of 20 nanograms per liter (ng/L) for PFAS6.

The project scope of this PDR includes the following components, which are provided in the PDR sections listed below:

- Section 2 - Basis of design (water quality, flow, applicable regulations, current treatment objectives, and space for future treatment needs)
- Section 3 - Identification of site considerations (soils and groundwater, environmental hazards and regulations, site access and security, property ownership/boundaries, room for expansion)
- Section 4 and Appendices - Results of geotechnical investigation
- Section 5 - Preliminary design narrative and process flow diagrams for treatment processes (review of piloting protocols and results, sources, pumping, corrosion control, chemical feed systems, filtration, residuals management alternatives and feasibility analysis, disinfection, process equipment, hydraulics, monitoring)
- Section 6 - Building design (functions and rooms, architectural design approach and materials, structural design approach, electrical, standby power, HVAC, security, mechanical and plumbing design approach)
- Section 7 – Upgrades needed for Wells 1 and 2 for compatibility with the treatment design
- Section 8 - Instrumentation and control (architecture, alarms, integration with SCADA)
- Section 9 - Identification of required federal, state, and local permits and approvals
- Section 10 – Discussion of procurement approach
- Section 11 and Appendix F - 30% Opinion of probable construction cost and discussion of possible funding sources and project schedule
- Appendix A: 30% preliminary design drawings

2 BASIS OF DESIGN

Treatment objectives for upgrades to remove PFAS from the D'Angelis Water Treatment Plant (DWTP) and Wells No. 1 & 2 were developed based on the current conditions found to exist at each of the wells, on current and future regulatory requirements, and on desired project goals. This section summarizes historical and technical information obtained during previous investigations, information about regulations that have the potential to influence this project, and the overall project goals developed within those constraints.

2.1 RAW WATER QUALITY

Raw water quality data is presented in Table 2-1. This water quality data was collected as part of the piloting study conducted at the Well #2 and the DWTP between May 13th and 26th , 2021. The table also includes the applicable MassDEP regulatory limits for all parameters presented. Raw water from Well #2 is in compliance with all primary and secondary drinking water standards with the exception of PFAS6. Elevated levels of PFAS-6 exceeded the Massachusetts MCL in the raw water which includes:

- Perfluorooctane Sulfonic Acid (PFOS);
- Perfluorooctanoic Acid (PFOA);
- Perfluorohexane Sulfonic Acid (PFHxS);
- Perfluorononanoic Acid (PFNA);
- Perfluoroheptanoic Acid (PFHpA); and
- Perfluorodecanoic Acid (PFDA)

Volatile Organic Comounds (VOCs) including tetrachloroethylene (TCE), trichloroethylene (TCE) and 1,1 dichloroethane (DCE) were within drinking water standards as part of the pilot test results presented in Table 2-1 but have historical been out of compliance in the past as seen in Table 2-2.

Table 2-1: Raw Water Quality During Pilot Testing

Contaminant	*Unit*	Regulatory Limit or Guideline	Raw Water Source Concentration	Number of Samples
Alkalinity	*mg/L of $CaCO_3$*	-	44.00	3
Arsenic	*mg/L*	-	ND	3
Calcium	*mg/L*	-	40.05	2
Chloride	*mg/L*	250	176.00	3
Color (True/Apparent)	*A.P.C.U.*	15	ND	3/3
Hardness	*mg/L*	-	163.00	2
Iron	*mg/L*	0.3	ND	2
Manganese	*mg/L*	1	0.0049	2
Magnesium	*mg/L*	-	15.25	2
pH	*s.u*	-	6.48	3
Sulfate	*mg/L*	250	15.90	3
Sodium	*mg/L*	20	55.95	2
Zinc	*mg/L*	5	0.01	2
Total Coliform	*col/100mL*	negative	negative	3
Total Dissolved Solids (TDS)	*mg/L*	500	386.67	3
Total Organic Carbon (TOC)	*mg/L*	-	0.54	2
Total Suspended Solids (TSS)	*mg/L*	-	ND	3
Turbidity	*NTU*	-	ND	3
Oxidation reduction Potential	*mv*	-	196.67	3
Conductivity	*umhos/cm*	-	663.33	3
PCE (tetrachloroethylene)[1]	*ug/L*	5	0.52	3
TCE (trichloroethylene)[1]	*ug/L*	5	2.97	3
DCE (1,1 dichloroethane)[1]	*ug/L*	-	0.5	3
PFAS-6[2]	*ng/L*	20	22.20	4
PFBS (perfluorobutane sulfonic acid)	*ug/L*	-	2.57	4
PFHxA (perfluorohexanoic acid)	*ug/L*	-	4.91	4

Notes
ND indicates non-detection
- Indicates that the compound does not have a standard promulgated by MassDEP.
All concentrations represent averages based on the total amount of samples taken.

Table 2-2 presents the Contaminants of Concern (COCs) and include historical sampling results along with the piloting results from May 2021. Also presented are the analytical results from Well #1 and finished water from the DWTP.

Table 2-2: Contaminants of Concern Summary

Contaminant	Unit	Regulatory Limit or Guideline	Well 01	Well 02	Finished[4]
PCE (tetrachloroethylene)[1]	ug/L	5	0.96	0.99	< 0.5
TCE (trichloroethylene)[1]	ug/L	5	2.29	5.01	< 0.5
DCE (1,2 dichloroethane) [1]	ug/L	5	0.61	0.71	< 0.5
PFAS-6[2]	ng/L	20	16.8	25.9	21.2

[1]Average 2018-2021
[2] Average 2008-2021
[3] Average 08/12 & 08/27/2020
[4] Finished water samples were taken at DWTP and is representative of blended treated water from Wells 1 & 2.

PCE/TCE/DCE – All congeners of PCE's degradation pathway are present in raw well water (with exception of vinyl chloride), with the historical average TCE concentration exceeding the MCL of 5 ug/L which warrants the use of the existing air stripper (or other treatment method) for removing volatile organic compounds.

PFAS-6 (combined) – Both wells experienced a sharp uptick in concentration in Summer 2020, resulted in blended finished water exceeding the newly established MassDEP MCL of 20 ng/L.

2.2 DESIGN FLOWS

Wells 1 and 2 supply the DWTP and are currently operated at and have a combined approved withdrawal limit of 1.22 million gallons per day (MGD). Table 1 shows the breakdown for each well in terms of flowrate, typical run times, and withdrawal limits.

Table 2-2: DeAngelis Water Treatment Plant Wells Data

Well	Flow Rate (GPM)	Typical Run Time Hours (Summer/ Winter)	MassDEP Permitted Withdrawal (MGD)
Well 1	500	6 / 8	0.72
Well 2	350	6 / 8	0.5
Total	850	---	1.22

Under normal operations, Wells 1 and 2 pump simultaneously based upon a water level indicator in the 6,800 gallon clearwell at the DWTP. Water pumped from the wells flow through the aeration column and chemical injection in the DWTP before discharging into the tank as shown on the Process Flow Diagram in Appendix A. High head vertical turbine pumps on the clearwell pump finished water into the distribution system, which is controlled by pressure/water level in the Farm Street Water Storage Tank.

The new PFAS treatment plant will be designed for a flow rate of 850 gpm equal to a total permitted withdrawal of 1.22 MGD.

2.3 APPLICABLE RULES AND REGULATIONS

Existing rules and regulations governing projects of this type in Massachusetts were reviewed for their applicability to this project. Regulations reviewed included both those specific to water treatment projects and those applicable to building projects. The results of this review are summarized below.

2.3.1 Water Treatment Rules and Regulations

Drinking Water Standards: There are enforceable drinking water standards for numbers of contaminants, including broad classes like volatile organic chemicals (VOCs), synthetic organic chemicals (SOCs), and inorganic chemicals. These chemicals are regulated by the United States Environmental Protection Agency (EPA) under the National Primary Drinking Water Regulations. There are also secondary standards for aesthetic water quality, as well as Health Advisories. Massachusetts has in some cases adopted standards, guidelines, and health advisories that are more stringent than EPA's. Sampling and analytical requirements for the drinking water standards can be found in the Code of Massachusetts Regulations 310 CMR 22.07.
Assessment: Routine compliance monitoring shows that Millis is in compliance with these standards with the exception of PFAS6, which is not regulated at the federal level but is by Massachusetts (see below).

Ground Water Rule: The EPA promulgated the Groundwater Rule (GWR) in October 2006. The intent of the GWR is to monitor and control microbial contaminants in groundwater. It establishes an approach to identify water sources at a high risk of fecal contamination and specifies when corrective action is required. The primary GWR requirements for public water suppliers include:

- Massachusetts must conduct periodic sanitary surveys to assess significant deficiencies in groundwater systems.
- Source water monitoring to test for the presence of *E. coli*, enterococci, or coliphage.
- Corrective action for systems with significant deficiencies or source water fecal contamination. Corrective options include elimination of the contamination source or the addition of treatment. Treatment systems must be monitored to ensure at least 4-log virus removal is being achieved.

Assessment: The most recent sanitary survey conducted by DEP on December 28, 2020 revealed no major system deficiencies and the DWTP provides 4-log disinfection as required under the GWR.

Revised Total Coliform Rule: The Revised Total Coliform Rule (RTCR) was promulgated in 2013 and went into full effect in on April 1, 2016. The Total Coliform Rule (TCR) established an MCL for total coliform bacteria present in drinking water and resampling requirements from positive samples. The RTCR provides updates to the TCR and established a new "find and fix" approach with defined pathways for addressing positive total coliform hits through system assessments.

Assessment: Millis has disinfection processes for each well in the system. Millis is in compliance with this regulation although the most recent sanitary survey made recommendations for Millis to submit 4-log certification paperwork for Wells 3, 5, and 6 to document 4-log virus treatment or disinfection is achieved. Wells 1, 2 and 4 also currently submit all appropriate 4-log compliance paperwork.

Lead and Copper Rule (LCR) and Lead and Copper Rule Revisions (LCRR): The Lead and Copper Rule (LCR) was promulgated in June 1991 with the Lead and Copper Rule Revisions going into effect in June 2021. The two rules define the regulations for lead and copper in the distribution system, the source of which is primarily from household plumbing fittings and poorly performing corrosion control programs. The LCR established an Action Level of 0.015 milligrams per liter (mg/L) or parts per million (ppm) for lead and 1.3 mg/L for copper which are based on the 90^{th} percentile level of samples collected from the distribution system. The LCRR has now introduced a new Trigger Level for lead of 0.010 mg/L although the Action Level for lead will remain 0.015 mg/L. The new Trigger Level is intended to provide an early indicator that system and/or treatment changes are needed. Key changes to the rule more specifically define sample site selection, sample collection procedures, and treatment requirements. The rule also takes a "find and fix" approach similar to the RTCR for addressing site specific exceedances.

Assessment: Mills currently uses pH adjustment via air stripping and/or potassium hydroxide for corrosion control and is achieving results below the action levels and is therefore in compliance. As part of the piloting study, corrosion water quality parameters were also tested to compare existing treatment to proposed treatment. This analysis would then be used to determine if the change in treatment may cause significant changes to the corrosivity of finished water and ultimately if any changes to the corrosion control program are needed.

Stage 1/Stage 2 Disinfectants and Disinfection By-Product Rule: The Stage 1 Disinfectants and Disinfection By-Product Rule (Stage 1 D/DBPR) was promulgated on December 16, 1988. It applies to water systems that add a disinfectant to drinking water in any part of the treatment process. Its primary requirements include:

- Reduced allowable concentration of disinfection by-products in the distribution system and established minimum monitoring requirements. It set a standard of 80 micrograms per liter (ug/L) or parts per billion (ppb) running annual average of total trihalomethanes (TTHMs) in the distribution system and a standard of 60 ppb running annual average of total halo-acetic acids (HAA5s).
- It also set several additional standards for other DBPs and for disinfectants.

The Stage 2 rule is a new rule that builds on the Stage 1 rule by selectively identifying distribution sampling points. It applies the 80 ppb TTHM limit and 60 ppb HAA5 limit as a specific locational running annual average, instead of across the distribution system.
Assessment: Routine compliance monitoring and calculations of the locational running annual average basis (LRAA) show that Millis is in compliance with this rule.

Per and Polyfluoroalkyl Substances (PFAS) Compliance Requirements for Public Water Systems (PWS): The PFAS rule established by Massachusetts provides on October 02, 2020 amends the Massachusetts Drinking Water Regulations and establishes a Maximum Contaminant Level of 0.000020 mg/L or 20 ng/L for the sum of the six PFAS compounds (PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA) referred to as PFAS6. In addition to establishing an MCL, the rule also defines sampling requirements and corrective actions that PWSs must take if exceeded.
Assessment: Millis has exceeded the MCL for Wells 1 & 2 as shown in Section 2.1, which has led Millis to take corrective actions to pursue the installation of treatment.

<u>Unregulated Contaminants Monitoring Rule (UCMR):</u> The UCMR requires the EPA to publish a list of no more than 30 unregulated contaminants for PWSs to monitor during designated periods. Results from each round have aided the EPA and others with data and the occurrence of other contaminants not currently regulated, and help aid in regulatory decisions and development.

The fourth round of the UCMR rule (UCRM4) concluded sampling in December 2020. The survey included 10 cyanotoxins (nine cyanotoxins and one cyanotoxin group) and 20 additional contaminants (two metals, eight pesticides plus one pesticide manufacturing byproduct, three brominated haloacetic acid [HAA] disinfection byproducts groups, three alcohols, and three semivolatile organic chemicals [SVOCs]). The fifth round of UCMR (UCMR5) is currently still in draft form but lists 29 congeners of PFAS and lithium.

<u>Assessment:</u> Millis has sampled PFAS and several of the proposed UCMR5 compounds as part of the pilot study for this treatment plant design. Results are discussed in Section 5.1.

2.3.2 Other Regulations and Policies

Massachusetts Building Code: The treatment plant will be designed, permitted and built under the Massachusetts Building Code (9th Edition), which outlines requirements of all new construction.

Massachusetts Architectural Access Board (MAAB) and American with Disabilities Act (ADA): The MAAB and ADA outlines design requirements for buildings with the intent of providing safe and full access to the disabled. The architectural design shall be in compliance with 780 CMR, 521 CMR and ADA.

MassDEP Guidelines and Policies for Public Water Supplies: The treatment plant and associated appurtenances and upgrades will be designed in accordance with this document.

Other regulation driven permits and approvals, including environmental permitting requirements are discussed in Section 9.

2.4 PRIOR STUDIES

There has been recent work related to the treatment of the Millis DWTP, the results of which are included in the following documents:

- *PFAS Treatment Grant Application* – This application to MassDEP dated December 22, 2020 provided an overview of the existing Millis Water Department PWS, the extent of its known PFAS contamination and defined the Towns need for grant funding.
- *PFAS Treatment Solutions, D'Angelis Water Treatment Facility Technical Memorandum* (treatment memo)– This memo dated January 11, 2021 provided brief overview of per- and poly-fluoroalkyl substances (PFAS) removal and treatment options for Wells 1 and 2 at the DWTP.
- *Pilot Study Report* - This report, dated June 25, 2021 was prepared by Blueleaf, Inc (Appendix G Prior to commencing the pilot study, a pilot study protocol was developed to define the objectives and methods and was approved by MassDEP. The primary objective of the pilot study was to evaluate the effectiveness of granular activated carbon for the removal of PFAS. The results of the Pilot Study are discussed in Section 5.1.1.

2.5 TREATMENT TECHNOLOGY EVALUATION

As part of the *January 2021 Treatment Memo*, Kleinfelder evaluated several different treatment technologies for PFAS removal that is summarized herein. Based upon the concentrations of each contaminant of concern, and the importance of the D'Angelis supply to the Town's ability to meet demand, the removal of PFAS is paramount. Continued removal of VOCs is also needed under any modification to the treatment plant processes. Table 2-3 details several advantages and disadvantages of existing treatment technologies appropriate for use in the removal of PFAS and VOCs.

Table 2-3: Treatment Technology Advantages and Disadvantages

	Advantages	Disadvantages
Granular Activated Carbon (GAC)	• Will remove PFAS and VOCs • Lower overall equipment capital cost • Use with existing well configuration • Eliminates the need for air stripper • No water quality conflicts as with ion exchange (IX)	• Removal of VOCs in addition to PFAS may lead to more frequent carbon media exchanges
Anion Exchange	• Removes PFAS	• Does not remove VOCs- Will still need to operate air stripper

	Advantages	Disadvantages
(AIX)	• Smaller footprint/ building costs compared with GAC	• Will further elevate chloride levels and potentially lead to distribution system corrosion issues
Reverse Osmosis	• Highest removal effectiveness, all contaminants • Small process equipment footprint	• High capital investment and operational cost • Residuals management of concentrated brine makes this technology fatally flawed (economically infeasible) in this application

Based upon the treatment technology survey in Table 2-3, existing water quality conditions, and prior experience, Kleinfelder recommended GAC pressure filtration as the most suitable technology for PFAS removal as the primary COC and VOCs as a secondary goal.

2.6 TREATMENT OBJECTIVES

Performance goals for this treatment facility are based on the Millis's water system existing conditions, including water quality data, on current and future water quality standards, and on our understanding of the Town's objectives.

The main objective of the treatment plant will be to effectively remove PFAS-6 compounds via GAC to below regulatory limits with a goal of non-detect (by current laboratory standards). The GAC contactors are proposed to be installed upstream of the DWTP (and air stripping) and thus the pilot will also demonstrate the effective removal of the VOCs (PCE, TCE, DCE). The air stripper will remain at the DWTP for the continued benefit of pH adjustment. The treatment objectives for each contaminant of concern (COC) and the associated treatment process is listed in Table 2-4.

Table 2-4: Proposed Treatment Plant Treatment Objectives and Processes

Contaminants of Concern	Level of Concern[1]	Treatment Goal	Treatment Process
PCE (ug/L)	5	Non-detect to <5	GAC
TCE (ug/L)	5	Non-detect to <5	GAC
DCE (ug/L)	5	Non-detect to <5	GAC
PFAS-6 (ng/L)	20	Non-detect to <20	GAC

[1] *Lowest level of existing or proposed regulation or guidance (EPA or MassDEP)*

3 SITE CONSIDERATIONS

3.1 EXISTING SITE AND FACILITIES

The proposed site for the new D'Angelis treatment building for PFAS removal and potential future treatment will be located on the site currently used as a storage garage. There are two existing buildings on the lot: a former animal shelter currently used for parts storage and former garage used for miscellaneous equipment storage. The buildings are discussed in more detail in Section 3.1.4. The existing buildings will be removed and demolished prior to constructing the new treatment building. The proposed site is on an adjacent lot to the existing DWTP, located approximately 400 feet to the north along the Water Street access road. The existing DWTP has a design capacity of 1.22 million gallons per day and provides treatment for the removal of Volatile Organic Compounds by packed tower aeration, 7,500-gallon max with 6,800-gallon usable capacity clear well, corrosion control by pH adjustment (currently inactive), disinfection using sodium hypochlorite, and fluoridation. The DWTP is discussed in further detail in Section 3.1.2. On the existing D'Angelis facility lot there are several existing town buildings including a DPW garage, vehicle maintenance building and a storage building.

Table 3-1: Existing Site Information

Parameter	Information / Comments
Address	Water Street, Millis, MA
Location	400 feet north of existing D'Angelis WTP on Water Street, Millis, MA
Assessor's Parcel No.	Map 52, Lots 19 & 9
Acreage	Approximately 13.5 acres (lots 19 & 9 combined)
Zoning	Municipal Overlay; Groundwater Protection Overlay District (DEP Zone I Wellhead Protection Area)

3.1.1 Potential Soil Contamination

Kleinfelder performed an assessment of potential soil contamination by conducting a review of available information from the MassDEP and performing a subsurface investigation within the vicinity of planned work areas to be accessed. The subsurface investigation included three test pits and three borings near the proposed work area. Soil and groundwater conditions within the proposed building area were characterized by soil samples collected at two boring locations (B-1 & B-3). Soil analysis of limited samples collected did not identify contaminants of concern at concentrations above RCS-1 Reportable Concentrations.

Historical assessments on the property have noted specific evidence of buried debris materials including asphalt shingles, felt, cinders, coal, slag and brick fragments, as well as reported pieces of buried tanks. These materials were not reported to be removed from the site and are likely to exist within the southeastern portion of the access way leading to the old pumping house. It is also noted that, due to the documented history of dumping at this location, other areas of buried materials could be identified in areas which were not assessed during the limited boring program performed by Kleinfelder. If buried debris materials are identified, soil and debris would need to be managed in accordance with state, local and federal regulations. If conditions are identified which require notification to MassDEP, further assessment, remediation, and waste management may be required to meet regulatory obligations.

Kleinfelder recommends that a Soil and Groundwater Management Plan be developed by the Contractor for use across the Project to ensure compliance with best soil and groundwater management practices and MassDEP Massachusetts Contingency Plan (MCP) regulations during site work. The Contractor should also develop a site-specific Health and Safety Plan (HASP). Procedures for dust monitoring and control should be incorporated into the HASP or provided under a separate plan. See Appendix D for the complete Oil and Hazardous Materials Findings and Soil Recommendations Memo.

3.1.2 Existing D'Angelis WTP

The George D'Angelis Water Treatment Plant (2187000-01T) (DWTP), located on Water Street, receives water from the Water Street gravel packed Wells 1 and 2. The facility has a design capacity of 1 million gallons per day and provides treatment for the removal of Volatile Organic Compounds by packed tower aeration, corrosion control by pH adjustment (currently inactive), disinfection using sodium hypochlorite, and fluoridation. The water entering the distribution system currently has a pH of 8.0 without the addition of a hydroxide chemical since carbon dioxide (CO_2) is stripped from the water as it passes through the aeration tower, which increases the pH. Water from Wells 1 and 2 first enters a packed tower aeration unit designed for the removal of volatile organic compounds (VOCs) and this process also raises the pH of the water. The aeration unit is an eight foot by twenty-five-foot aluminum tower packed with 3.5-inch diameter polypropylene spheres and a 15 horsepower (hp) blower motor. The raw water is pumped to the top of the tower and allowed to cascade over the polypropylene spheres while the blower motor pushes air up through (counter current) the cascading water. Water from the aeration tower enters a 7,500-gallon clearwell (6,800-gallons usable capacity)) located under the aeration tower.

Figure 3-1: Existing D'Angelis Water Treatment Plant

Subsequently, sodium hypochlorite, liquid sodium hydroxide (currently inactive), and sodium fluoride are injected into the water as it enters the clearwell.

The Farm Street Water Storage Tank water level/pressure indicator controls the two 30-hp vertical turbine high lift pumps on the clearwell, that operate in an alternating lead lag configuration. There are also high and low level alarms (clear well) and pump controls for both the well pumps and the high lift pumps. The high lift pumps are equipped with variable frequency drives (VFD) and a flow meter on their discharge line. The water is injected with sodium hypochlorite (chlorine), and fluoride as it enters the clearwell. Water entering the distribution system from the treatment facility is continuously monitored for pH and chlorine. The system is alarmed for high/low pH, high/low chlorine, eyewash activation, and equipment failure. A high and low chlorine alarm shuts down the treatment facility and both Wells 1 and 2. The chemical addition process cannot be activated until a positive flow is established at the flow meter entering the treatment facility. This facility is equipped with emergency power. DWTP meets 4-log virus disinfection through a 24-inch contact pipe in the ground prior to distribution.

3.1.3 Wells 1 & 2

Gravel Packed Well #1 (01G), located off Water St, approximately 700 feet north of the DWTP., (see Site Plan in Appendix A - Drawings) is a sixteen-inch diameter gravel packed well that was constructed in 1955 to a depth of 60 feet with 40 feet of casing, a 20-foot screen, and a 15-horsepower vertical turbine pump capable of pumping up to 500 gpm. The well has a MassDEP approved maximum daily pumping volume of 0.72 MGD. This well has a 400-foot Zone I and is equipped with emergency power.

Gravel Packed Well #2 (02G), located off Water St, 550 feet north of the DWTP (see Site Plan in Appendix A – Drawings), is a sixteen-inch diameter gravel packed well that was constructed in 1960 to a depth of 50 feet with 30 feet of casing, a 20-foot screen, and a 10-horsepower vertical turbine pump capable of pumping up to 350 gpm. The well has a MassDEP approved maximum daily pumping volume of 0.50 MGD. This well has a 400-foot Zone I and is equipped with emergency power.

3.1.4 Old Storage Buildings for Demolition

The proposed location for the new treatment building is an existing 1,600 square-foot brick building being used as a storage garage for the Millis DPW (Figure 3-2). The second building on the lot is a former masonry animal shelter (480 square foot), now used for storage (Figure 3-3). The existing facilities will be demolished and replaced with a new treatment building.

Figure 3-2: Storage Garage

Figure 3-3: Former Animal Shelter

3.2 PROPERTY BOUNDARIES AND SITE SECURITY

The Millis DPW owns the 7-acre lot along with lots to the east and south; there are residential areas to the west. The location of the existing 1,600 square-foot garage building will be enough space for the proposed treatment building. The site security considerations focus on keeping all parts of the treatment process, including the plant building, secure and operational. The proposed site location is just north of existing Millis DPW facilities that have personnel onsite frequently. The proposed building is on the same access road, which has a gate at the entrance. The proposed building will match the existing buildings security, which include locked doors, alarm systems and motion sensors in building interiors. The proposed treatment building will add a security camera system and a new triangular gate along the access road to block vehicle traffic to the site.

Table 3-2: Site Use

Parameter	General Observations
Current Use	Existing Millis DPW Storage Garage, and abandoned animal shelter
Proposed Use	Water treatment plant for PFAS removal/treatment

3.3 WATERSHED LAND USE

The proposed lot is mainly forested land (deciduous and evergreen) with a small portion of wetlands on site to the east of the existing/proposed buildings. North and east of the site is forested land and wetlands, with Millis Town water supply wells located to the north. To the west of the site is residential developments. South of the site are existing Millis DPW garage buildings and the existing DWTP building.

3.4 STORMWATER AND WETLANDS

3.4.1 Wetlands

The proposed site is adjacent to a jurisdictional wetland resource area which is 310 CMR 10:55: Bordering Vegetated Wetland. The Wetland is part of an extensive system associated with Bogastow Brook. The brook is shown as a perennial stream on USGS maps and is more than 300 feet from the property. The site does not lie within and Estimated or Priority Habitat.

3.4.2 FEMA Flood Zone

The existing building is located within FEMA Zone AE. The local base flood elevation for the 100-year (1% annual chance) flood is 122 feet in elevation and the proposed building will have an approximate slab elevation of 134 feet. See the site location's FEMA FIRMETTE in Appendix E.

3.4.3 Stormwater Management

In accordance with DEP *Stormwater Management Standards*, rooftop runoff is considered "uncontaminated" and suitable for direct infiltration. The new parking area will be paved in square footage similar to existing conditions and runoff will be managed on site in accordance with local and state regulations. No other stormwater management will be necessary as part of the WTP design.

3.5 VEHICULAR ACCESS

Access to the proposed building will be via existing paved access roads. The paved area directly around and leading up to the new building may be reconstructed to improve road surfaces and provide better access future vehicles and maintenance. All existing dirt roads (those leading out to Wells 1 and 2) will remain as is.

3.6 SITE DESIGN AND CONSIDERATIONS FOR POTENTIAL EXPANSION

The two existing buildings will be demolished with hazardous material testing to be done during the next phase. The existing 10-inch water distribution line between the existing buildings will remain and have a water service line extended from it to serve the proposed building's connection. The existing access road coming from the DPW facilities will be paved and reconstructed and all existing dirt roads will remain as is (see Drawings, Appendix A).

The proposed building will be constructed on the approximate location of the existing storage garage. The area around the building will be paved and may cover slightly more surface area than existing conditions, to provide space for Town vehicles. The proposed building will add a security camera system and a new triangular swing gate to block vehicle traffic to the site. The building is being sized to accommodate the GAC contactors and also for the potential for additional water treatment prior to the GAC contactors, if future water quality needs require it. The additional space could house two filters for iron and manganese removal. A storage tank will be required onsite to assist handling of GAC contactors backwash water. A storage tank located below the proposed building and incorporated into the foundation design may maximize space onsite. Options are being evaluated to use space efficiently onsite and potentially reduce the required capacity of the tank. Considerations for future treatments backwash needs will be looked at for the tank design.

4 GEOTECHNICAL INVESTIGATION

4.1 GEOTECHNICAL INVESTIGATION

A geotechnical investigation, including the completion of soil borings, was completed at the site in April 2021. A Geotechnical Memorandum highlighting the findings and recommendations for the site has been included with this report as Appendix B. A summary of the preliminary geotechnical considerations for the proposed construction is provided below, based on subsurface information from the borings and soil testing.

A new building of approximately 44 feet by 67 feet is proposed where the existing abandoned storage building is located. The abandoned storage building will be demolished. The proposed building will be approximately the same footprint as the existing D'Angelis water treatment facility. The purpose of the proposed building is to house the new GAC contactor units. It is understood that a concrete backwash tank is proposed beneath the new building. A total of four (4) GAC contactor units that are approximately 12-feet in diameter will be housed inside the proposed building. The backwash tank will be approximately 130 cubic yards.

Borings B-1 and B-3 are located to the south of the proposed building and boring B-2-OW is located north of the proposed building footprint as shown on the preliminary site plant Drawing C-002 in Appendix A. The subsurface conditions at the Site generally consist of fill overlying a natural glacial sand deposit. The natural sand deposit consists of poorly graded sand, poorly graded sand with silt, and silty sand with various amounts of gravel. Based on the conditions encountered in these borings, we recommend supporting the proposed building on spread footings bearing on the natural sand deposit with a slab-on-grade foundation. We recommend supporting the portion of the building with the backwash tank on the natural sand deposit. Due to the underlying granular soils below the measured groundwater, liquefaction potential will be calculated during the final design phase.

5 PRELIMINARY DESIGN OF TREATMENT PROCESSES

5.1 PROPOSED TREATMENT PROCESS OVERVIEW

In order to meet regulatory compliance with regard to the concentrations of PFAS6 and VOCs from Wells 1 and 2, Kleinfelder proposes the installation of a Granular Activated Carbon Pressure Filtration Water Treatment Plant at the existing location of the storage garage between the DWTP and the wells. This will effectively insert the treatment immediately downstream of the wells and prior to the existing treatment at the DWTP. The DWTP will continue to provide all existing treatment processes including air Stripping / pH adjustment, fluoridation and disinfection. While a supplier of the pressure filtration system is not expected to be finalized until bidding, for the purposes of this report, Kleinfelder has based the design on the Calgon Model 12 (20,000 lbs) system with F400 type GAC media as produced by Calgon and piloted in May/June 2021. The proposed treatment process is presented in the Process Flow Diagram included in the drawings in Appendix A.

5.1.1 Pilot Testing Results

The pilot study was conducted by Blueleaf, Inc. between May 13th and 26th to test the effectiveness of GAC for the removal of PFAS6 and PCE (and degradation byproducts). The results of the pilot study are summarized here with the full report attached in Appendix G.

Blueleaf conducted the piloting test according to the pilot test proposal approved by MassDEP in April 2021. The pilot test ran for a total of 13 days with and filtered approximately 29,000 gallons of raw water equivalent to 2,600 Empty Bed Volumes (EBVs). The piloting setup consisted of three contactors filled with Calgon F400 GAC media, with the first containing 12-inches of GAC, and the subsequent two columns with 40-inches of media. The pilot test ran a simulated loading rate of 7.5 gpm/ft^2 on a total media bed depth of 92-inches . The pilot test was operated for a short 13-day duration and therefore no long-term fouling headloss development was observed and contaminant breakthrough (PFAS6 and VOCs) was not determined.

Key Takeaways from the Piloting include:

- GAC was effective at removing PFAS finished water over the course of the pilot study. The raw water Median Total PFAS6 concentration was 23.01 ng/L. The PAS6 concentration in the finished water at the GAC 100% sampling point was below laboratory detection limits:
    - No breakthrough of PFAS6 compound was observed at the GAC 100% sample point throughout the duration of the pilot test. All PFAS6 concentrations reported by the laboratories were below the detection limit for all sampling events.
    - PFAS6 breakthrough on the GAC 12” sample point column was observed on second sampling event (May 19th) and the third sampling event (May 26th)
        - PFOS, PFOA were detected on second sampling event (May 19th) at 2.18 and 2.16 ng/L, respectively.
        - PFOS, PFOA, PFNA on third sampling event (May 26th) 3.73-3.97, 3.21-3.53, and 2.46-2.52 ng/L, respectively.
    - Raw water from Well #2 detected several PFAS compounds not included in the PFAS6 group including. None of these were detected in the finished water at the GAC 100% sampling point.
        - PFBS, PFDoA – only detected in raw water
        - PFHxA, PFBA, PFPeA – detected in raw water and at the GAC 12” sampling point on the second and third sampling events (May 19th and 26th).
        - PFBA, PFPeA – detected in the raw water and at the GAC 12” sampling point on the third sampling events (May 26th).
- There was no breakthrough of PCE, TCE, DEC or other VOCs at any of the sampling points and events throughout the pilot test.
- Minimal headloss development was observed during the piloting. Differential pressure developed at a rate of 0.0295 psi/day.
- Arsenic was detected in the GAC 100% sampling point effluent during initial startup with a concentration of 0.0116 mg/L and decreased to below the detection limit in the second and third sampling event. Arsenic was not detected in the raw water.

5.2 WELLS AND WELL PUMPING

As previously stated in Section 2, the DWTP is fed by Wells 1 and 2 which both operate simultaneously with a maximum combined permitted withdrawal of 1.22 MGD. Wells 1 and 2 currently only operate with on/off controls and typically both operate when water is called for by the level indicators in the clearwell. The proposed improvements to the wells will include the addition of variable frequency drives (VFDs) and updates to controls to allow pumps to meet various design points and operate independently of each other. The pumps at both wells will be replaced and upsized by five horsepower (Well 1 upgraded to 20-hp and Well 2 upgraded to 15-hp) that will also be able to accommodate the added head required for backwashing conditions. Other ancillary equipment to be replaced include pressure gauges and flow meters. Additional information on these upgrades is provided in Section 7.

5.3 CORROSION CONTROL

For corrosion control the DWTP utilizes pH adjustment which can be accomplished by either Air Stripping or chemical addition of potassium hydroxide (KOH). The treatment plant operators currently use the air stripper for the combined benefit of VOC removal and pH adjustment. This also aids in reducing overall chemical and operation costs.

The results of the piloting observed no significant changes to the corrosivity of GAC effluent water in comparison with the existing raw water corrosivity over the course of the pilot study. Therefore, the design will not include changes to the existing corrosion control system. Although no impacts to the existing corrosion control approach are anticipated, the Town may consider evaluating pre- and post-treatment upgrades distribution system water quality monitoring. A representative number of sites would be tested for water quality parameters in addition to lead and copper before the new treatment process is put on-line to provide a baseline of distribution system water quality. Then six months to a year after, the sites would be tested again to compare results. This could help rule out treatment changes as a cause should an area of the system experience increased lead and/or copper or increased number of copper service line breaks.

<u>Air Stripper:</u>
The existing air stripper unit installed at the head of the existing plant is used primarily for the removal of VOCs from raw water. The unit also provides the ancillary benefit pH adjustment with the raw water pH between 6-7 s.u. and finished water pH between 7-8 s.u. Although the proposed GAC system (upstream of the unit) will provide the required VOC removal, the Town can continue

to operate the air stripper unit for its pH adjustment capabilities. As part of future operations considerations, a comparison between the air stripper and KOH chemical feed system should be conducted to verify if the air stripper system is more efficient and cost effective. Continuing to use and maintain the air stripper, along with the DWTP's existing chemical feed capacity, adds resiliency to the treatment system. Recommended improvement to the air stripper will include the addition of a bypass to allow operators to take the unit offline for maintenance. In a bypass situation, it is recommended that Operators feed KOH to provide the necessary pH adjustment.

Potassium Hydroxide:

The DWTP also has the capacity to feed KOH for pH adjustment. The existing KOH system has a 3,000-gallon storage tank with a 150-gallon day tank and two chemical metering pumps. KOH can be fed upstream of the clearwell and downstream of the high lift pumps and prior to pH analyzer and entry point to the distribution system.

Corrosion Control Parameters and Piloting Results:

During the pilot study, corrosion control parameters were also collected to analyze and determine if there was a significant change in the corrosivity of the water as a result of the added treatment process. This is accomplished by comparing the water quality parameters of the raw water to that of the GAC effluent. Common corrosion control indices such as the Chloride-Sulfate Mass Ratio, the Larson Skold, and the Langelier Saturation Index are also calculated in Table 5-1.

Table 5-1a: Analysis of Corrosion Control Parameter on Raw and GAC Effluent (Field Analysis)

Parameter	Unit	Raw	GAC Effluent
pH	s.u.	6.48 [3]	6.48 [2]
Carbon Dioxide	mg/L	23.87 [3]	17.6 [3]
Dissolved Oxygen	mg/L	0 [3]	0 [3]
Temperature	°C	12.56 [3]	12.76 [3]
Total Conductivity	umhos/cm	752 [3]	733 [3]

Table 5-2b: Analysis of Corrosion Control Parameter on Raw and GAC Effluent (Lab Analysis)

Parameter	Unit	Raw	GAC Effluent
Alkalinity	mg/L as $CaCO_3$	44 [3]	63.3 [3]
Calcium	mg/L	40.05 [2]	39.1 [2]
Chloride	mg/L	176 [3]	161.67 [3]
Iron	mg/L	ND [2]	ND [2]
Manganese	mg/L	0.0049 [2]	0.001267 [2]
Magnesium	mg/L	15.25 [2]	15 [2]
Sulfate	mg/L	15.9 [3]	17.37 [3]
Sodium	mg/L	55.95 [2]	55.75 [2]
Oxidation reduction Potential	mv	196.67 [3}	196.67 [3]
Total Conductivity	umhos/cm	663.33 [3]	650 [3]
Total Hardness	mg/L as $CaCO_3$	163 [2]	159.5 [2]

Notes:
[ ] – indicates total number of samples.
All concentrations represent averages of the pilot test result data
ND – indicates that sample was non-detect at or below the reporting limit for the specified compound.

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Corrosion Indices:

Engineers have developed indices based on the water quality parameters (WQPs) of different water sources to effectively rate corrosivity. Each index combines and compares several different WQPs to calculate an index number. The result can then be compared with known corrosive or non-corrosive index numbers and ranges to establish and predict the corrosion potential of a given water source/sample. Some well-known and studied indices include: the Langelier Saturation Index, the Larson Skold Index, and the Chloride Sulfate Mass Ratio.

Langelier Saturation Index (LSI)

The Langelier Saturation Index was developed by W.F Langelier in 1936 at the University of California at Berkely[1]. The index is also known as the calcium carbonate saturation index or saturation index and it describes the solubility of calcium carbonate within a solution. The methodology calculates the solubility of calcium in relation to the pH and is determined by factors including pH, alkalinity, calcium, total dissolved solids, and temperature. The resulting index describes the deposition or scale formation of calcium carbonate forming a protective barrier on the interior surface of pipes. It is also important because of the known effects that alkalinity has in subduing corrosion driven by chlorides and sulfates.

Langelier Saturation Index (LSI) = pHs - pH

where: pH = pH of solution
pHs = saturation constant of calcium carbonate at the given pH

The *US EPA Corrosion Manual for Internal Corrosion of Water Distribution Systems*[2] defines the methodologies for determining the saturation constant of Calcium Carbonate in addition to Langelier's paper. Results calculated from the index are only <u>qualitative</u> in predicting calcium carbonate dissolution or scale formation. Index values are interpreted accordingly:

LSI < 0 water is undersaturated and will dissolve calcium carbonate
LSI = 0 water is in equilibrium
LSI > 0 water is supersaturated and will precipitate calcium carbonate

<u>Larson-Skold Index (LSK)</u>

The Larson-Skold index was developed in the late 1950s from in situ data on the corrosion of steel piping with Great Lakes water. The index derives a ratio between corrosion accelerators, namely chlorides and sulfates vs. corrosion mitigators, alkalinity and calcium[3].

$$\textit{Larson-Skold Index (LSK)} = \frac{[\textit{Chlorides}] + [\textit{Sulfates}]}{[\textit{Alkalinity}]}$$

The calculated value is typically interpreted in the following ranges:

LSK > 0.8:	Chlorides and Sulfates are unlikely to prevent scale formation
0.8 < LSK < 1.2:	Chlorides and Sulfates may interfere with scale formation
LSR < 1.2:	Chlorides and Sulfates will interfere with scale formation and may lead to corrosion

Chloride-to-Sulfate Mass Ratio (CSMR):

The CSMR measures the impact that chlorides and sulfates have on the corrosion of leaded materials in plumbing components. Many examples in literature have attributed CSMR ratios greater than 0.58 to be associated with high levels of lead corrosion on copper and leaded components within public water systems[4]. Although raw water prior to treatment is analyzed in this report, the CSMR is important to consider from an overall corrosivity standpoint because of its downstream effects on the distribution system. Index values are interpreted accordingly:

CSMR < 0.58 : No adverse impact on leaded plumbing materials
CSMR > 0.58 : Tendency for an increased concentration of lead chloride

Corrosion Indices Results:

The water characterization for the original and replacement wellfields are used to calculate the values for each of the corrosion indices described above. Each index is the then interpreted below to compare the corrosivity of each raw water supply.

Table 5-3: Calculated Values for Corrosion Indices

Parameter	Raw	GAC Effluent
Langelier Saturation Index	-1.90	-1.75
Larson Skold	6.02	3.89
Chloride Sulfate Mass Ratio	11.07	9.32

- The Langelier Saturation index on the raw water decreased from -1.90 to -1.75 on the GAC effluent, representing an increase of 8%. While a negative value of this index suggests the water is undersaturated and will dissolve calcium carbonate, the increase towards “0” which represents equilibrium, or positive integers that signal scale formation, indicates a decrease in the “overall corrosivity” but does not represent a significant change that may affect scale formation.
- The Larson Skold ratio on the raw water was 6.02 and decreased to 3.89 on the GAC effluent, representing a decrease of 35%. This change is principally due to the overall increase in alkalinity attributed to the first GAC 100% sampling point event (May 13th) - see piloting report results in Appendix G. Removing this sampling event from the GAC 100% sampling point effluent data lowers the average alkalinity to 46 mg/L as $CaCO_3$ and recalculates the ratio as 5.35. This 11% decrease is more representative; however, this

range of the ratio still indicates that chlorides and sulfates will interfere with scale formation and may lead to corrosion.

- The CSRM on the raw water was 11.07 and decreased to 9.32 on the GAC effluent which represents an 18% decrease. Due the simplicity of this ratio, slight changes in one or both parameters may cause swings, and in this case both parameters changed with the average [chloride] decreasing and average [sulfate] increasing. A CSRM greater that 0.58 may indicate a tendency for an increased concentration of lead chloride.

Conclusions and Recommendations:

While all corrosion indices calculated indicate a generally corrosive raw water from Well #2, <u>the addition of GAC contactors does not increase the corrosivity of water going to the DWTP for additional treatment.</u> As mentioned, pH adjustment for corrosion control via the Air Stripper or chemical addition of KOH is done downstream of the proposed treatment process at the DWTP with the Town demonstrating continued compliance with the Lead and Copper Rule through satisfactory compliance monitoring. Millis should continue using pH adjustment to raise the DWTP finished water pH. Currently and unless distribution compliance monitoring samples indicate elevated concentrations of lead, copper, or other water quality parameters that are violate drinking water standards, there is no need to alter the Towns current corrosion control program at the DWTP with the addition of GAC treatment process.

5.4 CHEMICAL FEED SYSTEMS

The proposed GAC system will be implemented upstream of the existing water treatment process and will therefore not require any additional chemical feed systems. As the project moves into the 60% design phase and specific equipment is specified, there may be the need to update chemical metering pumps to be compatible with new VFDs and flow meters to ensure proper chemical metering is achieved.

5.5 GAC FILTRATION

The treatment technology evaluation determined that GAC media would be the best approach to meet the Town's and regulatory treatment objectives for both PFAS and VOCs and also satisfy site constraints. The results of the *Pilot Test Study* performed by Blueleaf confirmed that GAC media was effective at removing all contaminants of concern. Based upon these evaluations, Kleinfelder recommends that the Town construct a pressure filtration treatment facility at the existing DWTP with GAC media to remove PFAS and VOCs.

5.5.1 Pressure Filtration

Pressurized filtration is a process by which pressurized source water is forced through a filtration media to remove contaminants. To maintain a pressurized flow, the media is housed in individual GAC contactors. Depending on the desired production rates, multiple GAC contactors may be required. In such instances, the GAC contactors are operated in parallel, with water passing through only a single filter during the treatment process.

In consideration of Millis's source water characteristics and design flow rate of 1.22 MGD, it was determined that the pressure filtration system will need to consist of four (4) GAC contactors. There will be two treatment trains with two contactors per train and arranged with one lead and one lag per train. The total flow of 850 gpm will be split evenly between the two trains for a flowrate of 425 gpm each and a maximum surface loading rate (SLR) of 3.76 gpm/ft^2. Each train will provide an Empty Bed Contact Time (EBCT) of 23.47 min, equal to 11.73 minutes per contactor which meets and exceeds the recommended 10-minutes of EBCT for PFAS removal. The lead-lag filter design allows for water quality sampling for PFAS from the lead filters to monitor for PFAS breakthrough, which indicates the media has reached its useful life. Having the lag filters ensures continued treatment removal of PFAS even if breakthrough has occurred. Each vessel will contain granular activated carbon (GAC) media to capture PFAS compounds in the raw water. Additional design criteria for the pressure filtration system are provided in **Error! Reference source not found.**3. While the procurement approach is not yet determined (see Section 10) the basis of preliminary design is the Calgon Carbon filtration system that was piloted in May/June 2021.

Table 5-4: Pressure Filtration System Basis of Design

Parameter	Design Criteria
Design Flow Rate	1.22 MGD / 850 gpm
Filter Loading Rate - (assumes flow to two lead filters and two lag filters)	3.76 gpm/ft^2
Number of GAC contactors	4
Number of Skids (2 Contactors per Skid –	2
Skid Contactor Configuration	Lead/Lag

Parameter	Design Criteria
Empty Bed Contact Time (per train)	23.47 min
Empty Bed Contact Time (per contactor)	11.73 min
Skid Dimensions	14 feet x 32 feet
Skid Height (Floor to Top of Vessel)	16 feet
Pressure Vessel Nominal Diameter	12 feet
Pressure Vessel Shell Height	165 inches
Total Filter Surface Area	452 ft^2
Media Depth (per filter)	5.8 ft.
Total Media Volume	2,668 ft^3
Total Media Weight	80,000 lbs

5.5.2 Backwash

GAC contactors will require periodic backwashing. The backwashing is not intended to remove PFAS from the media but to remove fines that can blind the media bed, restrict flow, and reduce filter capacity or flow output. The frequency of backwashing will depend on water quality parameters and operational conditions. Initial operations will be set to trigger a backwash when the lead contactor sees a differential pressure of 10 psi over normal conditions. The backwash source will be the post GAC train effluent. The GAC filtered water will be valved to close off normal operation and redirect the pumping volume to reverse flow through one GAC filter at a time for backwash. Since the treatment plant is designed in two separate lead-lag trains, the lead contactors will require backwashing more often than the lag contactors. Based on pumping hydraulics and available capacity the system will be able to provide adequate flow for GAC contactor backwashing. Table 5-4 shows the assumed backwash conditions required for each contactor.

Table 5-5: Backwash Design Criteria – Calgon F400 Carbon

Parameter	Design Criteria
Design Backwash Cycle Frequency	>10 psi headloss
Backwash Process Durations Per Contactors	15 minutes
Backwash Cycle Duration (All Four Contactors)	60 minutes
Backwash Rate per Contactors	950 gpm (max)
Backwash Loading Rate per Contactors	8.4 gpm/ft^2
Total Backwash Volume (All Four Contactors)	57,000 Gallons

The proposed pumps to be installed at Wells 1 and 2 will have adequate capacity to flow through a train and then backwash each contactor one at a time. Table 5-4 shows the maximum volume if all four contactors were backwashed. In operation each train will be backwashed (two contactors) with the lead filter being backwashed more frequently. The frequency of backwashes, including the difference in backwash frequency between lead and lag, will be determined once the system is operation and water quality parameter impacts on the contactors can be assessed.

5.6 RESIDUALS MANAGEMENT

The backwash cycle for the GAC contactors results in the production of backwash waste that must be managed as part of the overall treatment process. The backwash waste is a mixture of water and concentrated solids. To manage this residual backwash waste efficiently the following options are available:

- Sewer Discharge to Charles River Pollution Control District (CRPCD)
- Above Ground Storage Tank and Offsite Disposal
- Backwash Decant & Recycle

Infiltration via surface lagoons was considered, but ruled out early on, due to the site constraints including, suitable level ground with sufficient elevation above the water table.

5.6.1 Sewer Discharge to Charles River Pollution Control District

This option would be to construct a sewer extension approximately 440 linear feet to convey backwash wastewater to the municipal sewer. The DPW site just south of the proposed treatment building location is currently under construction with part of the work to install a new sewer line and a manhole in the center of the paved area. The proposed manhole is approximately 440 linear feet away from the treatment building. Due to the volume of flow during the periodic backwash cycles, storage will be required to prevent overflowing the existing sewer system. The most efficient use of space will place the residuals storage tank below the proposed building and incorporate it into the proposed foundation design. The storage tank would need to hold the entire backwash volume of a single train, 28,500 gallons, and allow a constant low flow rate to the conveyance line. The maximum flow rate will be limited by the capacity in existing sewer pipes (6-inch to 12-inch PVC) and the capacity of the existing grinder pump station directly south of the DPW site. The pump station collects all flows from the DPW sewer and sends it into a 12-inch force main downstream.

The benefits of a direct sewer discharge and below grade tank would be:

- Above grade space is kept available for vehicle access and building footprint flexibility.
- Minimize maintenance and costs, as it does not require pumps.
- Simplify system operations.

The proposed construction would consist of an 8-inch diameter pipe to convey backwash waste to the nearby municipal sewer system run by the CRPCD. The exact diameter of the conveyance pipe will be determined by the existing sewer and the amount of total storage onsite. The run of pipe would require a minimum of two manholes prior to connection to the existing structure near the existing DPW garage.

Conveying backwash directly to the sewer would waste approximately 28,500-gallons per train during each backwash cycle. The discharge will result in the loss of some water supply from the existing wells. The total amount will depend on how frequent backwash cycles occurring during treatment. Backwash frequency is not anticipated to cause significant water loss on a yearly basis under this design. Construction of the direct to sewer discharge will be subject to the Charles River Pollution Control District requirements.

5.6.2 Above Ground Storage Tank and Off-site disposal

Due to the limited space at the existing site an above ground storage tank to store the backwash for either sewer conveyance or until pumping and hauling offsite is not the best option for this site. The size of the tank required to contain the volume from a backwash cycle, approximately 28,500-gallons from one train, would be prohibitively large. The site constraints would make siting the tank of that size difficult and minimizing that tank size would require hauling after each backwash cycle. An above ground tank with only intermittent use would also require additional freezing protections.

5.6.3 Backwash Decant and Recycle

Backwash waste could be stored onsite and recycled through the GAC contactors to minimize water loss. Backwash waste would be discharged to a Backwash Settling Tank where it will remain for at least 6-hours to allow solids to settling. After this settling period, the design concept calls for a floating decant pump to be activated in order to recycle the water remaining above the solids back to the head of the treatment plant. The pump suction location at the surface of the tank will minimize the solids returned to the treatment process. Also, returning tank content to the treatment process will reduce the total volume of waste to be discharged to the existing sewer collection system. The recycling rate will be set so that the flow from the floating decant pump will not exceed 10% of the total flow entering the head of the plant. While only one decant pump is necessary for this operation, two would be installed for redundancy, with only a single pump operating at a time and pump use to be cycled on a routine basis.

Providing a decant and recycle pumping system would add complexity and maintenance to the operation at the proposed treatment building and would require a tank large enough to store the full backwash volume. This option is less preferable than direct discharge from an operation and maintenance perspective and with anticipated backwash frequency not using a significant volume the benefits will be minimal.

5.6.4 Recommendation

Due to site constraints construction of a backwash settling/storage tank above grade that holds the entire backwash volume does not appear feasible. The benefits of reuse/recycle of backwash water back into the system do not outweigh the addition costs of all pumps, appurtenances, and additional operation and maintenance. The volume saved through recycle may not be significant based on anticipated backwash frequency. However, based on a preliminary look at the hydraulics of the nearby sewer system a simple direct connection may send more flow than that system can handle during backwash events.

<u>Construction of a dedicated backwash discharge directly to the local sewer would be the best option from a maintenance and operation standpoint.</u> Based on the current understanding a

storage tank will still be required to allow for a controlled and slower discharge flow to the sewer in order to avoid overloading the existing sewer system by discharging the contactor backwash immediately as it is generated. Due to the site constraints a storage tank that is located below the proposed building and incorporated in the foundation design will be the best option for storage. A more complete understanding of the Town's sewer system south of the gravity conveyance line in the DPW, specifically the grinder pump station, will be performed during the 60% design phase to completely evaluate the direct to sewer discharge option. However, considering site constraints and the volume of backwash during a backwash event, a storage tank situated below the proposed building capable of housing the backwash volume from one train, 28,500 gallons, and discharge to the sewer at a low flow rate will be the most effective option.

5.7 DISINFECTION STRATEGY

The DWTP in its existing capacity provides 4-log inactivation of viruses consistent with the Groundwater Rule through a free chlorine residual and a 24-inch diameter pipe loop downstream of the plant prior to the distribution system entry point. The plant doses sodium hypochlorite to achieve a free chlorine residual in the finished water of 0.65 mg/L. With the addition of the proposed GAC filtration upstream of all other existing treatment processes it is not anticipated that any significant changes to the disinfection strategy will occur. The implementation of GAC and new flow controls at the wells, updates to the chemical metering pumps may be required. Additionally, the added GAC filtration process may lessen the overall hypochlorite dose to achieve the required free chlorine residual.

5.8 PROCESS MONITORING

The proposed GAC filters come equipped with two pressure transducers per train and manual pressure gauges upstream/downstream of each contactor. Flow meters will be installed on the influent for each treatment train and on combined backwash effluent. The parameters that will be continuously monitored and logged include the items below:

- Raw water flow for each GAC train
- GAC contactor differential pressure:
    - Influent pressure transducer
    - Effluent pressure transducer
- Backwash flow

Manual gauges with readings taken by operators will include:

- GAC contactor differential pressure:
    - Influent pressure
    - Effluent pressure

Three sample taps will be installed on each GAC train to enable sampling influent and effluent of each GAC contactor. Waste from these sample taps is expected to be minimal.

5.9 FUTURE PROCESS CONNECTIONS

The *Pilot Study Report*, historical compliance monitoring, and operator experience has indicated that iron and manganese have not been an issue at the DWTP. However, water quality of ground water has been known to change over time, sometimes rapidly, and many neighboring towns are required to employ treatment processes for iron and manganese removal. Kleinfelder recommends that the proposed treatment building be designed to fit the available site and include an area for future treatment processes (such as greensand filtration for the removal of iron and manganese). This is reflected in the architectural drawings included in Appendix A and described in Section 6.

6 BUILDING DESIGN

The conceptual design (Drawings in Appendix A) includes a preliminary layout for the new WTP GAC building.

6.1 BUILDING FUNCTIONS

The proposed treatment building has been provided with areas reserved for GAC filtration and all associated project functions within the facility.

6.1.1 Treatment Process Area

The treatment process area will take most of the square footage in the building, including the four GAC contractors, process piping, and all associated valves and appurtenances.

6.1.2 Electrical Room

A separate, enclosed room to house electrical equipment will be provided. This area will be temperature controlled to prevent over-heating.

6.2 ARCHITECTURAL DESIGN APPROACH

This section of the report discusses the architectural building systems proposed for this project. The building will be designed following the current (9th Edition) of the Massachusetts State Building Code (780 CMR) and ADA Accessibility Guidelines (ADAAG). The building is assumed to be unoccupied and to be Use Group “F” (Factory) for code requirement purposes. The building will be equipped with a fire alarm system, egress doors, and emergency lights. No sprinkler system is assumed, nor any toilet facilities.

6.2.1 Pre-Engineered Metal Building

The Pre-Engineered Metal Building (PEMB) type of building is the most economical option and was proposed in the 2020 Millis PFAS Treatment Memo and assumed in the cost estimates prepared for budgeting. The PEMB would be designed, furnished, and installed by the contractor (industry-standard approach for PEMB structures), however, Kleinfelder will design the foundation, based upon assumed building support reactions and framing.

Kleinfelder will prepare architectural drawings with plans, elevations, and details, to show the extent of the building and will also prepare technical specifications to complement the drawings. The technical specifications will include the performance standards and requirements for the PEMB design and construction.

The approximate 44 feet wide and 67 feet long building will be provided with an inside clearance height of approximately an average of 4 feet above the filters to allow access and maintenance of equipment. The final eave height of the building is 17-feet 0-inches as determined by the filter vessel height. The building will have two (2) double doors of 6 ft. x 7 ft. and six (6)14 ft. wide x 16 ft high wide removable exterior wall panels. Interior walls for the Electrical Room will be a non-load-bearing metal stud with metal panels to separate the main floor from the electrical room and pump control room.

The roof will be a standing seam composite insulated metal panel system, and the exterior walls and roof will consist of composite insulated metal wall panels. This type of roof will enable installation of solar panels, if desired. A zinc-rich paint coating system for these pre-manufactured panels will be specified to provide durability. The floor will be a concrete slab-on-grade.

This PEMB building option has a lower construction cost than a masonry building, however, the service life would also be lower than the masonry building due to the corrosive environment. Using high-performance paint coating systems and the use of dehumidification, an approximately 20-year service life could be expected (before significant repairs would be required).

6.2.2 Building Options/Upgrades

The foundation wall could be extended 1 to 2 ft. above grade to act as a starter wall, which would provide a hard surface around the building perimeter for an additional cost.

The south façade of the proposed options could incorporate insulated translucent wall panels to allow diffused natural light into the building, up to 50% light transmission is possible. The standard size/module would be 4 ft. long x 4 ft. high or 8 ft. long x 4 ft. high. The wall panels have options of vandal, graffiti, and impact resistance to minimize maintenance, all for an additional cost.

The roof of the building could be an open gable roof that emphasizes symmetry as seen in "Option 1" (Appendix A, Drawings A-101, 103, 105) or a shed roof to allow natural light into the central space of the building by incorporating insulated translucent wall panels as designed in "Option 2" (Appendix A, Drawings A-102, 104, 105).

6.3 STRUCTURAL DESIGN APPROACH

The structural systems for the treatment building and the various tank structures will be designed in compliance with the following codes as they pertain to the particular structure:

- American Concrete Institute; "ACI 318-14, Building Code Requirements for Structural Concrete"
- American Concrete Institute; "ACI 350-06, Code Requirements for Environmental Engineering Concrete Structures"
- American Institute of Steel Construction; "Steel Construction Manual, 14th Edition"
- American Society of Civil Engineers; "ASCE 7-10, Minimum Design Loads for Buildings and Other Structures"
- Massachusetts State Building Code; "780 CMR, Ninth Edition"

6.3.1 Pre-Engineered Treatment Plant Building

The treatment plant building will consist of a one-story pre-engineered metal building structure measuring approximately 44-feet wide by 67-feet long in plan. For this type of building, the structural steel superstructure will be designed, furnished and installed by the contractor to withstand dead, live, ASCE 7-10. The structure will consist of rigid steel frames and post and beam end walls with braced frames. Roof purlins and wall girts will likely be cold formed steel "Z" members.

The design of the building's foundation and embedded column anchor bolts will be designed by Kleinfelder based upon building frame support reactions, either provided by the manufacturer or assumed if nothing is provided.

An underground, reinforced concrete tank, will be located adjacent to the building or below the slab. The building's foundation will be dependent upon the location of the tank.

1. If located outside the building perimeter, the building's structural support frames will be supported on reinforced cast-in-place concrete spread footings bearing at least 4'-0" below finish grade. A continuous reinforced concrete wall supported on strip footings will be

provided around the perimeter of the building to support the exterior wall system. The wall will extend approximately 4-feet above the interior floor slab elevation and will provide anchorage and support of the exterior wall framing.

2. If the tank is located inside the building, the foundation walls and footings will be deeper to support the tank. The footings will also be wider due to the lateral earth pressures. The footing layout, tank walls and floor slab system will be investigated further during design phase if this option is selected.

The floor will be a reinforced cast-in-place concrete slab designed to support a 125 psf live load. Isolated concrete pads will be provided to support process filtration and treatment equipment.

6.4 ELECTRICAL DESIGN APPROACH

The conceptual electrical design has been prepared based on the required treatment process, equipment and controls needed within the new treatment building, the required power and control for the pump stations, and existing SCADA controls available at the D'Angelis Treatment Facility. The electrical systems shall comply with the following standards.

1. Massachusetts State Building Code 780 CMR.
2. 2020 Massachusetts Electrical Code
3. 2018 International Energy Conservation Code.

6.4.1 Electrical Room

The new treatment building will contain a separate enclosed room which will house the necessary electrical equipment for building operations. This area will be temperature controlled to prevent over-heating and contain the equipment required to power the automated temperature controls including the HVAC system, fire and security alarms and devices, lights (emergency and normal), waste pumps and monitoring devices required for the treatment process. The conceptual layout for the electrical room is provided in the mechanical drawings attached in Appendix A and is currently proposed to encompass 40 square feet.

6.4.2 Electric Service

The electrical service for the new treatment building shall be a 480/277 Volt, 3-phase, 4-wire, 150 Amp service, which will be back fed from the D'Angelis Water Treatment Plant's Main Motor Control Center (MMCC). Modifications to the MMCC will be required to facilitate the electrical service to the new treatment building. The existing single circuit breaker feeder bucket section will be replaced with a dual circuit breaker feeder bucket section containing a 150 Amp circuit breaker for the new treatment building. The electrical service will be provided from the MMCC to a distribution panel (DP-1) located in the new treatment building via a 150-amp feeder underground duct bank. The duct bank will need to be installed as part of the proposed design. Any future treatment processes or equipment needed beyond what is currently proposed can be powered with the spare demand load of 40 kW (see section 6.4.3 below). If future modifications to the treatment processes increase the demand load beyond the 80 kW feed, then modifications to the existing power distribution will be necessary. If the power demand exceeds the 80-kW feed the Town can pursue one of the following actions:

1. Increase the service and generator at the existing DWTP. This approach requires at a modification to the existing motor control center or new equipment and generator replacement.

2. Provide a separate service and generator to the new GAC treatment building.

3. Provide a gas service to the treatment building to provide heat which will save on the power demand.

If the Town seeks to increase the power demand beyond its current capacity of 80 kW, a more detailed approach will be provided for construction and bidding purposes.

6.4.3 Power Requirements

The existing D'Angelis Water Treatment Plant has a 480V/277 Volt, 3-phase, 4-wire, 400 Amp service with a 175KW backup standby power generator that provides power the MMCC. Based on the existing one line drawing (Sheet E-1 of the 1997 Bid Set – Tata and Howard) the plant has a total connected load of 185KW with a demand load of 95KW, leaving 80KW of spare demand load capacity available. The new treatment building will have a connected load of 55 KW with a demand load of 40 KW. The D'Angelis Water Treatment Plant spare demand load capacity exceeds the demand load of the new treatment building and therefore sufficient power can be delivered to the new treatment building without the need for additional power.

6.4.4 Power Distribution

The section below describes the conceptual components needed for the power distribution system within the new treatment building. A manual motor with disconnect switch shall be provided for the motor operated valves and any motor or equipment that contains a 480 Volt service. Convenient duplex receptacles shall be provided within the treatment process area, electrical room and on the exterior of the building. The following power distribution panels will be located in the proposed electrical room.

Distribution Panelboard 1 (DP1)

This panel shall be a 480 Volt, 3-phase, 4-wire, 225 Amp distribution panelboard. A 150 Amp main circuit breaker, surge protection device and feeder circuit breakers shall be provided for the following equipment.

- 15KVA Transformer
- Dehumidifier Unit DHU-1
- Motor Operated Valves
- Dehumidifier Condenser ACCU-1
- (2) 10KW Electric Unit Heaters (Filter Room)
- A 3KW Electric Unit Heater (Electric Room)

Lighting Panelboard 1 (LP1)

This panel shall be a 100 Amp, 120/208 Volt, panelboard, and shall provide 120V and 208V power to the following loads:

- Lights
- Receptacles
- Filter Control Panel
- Instrumentation
- Exhaust Fans and Dampers
- Security Control Panel
- Flow Meters

15KVA Transformer

A 15 KVA 480/120/208 Volt dry type transformer shall be provided to step down the distribution power from 480 Volts to 120 Volts for the LP1 panel described above.

6.4.5 Lighting at New Treatment Building

The lighted for the new treatment building shall be provided based on two categorical uses, normal and emergency lighting. A conceptual description of the equipment and design is provided below for each type of lighting categories.

<u>Normal Lighting</u>
A vapor tight, 4' long polycarbonate housing LED light fixtures with localized light switch control shall be installed in the treatment area and the electrical room. Lighting shall provide approximately 30 to 40-foot candles of illumination in each area. Exterior LED wall pack light fixtures shall be provided above entrance doors and shall be controlled by either an astronomical time clock lighting switch or photocells.

<u>Emergency Lighting</u>
Emergency lighting battery units shall be provided in the treatment area and in the electrical room. Remote lighting heads shall be installed at the exterior of each exit door and will be connected into a local emergency lighting battery unit. Exit signs with integral backup battery shall be provided above each exit door.

6.4.6 Lighting at Pump Stations

The existing flourescent lighting at Pump Station #1 and Pump Station #2 shall be replaced with a vapor tight, 4-inch-long polycarbonate housing LED light fixtures. There is no exterior lighting proposed for the pump stations other than an exterior LED wall pack which will be located next to the entry door and shall be controlled by an astronomical time clock lighting switch. No emergency lighting is proposed for either pump station.

6.4.7 Security and Fire Alarm

The new GAC treatment building, existing wells pump houses and DWTP shall be updated to include security cameras.
The new treatment building is not required to be protected by an automatic fire sprinkler system based on a review of the requirements of The State Building Code Table 903.2 and M.G.L. Chapter 148 Section 26 G. A dedicated fire alarm system shall not be provided for the new treatment building and the fire monitoring shall be integrated into the security system.

A UL listed conventional style combination Security and Fire Alarm system shall be provided and shall consist of a control panel, keypad, door switches, heat detectors, horn/strobe devices, and man down pull stations. The control panel shall be located in the electrical room and shall provide dry contacts to the FCP for both security, fire, and man down alarm conditions. The following devices for the security and fire alarm system are proposed for the new treatment area:

- Magnetic door contact switches at each exit door, which will be wired into a zone of the control panel for security intrusion detection (alarm).
- Heat detectors at each exit door, which will be wired into a zone of the control panel for fire alarm detection.
- Man down pull stations at each exit door, the electric room and within the treatment process area. The man down pull stations shall be wired into a zone of the control panel for man down alarm detection.
- Horn/Strobe devices shall be located throughout the treatment process area and within the electrical room. The Horn/Strobe devices shall have the following alarm conditions:
    - In the event of a fire alarm condition the system shall activate the horn/strobe in a 3-pulse temporal tone pattern.
    - In the event of a man down alarm condition the system shall activate the horn/strobe in a continuous tone.

6.4.8 VFD/Controls for Pump Station 1 and 2

A variable frequency drive shall be provided for the new 20-hp pump at Well 1 and a new 15-hp pump at Well 2. A new 50 Amp feeder circuit breaker bucket section shall be provided in both the existing pump station's motor control center. The existing well motor starter in the motor control center shall be left in place for both pump stations.

6.5 MECHANICAL DESIGN APPROACH

The HVAC design for the new treatment building will confirm to the following codes:

- Massachusetts State Building Code 780 CMR.
- 2015 International Mechanical Code in accordance with section 1105.6.3.
- 2018 International Energy Conservation Code.

The conceptual design is broken up into three sections based on the code requirements and maintenance of the electrical equipment and treatment processes.

6.5.1 Ventilating Systems

A wall mounted dome fan shall be provided in the treatment process area to exhaust 0.5 cubic feet per min (cfm) of air per square foot of floor space to comply with provisions of the International Mechanical Code. Exhaust fan internals shall be coated with corrosion resistant coating and the fan shall run upon activation of a manual wall switch located by the personnel entrance doors (total of two manual switches) and when the wall mounted Refrigerant Monitoring System enters an alarm condition. To replace the exhausted air from the fan, a makeup air wall louver and control damper shall be installed in the wall opposite the fan. In the electrical room, the heat generated from the equipment will be cycled with cooler air by a 100 cfm wall mounted fan. The exhaust fan shall cycle in response to a wall mounted thermostat. A makeup air wall cap shall be installed in the wall to allow outdoor air into the room to replace the air exhausted.

6.5.2 Heating Systems

A quantity of two ceiling mounted electric unit heaters shall be provided in the treatment process area. Unit heaters shall be sized to maintain a space temperature of 65 deg F but will normally be kept at 55 deg F and will provide quick temperature recovery when the doors are opened during the heating season. Heaters shall be controlled by wall mounted thermostats and the preliminary size of unit heaters is 10 KW each. An electric ceiling hung unit heater shall be provided in the electrical room and be sized to maintain a space temperature of 60 deg F but will normally be kept at 50 deg F. Heater shall be controlled by a wall thermostat. Preliminary capacity is 3 KW.

6.5.3 Dehumidification Systems

A Split System Dehumidification Unit shall be provided for the treatment process area. The unit shall be sized to maintain a space temperature with a dry bulb design condition of 75 deg F with 40% relative humidity and a dew point of 50 deg F. The dehumidification system will be designed for recirculation service with no outdoor air. An indoor air handler will cool and dehumidify the air and discharge the air into the room. A PVC condensate drain will be piped outdoors to discharge the condensed water from the air handler. A wall mounted controller will control the system and cycle the unit dehumidifier section to maintain the desire space conditions. A condensing unit placed outside will reject the captured space heat and the preliminary unit selection is a Desert Aire LW 10 with a capacity of roughly 8.5 tons cooling and the associated outdoor Condensing Unit.

6.6 PLUMBING DESIGN APPROACH

The conceptual design for the plumbing design within the new treatment building will confirm to the following codes and standards:

- Massachusetts State Building Code 780 CMR.
- Massachusetts State Plumbing Code 248 CMR.
- 2018 International Energy Conservation Code.

6.6.1 Domestic Water

A water line shall be installed in the new treatment building which will be extended from the existing 10-inch distribution line adjacent to (north of) the new treatment building. The water piped to the new treatment building will be chlorinated and will terminate inside the building with two hose connections and a frost proof wall hydrant. No domestic water piping is proposed within the building. The water line shall be a 2-inch domestic copper service with backflow preventer and all exposed cold-water piping shall be insulated. The following plumbing fixtures shall be installed within the new treatment building:

- Two hose bibs with integral vacuum breakers shall be provided.
- An exterior wall hydrant with integral vacuum breaker shall be provided.
- Floor drains and or a trench drain shall be provided in the treatment process area.

6.6.2 Waste and Vent Systems

The waste and vent systems shall be heavy duty, cast-iron piping with gasketed hub and spigot joints for new below grade piping. Accessible and exposed connections shall be no-hub piping with four banded and six banded couplings. Waste and vent connections to the floor and trench drains and a 4-inch through vent roof vent shall be provided.

6.6.3 Floor Drains

Floor drains will be provided to capture any wastewater from wash-downs or leaks. Floor drains will be equipped with sediment buckets and will be trapped and vented in accordance with Mass Plumbing Code. Floor drains will be piped together and tied into the sewer line.

6.6.4 Roof Drainage

Roof drainage will be provided by roof gutters and downspouts which will discharge to grade.

6.6.5 Insulation

Provide insulation on all domestic water piping. Use insulation which is four pound density fiberglass with factory applied white fire retardant, reinforced vapor barrier jacket. Install 1-inch thick insulation continuous through pipe sleeves. Provide pre-molded PVC covers with fiberglass inserts for all pipe fittings and valves.

7 WELL 1 & 2 PUMP STATION UPGRADES

The design will also include elements to upgrade the existing Well 1 and Well 2 facilities with new pumps, VFDs, and instrumentation as needed to supply water during filtration and backwash operations.

7.1 WELL PUMPS

The conceptual design scope includes new well pumps at both Well 1 and Well 2 to overcome the additional friction created by the proposed treatment upgrades. The Well 1 pump will be a 20-horsepower vertical turbine pump rated for 550 gpm at an approximate TDH of 102-ft. The Well 2 pump will be a 15-horsepower vertical turbine pump rated for 400 gpm at an approximate TDH of 100-ft. Due to the increased flow rate through the contactors during the backwashing process, the backwash condition will be the primary design point. The TDH includes static head, friction losses of the exterior yard piping, proposed friction losses through the water treatment plant at the design and backwash flow rates, and all minor losses. Each pump will be provided with a VFD as described in Section 6.4.8. VFDs will be used to control the pumps as needed to meet the numerous design points for the normal operation, backwash, and the filter bypass scenarios as shown in Table 7-1 below.

Table 7-1: Well Pump Design Points

Well	Normal Operation	Backwash	Bypass
1	500 GPM @ 91' TDH	550 GPM @ 102' TDH	500 GPM @ 85' TDH
2	350 GPM @ 89' TDH	400 GPM @ 100' TDH	350 GPM @ 83' TDH

7.2 FLOW METERS

The Well 1 and Well 2 pump discharges are currently equipped with 4" turbine meters. Both wells will be upgraded to 4" magnetic flow meters. Record plans indicate there is at least 3' of straight run pipe in each pump station, which is sufficient to accommodate a 4" magnetic flow meter.

7.3 DISCHARGE PIPING

In order to accommodate new pumps and flow meters, minor modifications may be required on the discharge piping of Well 1 and Well 2. New pressure gauges will be installed on each pump discharge and the existing double door check valves will be replaced.

8 INSTRUMENTATION AND CONTROL DESIGN

8.1 CONCEPTUAL DESIGN FOR INSTRUMENTATION AND CONTROL

The existing main SCADA control panel is located in the D'Angelis Water Treatment Plant and consists of the legacy Allen Bradley SLC 500 PLC system, which utilizes a 5/05 processor with Ethernet communications. The main control panel communicates with a remote RTU control panels located at Pump Stations 1 & 2 over an ethernet/fiber optic network. The existing SCADA HMI computer and alarm dial software allows for operators to monitor the system and resides in the Public Works Garage break room. During an alarm condition, the alarm dialer sends out phone call messages to the configurated phone numbers listed upon the system alarm. The existing SCADA HMI computer and alarm dialer software shall be modified to include remote monitoring and alarm notifications for the new treatment building. The contactors within the new treatment building shall be provided with an OEM filter control panel that utilize the Allen Bradley Compact Logic PLC Platform (FCP). The FCP shall read and write the required inputs and outputs (I/O) to properly run the new contactors, which shall be ethernet networked to the existing SCADA PLC via a new underground fiber optic service. The fiber optic service will run between the D'Angelis Water Treatment Plant and the new treatment building. The FCP shall also monitor and control the motorized valves and instrumentation. The FCP shall also monitor the security control panel within the electric room. The existing SCADA HMI software, which resides in the Public Works Garage Break room will be modified to add monitoring and control interfaces for the new treatment building.

8.2 INSTRUMENTATION

The new treatment building shall contain the following instrumentation:

- Three (3) - Endress Hauser Proline Progmag W 400 Mag Flowmeters. One meter will be provided at each train (PFAS filter run), one meter will be installed at backwash line.
- Four (4) – Differential pressure transmitters, one to be installed at each vessel. The differential pressure transmitter will be connected to the FCP.
- Two (2) - Temperature indicating transmitters, one to be installed in the electric room and the other in the treatment area.

9 PERMITTING & LICENSING

9.1 LOCAL

The following is a list of Local permits that were reviewed for applicability:

- Planning Board & Zoning Board of Appeals
- Board of Health
- Building Permits

Zoning Board Special Permit – NOT APPLICABLE

Based on a review of the Town of Millis Zoning Map (Amended June 2017), the proposed project falls within the Groundwater Protection District (DEP Zone I and Zone II). The proposed construction is located within the Zone I of Wells 1 and 2 and is directly related to the public water supply system. Therefore, in accordance with the Zoning Bylaws, a Special Permit will not be required for the project.

Planning Board Site Plan Review – APPLICABLE

The purpose of site plan review is to ensure the design of projects constitute suitable development for the Town of Millis. Though the proposed project is not considered a potentially significant addition to a developing or developed area of Millis, based on the requirements for the DPW Building project, it is anticipated that a Planning Board Special Permit Application with Site Plan Approval will be required.

Board of Health – NOT APPLICABLE

No septic systems or private wells are to be provided as part of the proposed project.

Town of Millis Conservation Commission / Wetlands Bylaw –APPLICABLE

Proposed work will fall within the buffer zone of bordering vegetated wetlands adjacent to the site. The project will need to file a Notice of Intent and receive an Order of Conditions. The Conservation Commission is charged with administering the Massachusetts Wetlands Protection Act and the Town's Wetland Protection Bylaw (Article XIX). Any work that involves removing, filling, dredging or altering an area within 100 feet of a wetland, or within 200 feet of any perennial river or stream, flood zone or other protected area, requires filing with the Conservation Commission.

The FEMA Map for the site depicts the site as within the 100-year flood zone which would be Bordering Land Subject to Flooding under the Wetlands Protection Act. However, the site elevation is clearly about 10 feet above the base flood elevation of 122 feet which represents the boundary of the 100-year flood zone. The project should obtain a FEMA Letter of Map Amendment (see Federal section below) so that the site is properly categorized for permit and flood insurance purposes.

Charles River Pollution Control District Industrial Permit Discharge - *APPLICABILITY TO BE DETERMINED*

The backwash water from the GAC filters is proposed to be discharged to the sewer which is controlled by the Charles River Pollution Control District. A new sewer connection permit and industrial permit discharge may be required. A more detailed investigation will be completed during the 60% and final design.

Building Permits – APPLICABLE

The contractor will be required to pull applicable permits prior to construction. During the 60% design, Kleinfelder will coordinate with local inspectors for appropriate plan reviews in conformance with local requirements.

9.2 STATE

The following is a list of State permits for which applicability has been reviewed:

- MEPA Environmental Notification Form & Environmental Impact Report
- Approval to Construct a Water Treatment Facility (BRP WS 24)
- Wetlands Protection Act/Rivers Protection Act
- Massachusetts Historical Commission Review
- Natural Heritage and Endangered Species Program Review
- MADEP Groundwater Discharge Permit

Massachusetts Environmental Policy Act (MEPA) – NOT APPLICABLE

MEPA applies to projects above a certain size that involve some state agency action. That is, they are either proposed by a state agency or are proposed by municipal, nonprofit or private parties and require a permit, financial assistance, or land transfer from state agencies. Based on the review thresholds listed in 301 CMR 11.03, no MEPA filing is applicable.

Approval of Pilot Study Report (WS22)- APPLICABLE

Pilot testing was conducted during the Preliminary Design Phase. A Pilot Test Report is being prepared for submittal to MassDEP for review and for the WS22 approval.

Approval of Treatment Facility Modification (WS25) – APPLICABLE

The modifications to the D'Angelis Water Treatment Plant will require review and approval by MassDEP under the BRPWS25 permit.

Massachusetts Historical Commission –APPLICABLE

The MHC is responsible for the review of projects that may potentially affect any significant historic and/or archaeological resources of the Commonwealth, pursuant to Section 106 of the National Historic Preservation Act or Chapter 254 of the Acts of 1988. A project notification will be required to be filed with the Massachusetts Historical Commission and a determination of applicability assuming that the project will be seeking a State Revolving Fund loan for construction. It is expected that no significant impact will be determined to be presented by the project.

Massachusetts Natural Heritage and Endangered Species Program – NOT APPLICABLE

The NHESP provides review for work in the vicinity of the habitat of rare and endangered species, pursuant to the Massachusetts Endangered Species Act. The NHESP publishes the Natural Heritage atlas, which includes maps of Priority Habitats of Rare Species and maps of Estimated Habitats of Rare Wildlife and Certified Vernal Pools. Based on review of NHESP mapping provided through the official Massachusetts Geographic Information System (MASS GIS), the project does not fall within any regulated habitats and does not require review by NHESP.

DEP Groundwater Discharge Permit – NOT APPLICABLE

Backwash residuals will be conveyed to the sewer. No groundwater discharge permit will be required.

9.3 FEDERAL

The following is a list of Federal permits that may be required:

- National Pollutant Discharge Elimination System (NPDES) – General Permit
- FEMA Letter of Map Amendment

National Pollutant Discharge Elimination System (NPDES): General Permit – *NOT APPLICABLE*
A NPDES General Permit (and the associated DEP BRP WM 13) is not required when backwash residuals are sent to a sewer.

FEMA Letter of Map Amendment – *APPLICABLE*
According to FEMA Floodzone maps, the proposed building footprint lies within the FEMA Zone AE. However, the recent survey indicates that the proposed building's slab elevation is about 10 feet above the local base flood elevation of 122 feet. A Letter of Map amendment will therefore need to be filed so that the site is properly categorized for permit and flood insurance purposes.

9.4 OPERATOR LICENSING

According to the Massachusetts drinking water Regulations 310 CRM 22.11B, public water systems must maintain certified operators on staff whose licensing is consistent with the treatment plant's facility grade. Millis has confirmed that most of their operators have Class II-T and II-D licenses. The existing DWTP facility is rate as a grade IT facility as detailed in the most recent 2020 sanitary survey. The addition of the proposed treatment will add six points to the grading score, increasing the existing score from 24 to 30 points. Treatment facilities with 30 points and less are considered Class 1-T and Class II-T is between 31 and 55 points. Based on our interpretation of the scoring system, the added treatment processes will not change the treatment grade of the facility. However, MassDEP will review the classification system, treatment modifications and make a final determination of the future grade of the treatment facility.

Table 9-1: Treatment Facility Rating for DWTP

Process/Item	Qualifying Score	Points for Existing Facility	Points for Proposed Facility
Design Flow Size	1.22 MGD	3	3
Water Supply Source [1]	Groundwater with Little or no Variation	0	0
Chemical Treatment/Addition Process	Fluoridation	4	4
Chemical Treatment/Addition Process	Hypochlorite	5	5
pH Adjustment/Corrosion Control	NaOH is used for pH adjustment	4	4
Other Treatment Process	Aeration	3	3
Other Treatment Process	Air Stripper	5	5
Other Treatment Process	Granular Activated Carbon Filter	0	5
Other Treatment Process[2]	Residual Disposal to sewer	0	0
Other Treatment Process	Facility Characteristics	0	1
Total Score		**24**	**30**
Treatment Grade		**I-T**	**I-T**

[1] Raw water quality is not subject to restrictions or treatment specified in 310 CMR 22.11B
[2] No residual Management exists at the existing facility
Treatment facility rating to be reviewed and approved by MassDEP.

10 CONSTRUCTION PROCUREMENT APPROACH

10.1 BUILDING AND APPURTENANCES CONSTRUCTION

The construction of this project will be publicly bid under M.G.L. Chapter 149. The General Contractor will be required to hold a Division of Capital Asset Management and Maintenance (DCAMM) certification in the category of “Sewage and Water Treatment Plants”.

Filed sub-bid categories will be established during full design. However, electrical and HVAC filed-sub bids are anticipated for the project. The need for additional categories will be determined based on the estimated cost for the work of various trades (>$25,000 requires a filed sub-bid). Filed sub-bidders will be required to be DCAMM certified for the sub-bid category that they bid.

Based on estimated construction contract value, pre-qualification of subcontractors will not be required for this project.

Chapter 193 requires an Owner’s Project Manager (OPM) for any building project with a construction value over $1.5 Million. This project will exceed that threshold. However, qualified staff internal to the Town are anticipated to fill this role. Given the construction is not expected to be overly complex, this approach is considered appropriate for this project.

10.2 GAC CONTACTOR PROCUREMENT

The GAC contactor units are the largest piece of equipment that will be provided as part of this construction contract. The specific characteristics of the system installed will have a direct impact on other aspects of the project, including the building footprint, pipe connection locations, facility layout, and controls. The Calgon™ Model 12 system was chosen as the preliminary basis of design.

However, designing around a single technology can present challenges in a public bidding environment. The Town has options for how to approach the procurement of the contactors, as described in the sections below. These alternatives will be reviewed with the Town so a preferred approach can be implemented for the 60% design phase.

10.2.1 Proprietary Specification

The filter system can be procured as part of a proprietary specification that requires the specific model be provided. Proprietary specifications may be used "... for sound reasons in the public interest stated in writing in the public records of the awarding authority ... such writing to be prepared after reasonable investigation." (MGL Ch. 30, Section 39M(b)). In practice, this would likely translate to an engineering evaluation of available technologies and a written statement from the Board of Water Commissioners.

The proprietary procurement approach allows exact equipment specified and assures the rest of the design will integrate properly with the equipment provided. It also assures the pilot study results will be indicative of full-scale performance and allow construction to proceed as rapidly as possible.

The main disadvantage of a proprietary specification is the elimination of competitive pricing, which can lead to higher costs for the filter system. In addition, there is often an increased risk of protests from other manufacturers against the use of a proprietary specification.

10.2.2 Performance-Based Specification

A performance-based specification would detail the required performance criteria for the contactor system, without specifying a manufacturer or model. The performance-based approach offers the advantage of a fully open, cost-competitive procurement. The use of performance criteria puts the burden for effective filtration on the contractor and manufacturer and assures the finished water will meet the Town's goals.

The design will be based on the Calgon™ Model 12 system and the Filtrasorb F-400 GAC. The specification will note these products as the basis of design and will put the responsibility of re-design and additional pilot testing on the Contractor should they choose to propose alternative products.

10.2.3 Pre-Bidding Filter Equipment

The GAC contactor units could be pre-bid before the design phase is completed. The bid results would be used to identify the technology to be used for the system. This approach would allow the design team to develop its final design around the specific equipment to be provided. It also assures an open, cost-competitive procurement. This approach may slightly reduce the overall length of the construction schedule and allow the new facility to be brought online quicker. The GAC contactors have a lead time of approximately 5 months. If the contactors were pre-bid prior to award of the construction contract they could be manufactured and delivered to the site for the start of construction thereby reducing the overall construction schedule.

This approach splits responsibility for treatment performance between the system supplier and the general contractor. This arrangement can result in disagreements concerning the responsible party to address any deficiencies, as each entity may blame the other for any problems. In addition, this approach requires the time and expense of a separate set of plans and specifications, bid advertisement and bid process for the GAC contractors. This approach is not recommended unless absolutely necessary to meet a specific schedule.

10.3 RECOMMENDED PROCUREMENT APPROACH

The recommended procurement approach for the filtration equipment is the performance-based specification. The specified performance criteria would represent the design basis water quality as indicated in Section 2.1. Bidders would have the opportunity to propose alternative equipment if willing to commit to the specified performance criteria. The bidder would need to include the cost of pilot testing and DEP approval into their overall bid price as well as any necessary re-design.

We consider this approach to provide the Town with the full treatment capability intended for the design, without eliminating open competition from the bid process. The approach also appropriately leaves full responsibility for filter performance with the bidder and equipment supplier.

11 PROJECT COSTS AND SCHEDULE

11.1 OPINION OF PROBABLE CONSTRUCTION COST

The design process starts out with the preliminary design report. The PDR lays the foundation for what the treatment process will be based upon and will provide a basic building footprint and associated design parameters, as provided herein. The subsequent Final Design phase will flesh out construction details until a biddable document set is developed.

At this preliminary level of project conceptualization, and using standard approaches for cost estimating in accordance with a Level 4 estimate (AACE, 2005), the probable construction cost could vary from +50% to -20%. As the design progresses to a higher level of detail, the OPCC will be refined. The final costs of the project will depend on the final design components, actual labor and material costs, competitive market conditions, implementation schedule and other variable factors. As a result, the final project costs may vary from the estimates presented herein. It is also important to note the unusual circumstances of this current moment, which make accurate cost estimates difficult in a volatile bidding climate. The economic recession related to the COVID-19 pandemic has disrupted supply chains and the labor market. At the same time, new PFAS regulations in New England states are driving up demand for GAC filtration units and associated construction trades.

The opinion of probable construction cost (OPCC) was developed based on the preliminary design described in this report which includes the following:

- Demolition of two brick / block buildings (480 sf, 1600 sf)
- Pre-engineered metal building (2,730sf) with process area and electrical room
    - The cost assumes the selection of Option 1 – a simple gable style building
- Four 12-ft diameter GAC filtration units, design capacity of 1.22 MGD
- Building footprint sized to fit the existing site and accommodate potential future treatment requirements
- Residuals management concrete tank below floor slab (two tanks – Backwash and future clear well)
- 585 LF connection to sewer pump nearest sanitary sewer manhole
- Replacement of vertical turbine pumps for Wells 1 and 2

- Process piping and appurtenances
- Flow control and measurement
- SCADA control and instrumentation
- Electrical work
- Dehumidification and electric heating

Table 11-1 Summarizes the preliminary estimate for probable construction costs of approximately $4.96 million. This figure includes construction costs, including a 30% contingency, and contractor overhead and profit (21%). Currently, construction phase engineering services are estimated in the range of $550,000 to $650,000 depending on the project duration. This is based on a conservative assumption of construction administration as well as full time resident engineer construction observation services. The need for full time resident observation and this cost will be evaluated and refined during the next phase of design The OPCC does not include any increases to the project scope. It excludes design phase engineering costs estimated at $200,000. It also does not include future operations and maintenance costs, which are described in Section 11.2.

Table 11-1: Opinion of Probable Cost

Account	Description	Total
1	Demo	$90,896
2	Site Work	$202,527
3	Building	$1,308,632
4	Mechanical	$2,044,549
5	Well 1	$84,136
6	Well 2	$76,271
7	Electrical, Instrumentation, HVAC and Plumbing	$507,429
Construction Cost with Contingency (30%) and Contractor Overhead and Profit (21%)		$4,314,440
Construction Phase Engineering Services		$650,000
Total Probable Cost of Construction		**$4,964,440**

11.1.1 Optional Building Cost

Kleinfelder held a preliminary design meeting with the Department of Public Works on June 02, 2021. An important point of discussion was whether to consider a larger building size to accommodate any future treatment process if water quality were to change. Pre-engineered metal buildings are cost effective solutions for treatment plant projects such as this but can be costly to modify to add such space for future treatment processes. The result of the meeting discussion was a consensus to move forward with designing a larger building to accommodate future treatment processes.

The OPCC presented in Table 11-1 is for the larger building (44-feet by 67-feet) that includes space for future treatment processes. Table 11-2 compares the costs of the proposed larger building to a smaller building (measuring approximately 44-feet by 44-feet) that does not include an area future treatment. The difference in cost for the proposed building and the smaller building options equates to $4.21 million and $3.74 million, respectively, or a 15% overall cost difference. The primary drivers of the cost differences are attributed to the site work and the actual building costs.

Table 11-2: Building Size Cost Comparison

	Proposed Larger Building[1] (44' x 67')	**Smaller Building (44' x 44')**
Site Work	$202,527	$200,031
Building Cost	$1,308,632	$736,489
Construction Cost[2]	$4,314,440	$3,739,801

[1]Proposed building is treatment plant presented in PDR with space for future treatment processes.

[2]Total construction cost with contingency (10%) and contractor overhead and profit (21%)

11.2 OPERATIONS AND MAINTENANCE COSTS

As indicated in our January 2021 the operational costs to run the new GAC filtering building would include replacing the media periodically. Based on the observed PFAS concentrations in the raw water during the Pilot Study, the media would be expected to last at least a year, potentially longer; it is impossible to determine the exact life expectancy of the GAC media. Calgon's budgetary estimate for removing the median and educting (educt: a substance extracted from a mixture, as distinguished from a product) the new media is currently $2.05/lb. This price may be subject to some flexibility depending on the exhaustion rate of the media and if all contactors will require exchanges. The carbon replacement is estimated to cost $164,000.

11.2 FUNDING SOURCES

The Town's Enterprise Committee and Select Board have been planning ahead for this project since the PFAS issue was discovered. It is our understanding that the Town intends to appropriate funds at Town Meeting in November 2021. This section discusses other potential sources of project funding.

11.2.1 MassDEP PFAS Treatment Grant

The costs to complete the design to approximately 30% and prepare this Preliminary Design Report, including costs of site survey and pilot testing, have been entirely funded by a MassDEP grant under Round 2 of the MassDEP PFAS Treatment Grant program. The Town has appropriated its own funds for completing the Final Design. However, the costs for Final Design are expected to also be eligible for a subsequent round of Treatment Grant funding. If offered, the Town should apply for reimbursement of its costs for Final Design. The next round is likely to be announced in summer 2021. The MassDEP does not currently offer grants for the construction costs to implement PFAS treatment. State funding for construction is primarily available via the State Revolving Fund Program.

11.2.2 Community Project Funding (EPA State Assistance Grant)

The Town has worked with State Representative Auchincloss to submit a request for federal project funding of $4.5M under the Community Project Funding program which consists of EPA State Assistance Grant for water infrastructure projects.

11.2.3 State Revolving Fund (SRF) Drinking Water Program

Construction capital costs and construction phase engineering services would be eligible for a 2% interest loan under the SRF Program. A major drawback of this approach is its impact on schedule. For the SRF schedule, a Project Evaluation Form must be submitted by August, the list of selected projects (the Intended Use Plan or IUP) is published in fall, and then finalized in winter.

Project proponents then submit a loan application, along with buildable plans and specifications by October 15th. Once approved, the proponent has six months to initiate construction. Therefore, if the Town chose to utilize SRF Funding, project construction could not start until after October 2022. As the extent of the PFAS issue was not known until late August 2020, the Town could not have submitted a PEF in time to be eligible for 2021 funding.

11.3 PROJECT SCHEDULE

The critical path deadline for the project is to complete the design plans and specifications, and complete a detailed 100% cost estimate, before Fall Town Meeting, which is assumed to be held the second Monday in November (November 8, 2021). Following completion of this Preliminary Design Phase, Kleinfelder is prepared to initiate the Final Design and Bidding Phase immediately upon receipt of a contract and notice to proceed. With the July 1 fiscal year beginning and the next expected Select Board Meeting on July 19, 2021. Given the compressed timeframe, it will not be possible to complete bidding and obtain bids before Town meeting. Appropriation of funding will need to rely on a detailed cost estimate which considers the local bidding climate. Kleinfelder will team with a specialized and experienced professional cost estimator, practicing locally, to assist in developing as accurate a cost estimate as possible. The professional cost estimator will also develop an estimate at the 60% phase, so that if necessary, design modifications can be incorporated between 60 and 100%.

The estimated Project Schedule is shown below in Table 11-3. Completing the design schedule outlined below is achievable if the following assumptions are met: the design contract is awarded in July 2021, major design decisions are made without delay, and the design does not change substantively from that which is presented in this PDR. The construction timeframe will depend upon many factors, including weather and availability of materials. Given a schedule of late fall 2021 bidding and winter award, it is likely that contractor mobilization would not be until early spring 2022. Therefore, a preliminary estimated time range is provided. The following is an approximate time frame for the Final Design and Construction Phases of the project based on these assumptions.

Table 11-3: Project Schedule

Task	Estimated Start Date	Estimated End Date	Duration
Design Contract Executed / Notice to Proceed	July 19, 2021	--	
Task 1 – Final Design	July 19, 2021	Nov 1, 2021	15
1.1 Design Development (60%)	July 19	Oct 4	11
1.2 Final Design Documents (100%)	Oct 4	Nov 1	4
Task 2 – Permitting *(depends on agency review timeline)*	July 19, 2021	Nov 1	15
2.1 Wetlands NOI			8
2.2 Letter of Map Amendment			12
2.3 MassDEP BRP WS25			12
2.4 Millis Site Plan Approval			8
Task 3 – Bidding	Nov 1	Dec 27	8
Contract Award & Execution	Dec 27	Jan 24, 2022	4
Construction *(depends on equipment lead times)*	Feb 2022	Feb to June 2023	12 to 16 months
DEP Acceptance, Start up Testing		Mar – July 2023	4 weeks

Assumptions:

1. Permits submitted along with 60% design packages. Permit review timelines are not cumulative and are subject to change based on actual agency review timelines.
2. Single phase of bidding. Equipment lead times may impact overall project duration.

12 REFERENCES

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(2) Environmental Science and Engineering Inc.; Oak Ridge National Laboratory. *Corrosion Manual for Internal Corrosion of Water Distribution Systems*; Washington D.C., 1984.

(3) Larson, T. E.; Skold, R. V. Laboratory Studies Relating Mineral Quality of Water To Corrosion of Steel and Cast Iron*. *Corrosion* **1958**, *14* (6), 285t-288t.

(4) Edwards, M.; Triantafyllidou, S. Chloride-to-Sulfate Mass Ratio and Lead Leaching to Water. *J. / Am. Water Work. Assoc.* **2007**, *99* (7).