DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/24
Request No. Department 1-1	Witness: Chris Countie

REQUEST:
Reference: Petition, Bates Page 2

Please provide a complete copy of the approved application that was sent to the NHDES in its review of the Company's request for funding from the PFAS Remediation Grant and Loan fund.

RESPONSE: Please see attached Document entitled: Drinking Water Infrastructure Project: Final Application submitted to NHDES on March 28, 2024 as Exhibit DOE DR 1-1.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/24
Request No. Department 1-2	Witness: Chris Countie

REQUEST:
Reference: Petition, Bates Page 5; and Pre-filed Testimony of Mr. Countie, Bates Page 44, Line 18

Please provide complete copies of relevant reports and / or the evaluation generated by CDM Smith in relation to the need for increased bulk chemical storage at the Nashua water treatment facility, as well as a summary of each report, if available (and if not included in those reports).

RESPONSE: Please see attached, report entitled: Pennichuck Water Works: Evaluation of the Chemical Storage and Feed Systems at the Nashua Water Treatment Plant, dated May 2023, prepared by CDM Smith attached as Exhibit DOE DR 1-2.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/24
Request No. Department 1-3	Witness: Chris Countie

REQUEST:
Reference: Petition, Bates Page 5; and Pre-filed Testimony of Mr. Countie, Bates Page 44, Line 20

Please provide a complete copy of the “condition and capacity assessment” that was performed for all the chemical feed systems in the plant, as well as a summary of the results of that assessment if not included in the assessment itself.

RESPONSE: Please see the Pennichuck Water Works: Evaluation of the Chemical Storage and Feed Systems at the Nashua Water Treatment Plant, dated May 2023, prepared by CDM Smith attached as Exhibit DOE DR 1-2.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024
Request No. Department 1-4
Date of Response: 7/25/24
Witness: Chris Countie

REQUEST:
Reference: Petition Bates Page 6; and Pre-filed Testimony of Mr. Countie, Bates Page 44, Line 22, and Page 45, Line1

a) Please provide the statements of qualifications and / or resumes, and project approach submissions from the firm that was chosen to lead the project, CDM Smith, as well as the other firms who were not chosen.
b) Please also provide a copy, and summary, if applicable, of the comprehensive review performed by the Company that resulted in choosing CDM Smith to lead the project.
c) Did the Company use a competitive bidding process, or issue a formal request for proposals? If not, please provide further explanation and explain why.

RESPONSE:

a) Please see attached documents entitled:
    a. Pennichuck Water Works, Inc.: Proposal Professional Engineering Services for the Nashua Treatment Plant Chemical Feed System Upgrades - CDM Smith dated June 10, 2022, attached as Exhibit DOE DR 1-4(a)(a),
    b. CEI Proposal: Pennichuck Water Works, Nashua Treatment Plant Chemical Feed System Upgrades, dated June 10, 2022, attached as Exhibit DOE DR 1-4(a)(b),
    c. Hazen Proposal: Nashua Treatment Plant Chemical Feed System Upgrades, dated June 10, 2022, attached as Exhibit DOE DR 1-4(a)(c).
    d. Stantec Proposal: Nashua Treatment Plant Chemical Feed System Upgrades, dated June 10, 2022, attached as Exhibit DOE DR 1-4(a)(d).
b) The selection process was completed by a team of PWW staff, utilizing the Selection Process and Criteria on pages 5 and 6 of the Nashua Treatment Plant Chemical Feed System Upgrades Request for Proposal attached as Exhibit DOE DR 1-4(b). All submittals were thoroughly reviewed by the selection committee, and after lengthy discussion, CDM Smith was chosen primarily for the following key reasons:
    a. Relevant experience in NH in similar projects. Most notably, their recent completion of the Manchester Water Works 7 MGD Treatment Plant along the Merrimack River in Hooksett.
    b. PWW's familiarity with the project team.
    c. CDM Smith's recent participation in our Asset Management project.
c) Competitive proposals were provided with the overall selection being made by considering project team, approach and then cost in accordance with the criteria in

Exhibit DOE DR 1-4(b). Please refer to above response to a) for the formal proposals submitted. A fifth firm was asked to propose but declined.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/24
Request No. Department 1-5	Witness: Chris Countie

REQUEST:
Reference: Petition, Bates Page 5; and Pre-Filed Testimony of Mr. Countie, Bates Pages 43 - 44
Please indicate when the Company transitioned its primary water supply from the Pennichuck Brook Reservoir (PBR) to the Merrimack River (MR)? If over a period of time, please provide the general start and end dates of that transition.

RESPONSE:

The Company first began utilizing the Merrimack River as a secondary source of supply in 1984. It was used primarily to supplement the flow of the PBR system in the summer during periods of high customer demand. This was the case for many years and in some years, the MR was not utilized at all.

Between 2015 and 2019, two major upgrades to the Merrimack River Intake (MRI) station and related transmission mains were completed. First, the main from the MRI to the Nashua WTP was constructed, which allowed water from the MR to be conveyed directly to the WTP and bypassing the PBR completely. Next, a deep-water intake was constructed to allow for year-round pumping from the Merrimack River. The original intake structure withdrew water from the surface of the river and could not be used in the winter months due to icing conditions. The Company began pumping from the MR as a co-primary source of supply to the PBR in early 2020.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/24
Request No. Department 1-6	Witness: Chris Countie

REQUEST:
Reference: Petition, Bates Page 5; and Pre-Filed Testimony of Mr. Countie, Bates Pages 43 - 44

The Company explains that, at current levels, the available storage for ferric chloride is 18,000 gallons which lasts approximately 22 days with average use. In answering this question, please define the period of time that the Company defines as 'summer months.' If the Company determines the time period differently in any given year since 2019, please so state and explain why a different period of time is used.

a) Please confirm that this calculation reflects the average use of ferric chloride using the MR as the primary water source. If not, please explain why PBR was used as the water source for the calculation, and provide the relevant calculations with the MR as the primary water source
b) Based upon the above information, please confirm if the Company agrees that the average daily use of ferric chloride is approximately 818 gallons (18,000 gallons / 22 days).
c) The Company explained that during the summer months, the ferric chloride deliveries can be as high as three (3) 4,000-gallon bulk deliveries per week. Please confirm the average daily use during these months is approximately 1,714 gallons per day (12,000 gallons per week / 7 days).
d) Please generally explain if the increased usage of ferric chloride in the summer months is due to 1) a general increase in the amount of water processed, 2) a difference in raw water quality, therefore, requiring more treatment than for similar amounts of raw water during non-summer months, or 3) a combination of 1 and 2, or, possibly, other factors. Please explain.
e) Please provide a breakdown of the average ferric chloride use for each of the summer periods, during the last 5 years. If there was a change in the primary water supply during any of those periods, please indicate when that change took place in the response.

RESPONSE:

In general, the Company defines summer months as June through September.

a) This calculation reflects the historical usage based on varying water quality parameters experienced over ten years. During these years, both primary sources of supply would have been used (particularly since 2020) and continue to be used to this day. More discussion and analysis can be found in Section 2 of the CDM Report attached as Exhibit DOE DR 1-1 (hereinafter "The Report").

b) The Company agrees.

c) As noted, this can be the case. While stating the quantity of 4000 gallons per delivery, this rounds the actual delivered product to 4000 gallons as ordered. In reality, because the hauler has weight limits, the actual delivered amount can be lower. This statement in the petition and testimony was more of an illustration of how vulnerable the supply chain can be when relying on tanker deliveries at this frequency. More discussion of the supply chain vulnerability is contained in The Report (Section 2.4 beginning at 2-28) and in the response to DOE DR 1-6(a) below.

d) Increased usage in the summer months is generally a function of first, increased volume of water produced to meet demand and second, changes in water quality that result in higher chemical demand. Variability of water quality parameters are associated with weather conditions and in the case of the previous five years, periods of drought followed by periods of heavy rain.

e) Please refer to The Report for a more in-depth discussion on historical ferric chloride usage and primary factors influencing coagulant demand, specifically Section 2.3.2 at 2-12.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/24
Request No. Department 1-7	Witness: Chris Countie

REQUEST:
Reference: Petition, Bates Page 5

The Company cites the "Ten States Standard" of 30 days of bulk chemical storage on-hand at average demand. Further, it appears that the Company currently has 22 days of bulk ferric chloride on-hand at average demand.

a) Please explain, with supporting calculations, how many total gallons of bulk ferric chloride storage the Company will have on-hand once the proposed project is completed, and how many days at average use that represents.
b) Using the average demand of ferric chloride of 818 gallons per day, and the Ten States Standard of 30 days' supply at average demand, is it correct to conclude that, according to that Standard, the Company should have approximately 24,540 (818 * 30) gallons of bulk storage on-hand? If the Company believes another amount is more appropriate, please explain.
c) Please explain further what the Company's on-hand bulk chemical storage goal should be relative to the Ten States Standard cited above?

RESPONSE:

a) Please refer to Sections 2.5.2 and 2.6.1 of The Report for discussion of the existing system and proposed system. It is important to note that, although the tanks have a capacity of 6,600 gallons of product, based on the Company's experience, only 6,000 gallons per tank are usable due to mechanical restrictions in the transfer system to the Day Tanks.
b) Please refer to Sections 2.5.2 and 2.6.1 of The Report.
c) Please refer to Sections 2.5.2 and 2.6.1 of The Report.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/24
Request No. Department 1-8	Witness: Chris Countie

REQUEST:
Reference: Pre-filed Testimony of Christopher Countie, Bates Page 41, lines 8-11

a) The testimony mentions the need for increased bulk storage of ferric chloride and sodium hypochlorite as justification for the project. The need for the ferric chloride is discussed at some length in the Petition as well as the various portions of Mr. Countie's testimony, but the filing appears to be silent regarding the reasons behind the need for sodium hypochlorite. Please elaborate on the need for increased primary bulk storage for sodium hypochlorite, and please include any applicable and appropriate calculations as were provided in support of the increased bulk storage of ferric chloride (i.e. current storage capacity, proposed storage capacity, daily use under average conditions, the Ten State's Standard for on-hand bulk storage, etc…)

b) To the extent known at this time, please clarify whether an entirely new building is anticipated as on Bates Page 41, line 8, or whether an addition to an existing building serve the Company's needs.

c) If not provided elsewhere, please provide general site plans for the current water treatment facility, and the new / expanded facility.

RESPONSE:

a) Please refer to sections 2.5.3 and 2.6.2 of The Report for detailed discussions regarding sodium hypochlorite. In summary however, the primary drivers for replacing this storage are two-fold. First, the tanks were retro-fitted in a space that previously contained one-ton chlorine gas vessels. Because of this constraint, they were made to fit in a space that would only allow for 5-1800 gallon tanks. The desired minimum tank size is one that can contain at least one full load quantity of 4,000 gallons Second, the tanks have exceeded their life expectancy and are constantly leaking. This requires significant operator attention and effort to repair leaks in both the connected piping and the tanks themselves.

b) Both options were considered in the conceptual phase. A new building separate from the existing facility was deemed to be most desirable due to the structural considerations needed to add on to the building along the south side and for the continuity of traffic, particularly tanker truck traffic, around the facility. The criteria used to select the final concept for the design of what the Company is pursuing in this project is discussed in detail in Section 6 of The Report beginning at 6-1. Section 5 of The Report also provides the original concept that was presented to PWW staff for feed-back.

c) Please refer to Section 6.2 of The Report for a plan of the proposed new building in relation to the existing structure.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024
Request No. Department 1-9

Date of Response: 7/25/24
Witness: Chris Countie

REQUEST:
Reference: Pre-filed Testimony of Christopher Countie, Bates Page 42, line 1 through Bates Page 43, line 19

Please clarify the following related to the discussion of PFOA and PFOS standards and exceedances:

a) What standard(s) applied for each of these chemicals from 2019 to the present?
b) Please explain whether the standards indicated in the response to (a) were based on single test results, running averages, etc…?
c) With regard to each of the two raw water supplies, PBR and MR, please explain when and which standards were not met from 2019 to the present?
d) Please provide further clarification and explanation for the last sentence on Bates p. 42 continuing to Bates p. 43 ("The new MCL's for two chemicals…"). Please specify which chemicals the Company is referring to in that sentence.
e) Please explain whether, and how, the recent standards approved by the EPA (4.0 parts per trillion for both PFOA and PFOS, along with other standards for other PFAS chemicals) affect the analysis of the Company's operations or need for additional bulk chemical storage of ferric chloride and sodium hypochlorite as presented in the overall testimony.

RESPONSE:

a) In July 2020, NH House Bill 1264 was signed into law establishing the following Maximum Contaminant Levels (MCL) for four PFAS chemicals:

Perfluorooctanoic acid (PFOA) – 12 ppt

Perfluorooctane sulfonic acid (PFOS) – 15 ppt

Perfluorohexane sulfonic acid (PFHxS) – 18 ppt

Perfluorononanoic acid (PFNA) – 11 ppt

b) Compliance with the above standards is based on analysis performed on Distribution Entry Point (DEP) samples, taken quarterly and averaged on a quarterly running annual basis.

c) The Company has performed analysis of the raw water supplied by both the MR and PBR on at least a monthly basis since 2019. Please refer to the attached Excel spreadsheet entitled: *PFAS Holt.MerrimackRiver 2019-Present* for a compilation of this data attached as Exhibit DOE DR 1-9(c). At no point was the finished water produced from the Nashua WTP in violation of the established MCL. The facility utilized Granular Activated Carbon (GAC) to treat for and the removal of raw water PFAS contamination. As the referenced spreadsheet indicates, results of samples gathered from "The Holt", which is representative of the PBR, are significantly higher in PFOA and PFOS than the MR. The Company chooses to blend the PBR and MR supplies and in some periods, utilizes the MR exclusively in order to minimize the loading of these contaminants on the GAC and extend the life of the media's capacity to remove them.

d) The Company is referring to PFOA and PFOS.

e) The new standards recently approved by EPA will not directly affect the need for additional storage of ferric chloride or sodium hypochlorite. The new standards will however, further reinforce the need for the Company to utilize the MR as a primary source of supply, to maximize the life of the GAC media. The Company anticipates that, based on recent history, the GAC will become exhausted in 12-18 months, in regard to its ability to remove PFOA and PFOS, before requiring a complete change-out. The new approved MCLs for PFOA and PFOS will shorten this life span of the GAC media.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024
Request No. Department 1-10

Date of Response: 7/25/24
Witness: Chris Countie

REQUEST:
Reference: Pre-filed Testimony of Christopher Countie, Bates Page 44, lines 6 and 14

Are the 16,000 gallons cited on line 14 intended to be the same number as the 18,000 gallons on line 6? Please clarify and/or correct.

RESPONSE:

Yes, the referenced capacity in line 14 should be 18,000 gallons and not 16,000 gallons.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/24
Request No. Department 1-11	Witness: Chris Countie

REQUEST:
Reference: Petition, Bates Page 5; and Pre-filed Testimony of Mr. Countie, Bates Page 44, Line 17

The Company indicates that there are “ongoing operational indicators that the system requires more bulk storage.” If not provided elsewhere, please list and further explain those indicators, as well as their impact on the Company’s overall bulk chemical storage goals.

RESPONSE:

Please refer to The Report, Sections 2.3.2 at 2-12, for a discussion on the trend analysis and forecasting of these trends, as well as how those trends impact the sizing of bulk chemical storage and pumping equipment capacity.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/24
Request No. Department 1-12	Witness: Chris Countie

REQUEST:
Reference: Pre-filed Testimony of George Torres, Bates Page (Approvals), Bates Page 21

The Company indicated that certain other approvals were necessary to consummate the loan. Besides the approval of the Commission, it appears that an approval by the City of Nashua is the sole listed approval that remains. Further, it appears that a request for approval by the City was submitted on June 20, 2024. Please indicate the status of that approval by the City of Nashua.

RESPONSE:

A meeting of the City of Nashua, Pennichuck Water Special Committee was held on July 18, 2024. At this meeting, specifically called to address this project and its proposed funding. The Committee unanimously voted in favor of Resolution R-24-064 by all members of the Committee was made recommending approval by the full Board of Aldermen at a future meeting (at a time to be determined). A copy of the July 18, 2024 Pennichuck Water Special Committee minutes is attached as Exhibit DOE DR 1-12.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024
Request No. Department 1-13

Date of Response: 7/25/24
Witness: Chris Countie

REQUEST:
At any point in the project, will the Company be required to seek any variance, special exemption, etc…, from the City of Nashua, City of Nashua Zoning Board of Adjustment, NHDES, or any other State or Federal Agency? If so, please explain further, as well as the status of such.

RESPONSE:

The Company does not anticipate at this time, any variances or special exemptions required to complete this project.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/24
Request No. Department 1-14	Witness: Chris Countie

REQUEST:
Reference: Pre-filed Testimony of Mr. Countie, Bates Page 46, Line 5

a) The Company indicated that engineering and design will commence upon approval of the proposed financing in the second quarter of 2024, and that the project as a whole is anticipated to be complete in 2026. To which entity(s) is the Company making reference to with regard to its use of "upon approval"?

b) It appears that engineering and design were anticipated to start in the second quarter of 2024, even though the Company only filed the instant request on July 3, 2024, please further explain at what stage the project is currently.

RESPONSE:

a) In order to complete this project by the end of 2026, the engineering/design must begin in the second quarter or early third quarter of 2024. The Company feels that it is vital to correct the storage capacity and chemical feed capacity deficits as expeditiously as possible. The "upon approval" referred to the award of the loan by the NHDES PFAS Remediation Fund. That approval was critical as it provided a source of funding to initiate the design of this project. Once NHDES approved the loan the company could initiate the necessary approval process from Nashua and the NHPUC. The merits of the project are evident by fact that the NHDES granted the Company a loan to complete the project and those loan funds are competitively awarded based on project need and merit.

b) Engineering/design has commenced and is in the very preliminary stages. As indicated in its response to a) above, the Company believes that the remaining entities yet to approve the financing, will see the projects merits and approve the financing based on the fact that the NHDES, who has the technical and regulatory skill sets required to understand the need for this project, awarded the Company a loan to complete this project.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024 Date of Response: 7/25/24
Request No. Department 1-15 Witness: Chris Countie

REQUEST:
Reference: Pre-filed Testimony of Mr. Countie, Bates Page 46, Line 5

Regarding the Company's goal of completion of the project in 2026:

a) Please further explain when the Company anticipates filing for rate recovery for the anticipated costs of the project;
b) Please explain how the Company anticipates seeking rate recovery for the anticipated costs of the project; and
c) Please explain how such rate recovery interacts, and impacts, the other cost recovery methods already employed by the Company (i.e. the annual QCPAC and tri-annual General Rate Proceedings)?

RESPONSE:

a) The Company anticipates that it will utilize its QCPAC process in 2027, in order to achieve rate recovery for this project.

b) The Company expects to close on the final loan with the PFAS Remediation Fund in late 2026/early 2027 upon final completion of the project and will include it in its QCPAC filing in 2027.

c) The Company will be utilizing its approved rate recovery mechanisms to generate the revenues necessary to support this project. This project will not have any impact on the Company's approved cost recovery methods.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024
Request No. Department 1-16

Date of Response: 7/26/2024
Witness: George Torres

REQUEST:
Reference: Petition, Bates Page 10, paragraph 18

The Company requested a Commission Order no later than October 30, 2024, in order to be able to close on the Loan by November 30, 2024. In that regard, please further explain if the Company has been informed, or is aware, of a possible loss of financing, or other complication, if the Company is unable to close on the loan by November 30, 2024?

RESPONSE:

The Company is in regular communication with NHDES, which is aware of PWW's formal approval process sought before the Commission, as well as its timeline in regards to loan procurement. As such, any potential loss of financing or a negative adjustment in loan terms, has not been communicated, disclosed, or anticipated.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/2024
Request No. Department 1-17	Witness: Chris Countie

REQUEST:
Did the Company consider any other alternatives to the currently proposed project? If yes, please provide a detailed explanation of those alternatives. If no, please explain.

RESPONSE:

The Company was presented with many alternatives to certain aspects on this project and will continue to seek them as the final design comes to fruition. These alternatives are discussed in The Report at Section 6.2 *Finalized Basis of Design Criteria for the New Chemical Systems*.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/2024
Request No. Department 1-18	Witness: George Torres

REQUEST:
Reference: Schedule GT-4A, Bates Page 30, Line C, Coverage Multiplier

The Schedule applies a "coverage multiplier of 1.1, under DW 19-084." Please provide a brief explanation and provide a specific citation from DW 19-084 that supports this multiplier. In addition, please explain and provide any other supporting documentation, which supports applying the multiplier to this financing.

RESPONSE:

The creation of a "coverage multiplier of 1.1" was approved by Order No. 26,070 (November 7, 2017) in Docket DW 16-806, not Docket DW 19-084 as incorrectly referenced in Schedule GT-4A.

Order No. 26,070 in Docket DW 16-806 established the Debt Service Revenue Requirement "DSRR", which is composed of all debt service payments plus ten percent. As discussed in that order *"…the debt service revenue requirements will also allow PWW to comply with cash flow coverage requirements and to meet obligations on new debt incurred between rate filings."* See Order No. 26,070 at 6,7.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/2024
Request No. Department 1-19	Witness: George Torres

REQUEST:
Reference: Exhibit GT-8, Bates Page 37, "Terms of Borrowings"

a) It appears that the rate of the loan offered by NHDES may not be locked-in until the repayment of the loan commences. Please confirm and further explain. If the rate changes, explain how the rate may change, and how often, the rate may change from the initially quoted rate of 3.50%.
b) Please confirm that the rate offered will be a fixed rate once the loan payments begin.
c) If not provided elsewhere, please provide a copy of the letter awarding the financing from the NHDES. If not indicated in that letter, please provide further documentation provided by NHDES indicating all of the loan terms.

RESPONSE:

In response to parts a), b), and c), the Company refers the Department to the NHDES Funding Approval Letter attached as Exhibit DOE DR 1-19 and please see the attached Exhibit C – Promissory Note for the loan attached as Exhibit DOE DR 1-19(a).

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024
Request No. Department 1-20

Date of Response: 7/25/2024
Witness: George Torres

REQUEST:
Reference: Petition, Bates Pages 11 and 12

On Bates Page 11, the Petition includes a citation referring to a rate impact that is not discernable. On Bates Page 12, however, the Company indicates that this financing will not have a significant impact on rates. Does the Company believe that the terms “discernable” and “significant” are synonymous and have the same meaning.

RESPONSE:

Yes, the Company intended the term “discernable” to mean there was no anticipated perceptible or identifiable rate impact which it considers synonymous and not significant.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/2024
Request No. Department 1-21	Witness: George Torres

REQUEST:
Reference: Petition, Bates Page 9

Please provide the calculation for the combined state and federal tax rate of 27.00%

RESPONSE:

Here is the calculation of the combined state and federal rate used in the Petition:

Federal Rate	21.00%
NH BPT Rate	7.60%
Federal deduction of BPT Rate	-1.60%
Combined Federal and State Rate	27.00%

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/2024
Request No. Department 1-22	Witness: George Torres

REQUEST:
Reference: Petition, Bates Page 8, and Schedule GT-1, Page 2 of 2, Bates Page 26

Please provide further explanation for the $558,875 amount indicated including, but not limited to a) what the Company means by intercompany advances, 2) what this amount includes, and 3) how it was calculated.

RESPONSE:

a) The $558,875 of “Intercompany Advances” is representative of the annual P&L cash requirement of the proposed $11.45M PFAS Remediation Loan.

b) The $558,875 is inclusive of :
   - Estimated annual interest expense associated with the PFAS Remediation Loan;
   - Estimated property taxes associated with the completed project; and,
   - Estimated income taxes associated with the completed project.

c) The $558,875 is calculated as follows:

Annual Interest Expense	$400,750
Property Taxes	$266,327
Income Tax	($108,202)
	$558,875

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024	Date of Response: 7/25/2024
Request No. Department 1-23	Witness: George Torres

REQUEST:
Please indicate and explain how much the Company has spent on the project as of the filing date of the instant docket.

RESPONSE:

The Company expended the following amounts to date on the Chemical Feed Project:

2023 -	$48,785.00
2024 -	$90,390.00
Total	$139,175.00

Table of Contents

Drinking Water Infrastructure Project: Final Application

version 1.13

(Submission #: HQ2-79B0-QYHWQ, version 2)

Details

Submitted	3/28/2024 (112 days ago) by Hannah Marshall
Entity Name	Pennichuck Water Works
Submission ID	HQ2-79B0-QYHWQ
Status	Submitted
Active Steps	Staff Review

Form Input

Applicant Information

Public Water Supply ID# (if applicable):
1621010

Municipality/Entity Name:
Pennichuck Water Works

Entity Owner Type Definition:

Public (Municipalities, Village Districts, and Water Precincts)

Private (Privately owned water system such as a mobile home park, condominium association, or a public water system regulated by the NH Public Utilities Commission)

If you are unsure whether your entity is public or private please send an e-mail to dwsrf@des.nh.gov.

Owner Type:
PRIVATE

Applicant Contact Information

First Name	**Last Name**
Christopher	*Countie*

Phone Type	**Number**	**Extension**
Business	6039132372	

Email
Chris.Countie@Pennichuck.com

Address

25 Walnut St

Nashua, NH 03060

Billing/Payment Contact

First Name	**Last Name**	
Christopher	*Countie*	
Phone Type	**Number**	**Extension**
Business	6039132372	

Email
Chris.countie@pennichuck.com

Address

25 Walnut st

Nashua, NH 03060

Project Information

Project Title
PWW Nashua WTP Chemical Systems Upgrades

Project Description (5,000 character max)
Changes in raw water quality including PFAS contamination and increasing turbidity/TOC have put strain on the Nashua Water Treatment Plant's existing chemical feed systems. The goals of the project are to add additional chemical feed storage, increase the system's capacity, prolong the life of the carbon media for PFAS treatment, and return to compliance within the Ten State Standards.

Project Cost

Estimated Construction Cost
5,700,000.00

Construction Contingency
1,700,000.00

Estimated Engineering/Planning Costs
2,600,000.00

Other Costs
1,450,000.00

Other Costs Description
$1,100,000.00 Escalation to September 2025 Midpoint at 7%/year
$350,000.00 PWW Internal Labor and Management

Total Estimated Costs
11,450,000.00

NHDES Funding Plan

NHDES Funding Plan Table

Funding Source	Loan Amount	Grant Amount
Drinking Water State Revolving Fund (DWSRF)	0	
Drinking Water and Groundwater Trust Fund (DWGTF)	0	0
PFAS Remediation Loan Fund (PFAS-RLF)	11,450,000	0
Other NHDES Funding (ARPA, WIIN)		0
	Sum: 11,450,000	Sum: 0

Loan Term (DWSRF, PFAS)

Loan Term Notes

Please select a value for the loan term amount in years (5, 10, 15, 20, or 30 years).

Please Note: a system serving a community that meets the disadvantaged affordability criteria established in Rules Env-Dw 1100 & Env-Dw 1400 may request a 30-year term, provided the loan term shall not exceed the design life of the improvement for which the loan is being requested.

DWSRF Loan Rates

for more information regarding current DWSRF Loan Rates:
Click Here.

PFAS Loan Rates

for more information regarding current PFAS Loan Rates:
Click Here.

Loan Term
20

Authority to Borrow (Private Entity)

Instructions and Requirements, Please Read

For all loan funding programs you will need to submit an Authority to Borrow form. Please complete the appropriate form based on your entity type (PRIVATE). The original completed form will need to be mailed to NHDES Drinking Water and Groundwater Bureau, 29 Hazen Drive, Concord, NH 03302.

Authority to Borrow � Privately Owned Entities: This is a resolution authorizing the Borrower to enter into a loan agreement with the State and pledges a security interest which means an applicant�s real or personal property, to ensure repayment of the loan to the department. This also authorizes a representative(s) to sign all loan documents and disbursement requests associated with the project.
Authority to Borrow � Privately Owned Entities

I read and agree to the statement above.
Yes

Current Annual Residential Water Rate

Water Rate Notes

The current annual residential water use is based on the average usage of 90,000 gallons per year and represents the usage in dollars of one standard single family home. If the applicant is a municipality with no public water systems and therefore has no water rate please select 'Yes' indicating such in the question below.

Are you a municipality with no public water systems and therefore have no current water rate to report? If 'Yes', select the option below and continue. If 'No', select 'No' and please indicate the water rate in the box that will appear below.
No

Current Annual Residential Water Rate
850.97

Project Schedule

Anticipated Authority to Borrow/Accept Grant Date
10/01/2024

Anticipated Design Start Date
06/01/2024

Anticipated Construction Contract Award Date
04/01/2025

Anticipated Project Completion Date
12/31/2026

UEI Number

Unique Entity Identifier (UEI)

A UEI number may be obtained at Official U.S. Government System webpage.
Official U.S. Government System webpage (click here).

UEI Number
N/A

Vendor Code

Vendor Code Notes

If not already on file with NHDES, a vendor code must be obtained online on the Department of Administrative Services Vendor Registration webpage.
Department of Administrative Services Vendor Registration webpage (click here).

Vendor Code Number
155870

Environmental Review Acknowledgement

Environmental Review Instructions

An environmental review is the process of reviewing a project and its potential impacts on the human and natural environment. An environmental review is required for all drinking water infrastructure construction projects receiving funding assistance through the New Hampshire Drinking Water State Revolving Fund (DWSRF), Drinking Water and Groundwater Trust Fund (DWGTF), PFAS Remediation Loan Fund (PFAS-RLF), and American Rescue Plan Act Fund (ARPA) Programs to ensure potential environmental and socio-economic impacts of proposed projects/actions are considered, the public is informed, and the project meets federal, state, and local requirements. NHDES serves as the lead entity coordinating the environmental review process and upon completion NHDES will issue an environmental determination (Categorical Exclusion or Finding of No Significant Impact) or a requirement for the preparation of an Environmental Impact Statement. The environmental review must be completed prior to construction of a drinking water infrastructure project funded in part or wholly by a NHDES drinking water infrastructure funding program.

Funding recipients, or their consultants, are required to submit an environmental review template* in order to initiate the environmental review process. NHDES recommends that the environmental review template be submitted once the project scope and boundaries of the entire disturbed areas (both permanent and temporary) are adequately defined. The entire process can take anywhere from six weeks to a couple of months depending on significant environmental impacts, survey requirements (if applicable), public comments and submittal of the proper documentation.
Environmental Review Template

Acknowledgement
Pennichuck Water Works acknowledges that an environmental review must be completed in accordance with the requirements of Env-Dw 1100 prior to the start of construction and will submit an environmental review template during the design phase for the project.

I agree to the presented statement above.
Yes

Address (where work will be completed):
200 Concord St Nashua, NH 03060

Point of Contact for the Environmental Review

First Name	**Last Name**	
Hannah	*Marshall*	

Title
Engineer

Phone Type	**Number**	**Extension**
Mobile	9789956737	

Email
hannah.marshall@pennichuck.com

Financial Certification for Privately-Owned Systems

The section below is a statement that the applicant has the financial capacity to support both the project loan repayment and continuing operation and maintenance.

Financial Statement 1:
The Pennichuck Water Works has the financial capability to support both the project loan repayment and continuing operation and maintenance. The source of repayment of the loan is as follows (i.e., revenue earned from lot rents, condo fees, etc.)

Please provide details:
Revenue earned from water sales to existing customers.

Financial Statement 2:
The Pennichuck Water Works will conduct and report on a financial audit, including compliance and controls, in accordance with the applicable funding source(s) rules.

I agree to the presented statements above.
Yes

Asset Management Maintenance and Renewal Plan

Asset Management Acknowledgment
It is the intent of Pennichuck Water Works to maintain the funded asset(s) using methods and intervals that maximize their value to our customers while sustaining the overall infrastructure and to finance assets reinvestment needs internally. We therefore establish and maintain a reserve fund for this purpose and will annually appropriate to this fund such amounts as are required to sustain it considering current fund balances, future contributions, and future reinvestment needs. Appropriation amounts will be revised as necessary every five years based on expected reinvestment needs over the life expectancy of the asset(s) while maintaining the level of service that customers expect.

By checking this box the entity agrees to the statement above and will complete the required asset management requirements associated with this project.
Yes

Please select one of the following:
We already have an existing asset management program in place and we will incorporate the new assets into the program. We will submit verification of inclusion of the new assets prior to the completion of the project and submittal of final disbursement request.

Project Attachments

Drinking Water Infrastructure - Final Application Checklist

The chart below outlines some of the documents required for your project. For a complete list of requirements for all project types please refer to the link below. Attaching documents to this application can be performed below.
Checklist Link

Document Requirement	Document Name	Funding Source	Document Description/Notes	Links

Document Requirement	Document Name	Funding Source	Document Description/Notes	Links
Required	ENVIRONMENTAL REVIEW	SRF, TF, PFAS, ARPA	The Environmental Review template should be submitted once the project scope and boundaries of the entire disturbed areas are adequately defined.	https://onlineforms.nh.gov/app/#/formversion/af181afb-5f55-4f08-91b3-17291186f864?FormTag=NHDES-W-03-058
Required	PLANNING DOCUMENTS	SRF, TF, PFAS, ARPA	Project descriptions of need, scope, alternatives & most cost-effective option, cost estimate, and anticipated schedule with monthly cash flow.	NONE PROVIDED
Required	CERTIFICATE OF INSURANCE	SRF, TF, PFAS, ARPA	Does not apply to loans for publicly owned entities. Certificate holder must be State of New Hampshire, Department of Environmental Services 29 Hazen Drive, Concord NH 03302. At least $2,000,000 for bodily injury/death; $500,000 for property damage & Workers� Comp Waiver Statement if applicable. Policy(ies) must be current through anticipated G&C approval date.	NONE PROVIDED
Required	ASSET MANAGEMENT MAINTENANCE & RENEWAL PLAN	SRF, TF, PFAS, ARPA	An inventory of assets must be completed for all assets being funded and submitted prior to the final disbursement request. Excel format of the inventory form and examples are available upon request.	NONE PROVIDED
Required for All Loans	AUTHORITY TO BORROW/ACCEPT GRANT ATTACHMENTS	SRF, TF, PFAS	Copy of warrant article(s)/resolution.	NONE PROVIDED

Document Requirement	Document Name	Funding Source	Document Description/Notes	Links
Required for All Loans	AUTHORITY TO BORROW/ACCEPT GRANT ATTACHMENTS	SRF, TF, PFAS	Copy of Bylaws and Articles of Incorporation.	NONE PROVIDED
Required for All Loans	FINANCIAL DATA	SRF, TF, PFAS	Most Recent Annual Financial Reports/Statements for previous year.	NONE PROVIDED
Required for All Loans	FINANCIAL DATA	SRF, TF, PFAS	Once the final application has been submitted an e-mail will be sent requesting specific financial information which will need to be sent to the NH Business Finance Authority.	NONE PROVIDED
As Applicable	SECRETARY OF STATE - CERTIFICATE OF GOOD STANDING	SRF, TF, PFAS, ARPA	Private systems only - Must be current (Annual cycle runs 4/1-3/30)	https://quickstart.sos.nh.gov/online/Account/LandingPage
As Applicable	NH PUC APPROVAL	SRF, TF, PFAS	Private systems regulated by PUC only.	NONE PROVIDED

Other Project Documentation

Certificate of Insurance for Pennichuck Corporation.pdf - 03/22/2024 02:05 PM
PWW Chemical Systems Final Report - 05102023.pdf - 03/22/2024 02:10 PM

Comment

PWW shall provide the follow documents at closing:
- NH PUC Approval
- Certificate of Good Standing
- Environmental Review.

Pennichuck's current asset management plan is digital, all new assets shall be incorporated into the existing plan.

Attachments

Date	Attachment Name	Context	Confidential?	User
3/22/2024 2:10 PM	PWW Chemical Systems Final Report - 05102023.pdf	Attachment	No	Hannah Marshall
3/22/2024 2:05 PM	Certificate of Insurance for Pennichuck Corporation.pdf	Attachment	No	Hannah Marshall

Status History

	User	Processing Status
3/25/2024 11:14:08 AM	Hannah Marshall	Draft
3/28/2024 12:35:58 PM	Hannah Marshall	Submitted

Processing Steps

Step Name	Assigned To/Completed By	Date Completed
Form Submitted	Hannah Marshall	3/28/2024 12:35:58 PM
Staff Review	Johnna McKenna	

Step Name	Assigned To/Completed By	Date Completed
Application Certified		

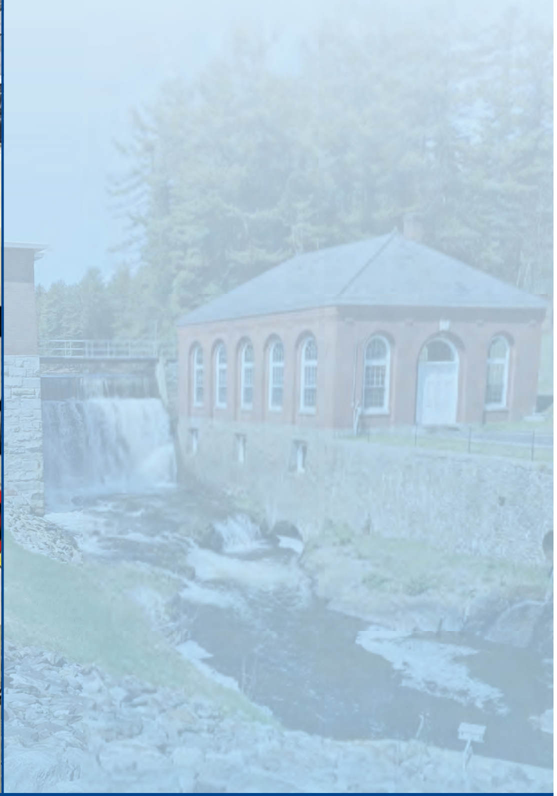
Revisions

Revision	Revision Date	Revision By
Revision 1	3/18/2024 8:55 AM	Hannah Marshall
Revision 2	3/25/2024 11:14 AM	Hannah Marshall

Pennichuck Water Works

Evaluation of the Chemical Storage and Feed Systems at the Nashua Water Treatment Plant

May 2023



Final Report

CDM Smith

CDM Smith
670 N. Commercial Street, Suite 208
Manchester, New Hampshire
tel: 603 222 8300

May 10, 2023

Mr. John Boisvert, P.E.
Chief Engineer
Pennichuck Water Works
25 Walnut Street
Nashua, New Hampshire 03060

Subject: Finalized Report
Nashua Water Treatment Plant – Chemical Systems Assessment
Nashua, New Hampshire

Dear Mr. Boisvert:

The enclosed finalized report presents the results of our assessment of the plant's existing chemical systems that began in the summer of 2022. The work was arranged in four tasks, as follows:

- Task 1 – Desktop evaluation of available data and existing chemical storage and feed equipment
- Task 2 – Condition assessment of existing chemical storage and feed systems
- Task 3 – Conceptual design development
- Task 4 – Preparation of draft and finalized report

This work revealed the need for additional coagulant and sodium hypochlorite storage at the plant. The increasing use of the Merrimack River source due to PFAS management considerations has required additional coagulant dosing. The provision of additional storage of both of these critical chemicals will provide Pennichuck Water Works with increased resilience to ensure drinking water production and delivery through high dosing and water demand periods. The report also identified several mechanical equipment and instrumentation systems that have reached or are approaching obsolescence given their approximate 20-year service life, with recommendations to replace such equipment in the near-term. Finally, the remainder of the bulk storage and day tanks in the plant are identified as having some remaining service life, with recommendations to replace them in the 2032 timeframe.

During the progression of the work, PWW and CDM Smith coordinated to add additional work to augment this report. Specifically, PWW contracted land survey services from a local firm and Task 5 was added to authorize CDM Smith to prepare more refined site plan drawings that will aid in initiating final design efforts more swiftly than if land survey were to begin in a future phase. Further, PWW authorized Task 6 for the drilling of geotechnical borings, with the field work completed in December 2022. Accordingly, site drawings and a geotechnical report are included in this report.

In the period from January 2023 to April 2023, PWW and CDM Smith discussed an alternative location for the proposed new chemical building. Section 4 of the report presents a location on the south side of the site, across the driveway. Section 5 was added in March 2023 to contrast that location to placement of the new building immediately adjacent to and abutting the existing building. After consideration and discussion of both siting options, the new chemical building location across the driveway will be advanced through a future design and construction effort.

CDM Smith is grateful for your assistance and that of your colleagues throughout this study. We especially thank Mr. Christopher Countie and Ms. Hannah Marshall.

This report was prepared by CDM Smith staff under my general supervision. Mr. David G. Polcari, P.E. served as Principal in Charge. Ms. Michaela L. Bogosh, P.E. and Ms. Tarun Gill, ENV SP provided project management assistance and technical support, and Ms. Jihyon Im, P.E. and Ms. Maddison Ledoux, P.E. served as Project Engineers.

Thank you for the opportunity to work on this project.

Sincerely,

STATE OF NEW HAMPSHIRE - PROFESSIONAL ENGINEER
ALAN
GARY
LEBLANC
No. 10157
LICENSED

Alan G. LeBlanc, P.E., BCEE
Senior Vice President
CDM Smith Inc.

cc: Christopher Countie and Hannah Marshall – Pennichuck Water Works
D. Polcari, M. Bogosh, T. Gill, J. Im, and M. Ledoux - CDM Smith

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Section 1

Introduction

This section provides an overview of the background, goals, and organization of the report.

1.1 Background

Through its April 15, 2022 Request for Proposals, Pennichuck Water Works (PWW) selected CDM Smith to evaluate the Nashua Water Treatment Plant (WTP)'s chemical storage and feed systems.

PWW's Nashua WTP is located at 200 Concord Street, Nashua, New Hampshire. The WTP treats two different surface water supplies, Pennichuck Brook and the Merrimack River. The plant is nominally rated to produce up to 32 million gallons per day (mgd), with the Superpulsator clarifiers having the capability to expand up to 40 mgd in the future, to supply water throughout Nashua and portions of surrounding communities.

A locus map appears as **Figure 1-1** and the existing process flow diagram is presented as **Figure 1-2** at the end of this Section.

PWW has been faced with recent challenges at the Nashua WTP, wherein production of the plant's full rated capacity is limited by the capacity of the plant's chemical storage and feed systems. Specifically, as per- and poly-fluoroalkyl substances (PFAS) have become regulated in New Hampshire, PWW has begun to use the Merrimack River as its primary water source. The variability of the river's water quality, with potential influences from climate change to exacerbate variability in the future, has manifested itself within the existing plant in several ways:

- Changing water quality has been exhibited in higher source water organic content (total organic carbon, or TOC), turbidity, color, and manganese in the river. This has required appreciable increases in the dosages of some of the plant's treatment chemicals, notably a near-doubling of coagulant dose and an appreciable increase in sodium hypochlorite dosing. This has led to an increase in bulk chemical delivery frequency and has revealed a shortage of bulk chemical storage volume in the existing facility.
- The increased chemical dosing requirements and limitations of the existing systems have made it difficult for PWW to produce the plant's full 32 mgd to serve existing and potential new customers.

Given the above challenges, coupled with chemical supply chain challenges from 2020 to present, PWW initiated this review of the Nashua WTP's chemical storage and feed systems, to evaluate the existing systems' adequacy and long-term viability.

This report is not intended to consider replacement of the existing water treatment processes (clarification, filtration, and disinfection), as treated water quality has been good and regulatory compliance has been met. Rather, the focus of this report is to assess and provide recommendations for chemical system upgrades to ensure reliable storage volumes and ancillary support systems are available on site.

1.1.1 Information Reviewed

CDM Smith used the following information sources to conduct this review:

- Personnel visits to, and visual inspections at, the Nashua WTP
- Water production records
- Historical source water quality data
- Safety Data Sheets (SDS) for chemicals used at the Nashua WTP
- Facility record drawings
- Chemical supplier contact information

1.2 Project Goals

Through this study, PWW is provided an independent, professional review of chemical system adequacy and condition.

This report is intended to present the evaluation of existing source water quality, chemical system operational practices, and infrastructure conditions. The conclusions of the report present recommendations, implementation timelines, and opinions of probable project costs to aid in PWW's future planning.

1.3 Report Organization

This report has been prepared to provide a succinct review the existing plant status; trends in the plant's source water quality, water production and chemical dosing; observations on existing conditions; and recommendations for future improvements. The report is thus organized thus:

- Section 1 – Introduction
- Section 2 – Preliminary Design Criteria Development
- Section 3 – Condition Assessment
- Section 4 – Conceptual Design of Chemical System Upgrades
- Section 5 – Updated Conceptual Design of Chemical System Upgrades – March 2023
- Appendix A – Technical Memorandum – Task 2 Condition Assessments of the Existing Chemical System
- Appendix B – Technical Memorandum – Geotechnical Recommendations

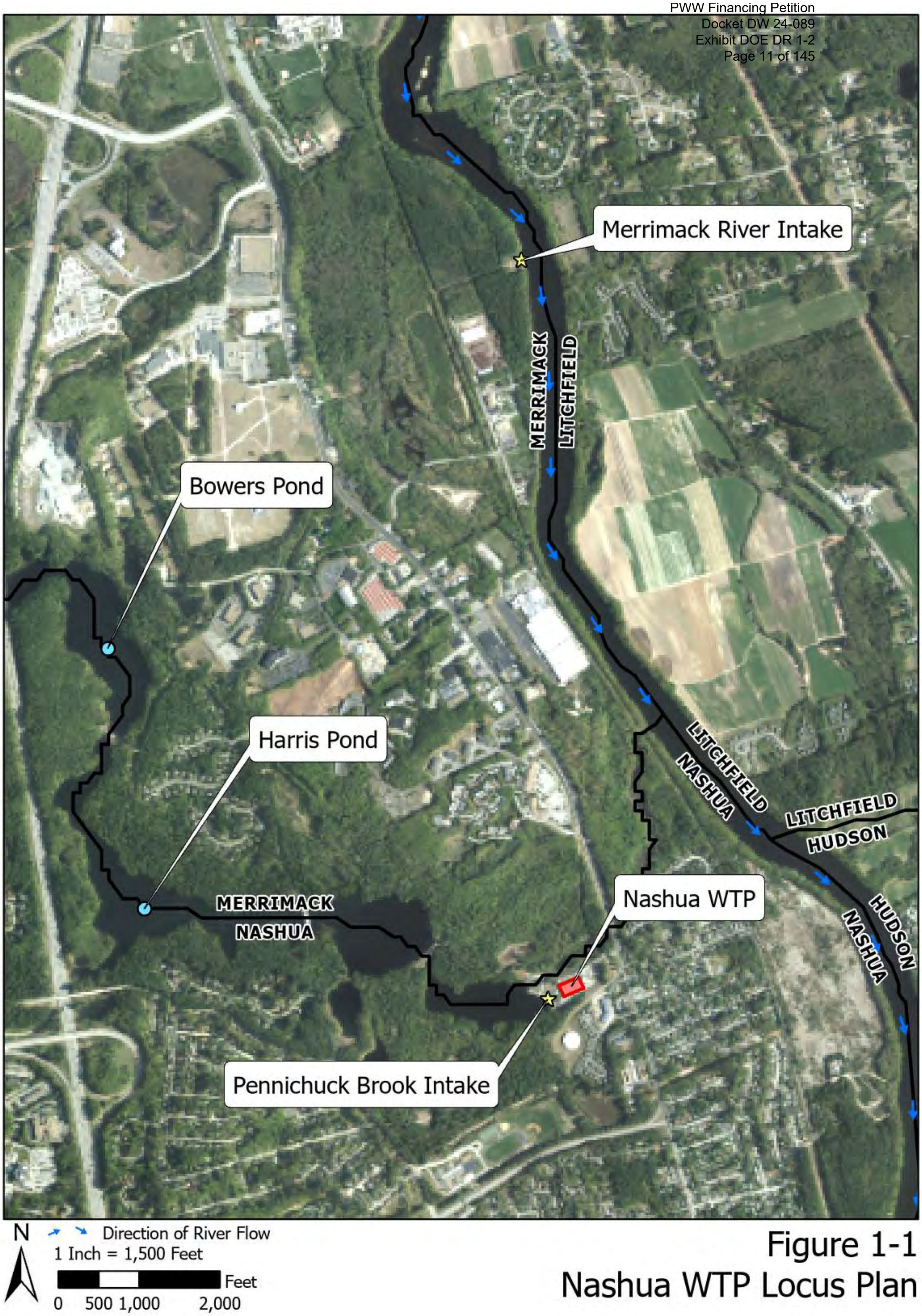


Figure 1-1
Nashua WTP Locus Plan

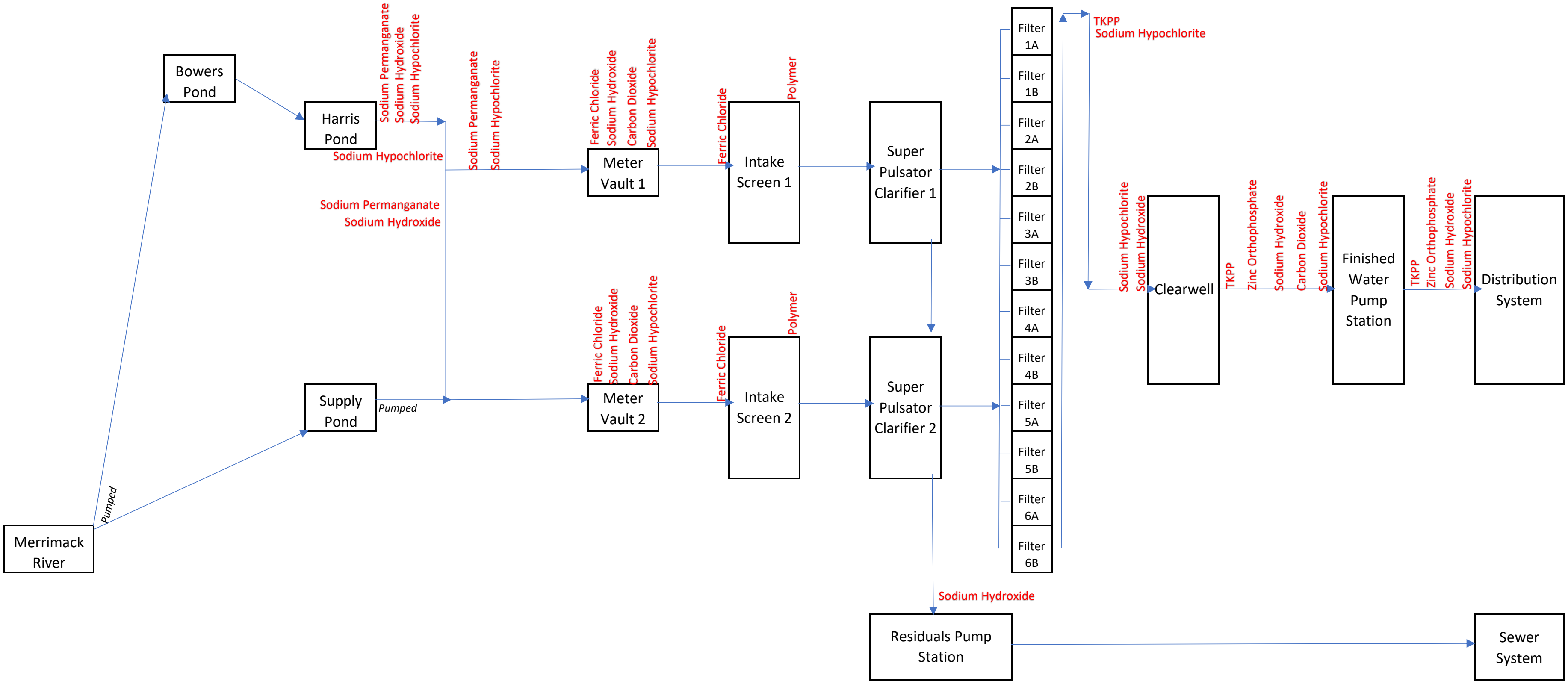


Figure 1-2
Existing Process Flow Diagram and Chemical Injection Points

Section 2

Preliminary Design Criteria Development

This section summarizes the desktop evaluation of the existing chemical systems at the Nashua WTP to understand the suitability of the existing chemical storage and feed systems for the current and future demands. The following tasks were performed as part of this desktop evaluation:

- Data analysis of plant flow (Section 2.1) and source water quality parameters relevant to chemical dosing (Section 2.2).
- Data analysis of chemical dosing and usage trends and subsequent computation of storage volume and feed rate range requirements (Section 2.3)
- Interviews with chemical suppliers to verify chemical variability, pricing, standard delivery volumes, and supply chain considerations (Section 2.4)
- Comparison of the storage and feed capacities of the existing chemical systems to the required volumes and rates (Section 2.5)
- Preliminary design criteria of the new chemical systems (Section 2.6)

The findings presented in this section become the basis of the recommended upgrades presented in Section 4.

2.1 Plant Flow

2.1.1 Raw Water Flow

Historical plant flows recorded by the raw water flow meter from January 1, 2012 to May 31, 2022 were reviewed and analyzed in order to determine the operating flow range to be used in evaluating the capacities of the existing chemical systems and designing the new chemical systems. **Figure 2-1** plots the daily raw water flow in million gallons per day (mgd) while **Table 2-1** presents a summary of the daily raw water flow statistics for the entire dataset as well as each year. During the winter months, the flow has ranged consistently between 8 mgd and 10 mgd while during the higher demand summer months, the plant frequently treated up to over 20 mgd in the recent years. Overall, the historical flow data are characterized by the 5th and 95th percentile (PCTL) range of 8.7 mgd and 20.9 mgd with an average value of 12.6 mgd and the maximum flow observed at 28.8 mgd.

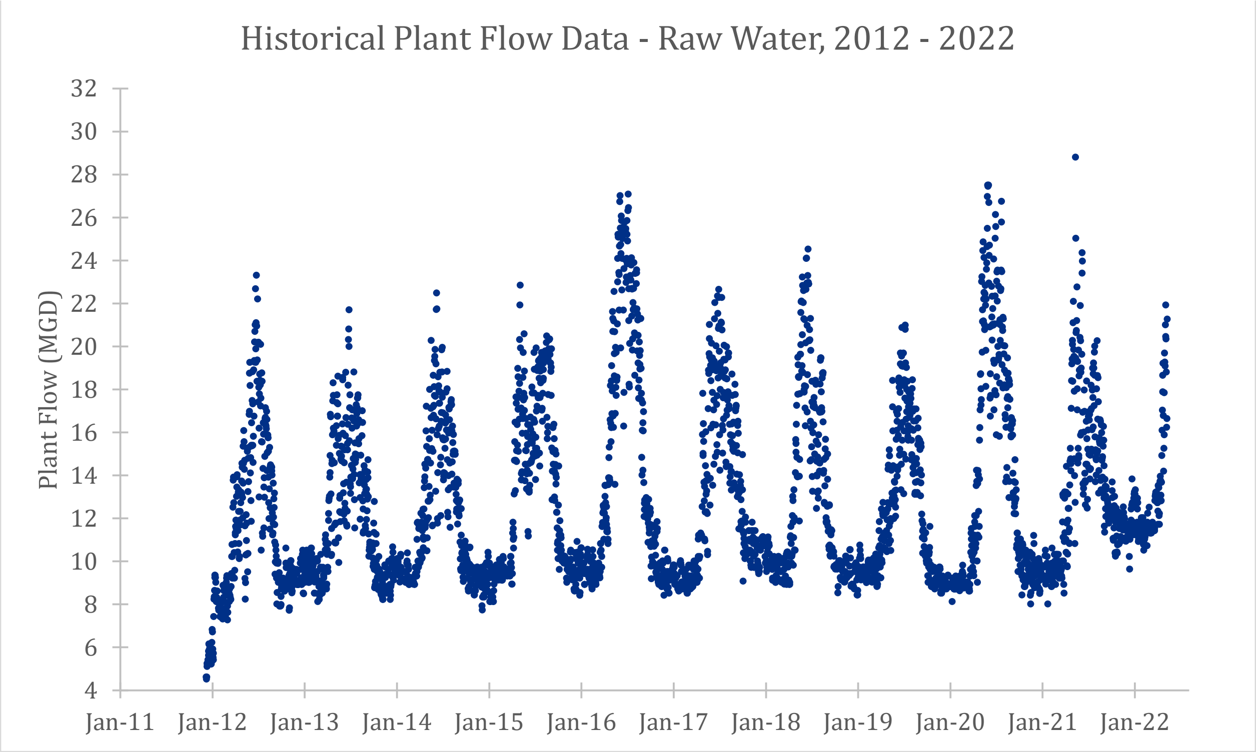


Figure 2-1. Historical Plant Flow Data - Raw Water (January 2012- May 2022)

Table 2-1. Summary of Historical Plant Flow Data - Raw Water (1/1/2012- 5/31/2022)

Flow (MGD)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022[2]	2012-2022
Minimum	4.5	8.1	7.8	8.2	8.4	8.5	8.6	8.5	8.0	8.0	9.7	**4.5**
5th PCTL[1]	5.7	8.5	8.9	8.9	8.9	8.8	9.1	8.9	8.7	9.2	11.0	**8.7**
50th PCTL	9.6	10.6	10.2	11.0	11.6	11.1	10.6	10.4	10.6	12.1	11.8	**11.0**
Average	11.2	11.8	11.9	13.0	14.4	12.7	12.7	12.0	13.6	13.0	12.9	**12.6**
95th PCTL	18.8	17.4	18.0	19.7	25.2	19.8	21.2	18.2	24.0	19.9	19.2	**20.9**
Maximum	23.3	21.7	22.5	22.9	27.1	22.7	24.5	21.0	27.5	28.8	21.9	**28.8**

[1] PCTL = percentile

[2] Represents statistics 5 months of data, not 12 months.

In order to determine the appropriate operating flow range to use as a basis of the capacity evaluation of the existing chemical systems as well as new chemical systems to serve the WTP for years to come, potential increases in the flow rates that the plant will have to treat in the future were evaluated. **Figure 2-2** plots the annual average and 50th percentile in the top graph and the annual maximum and 95th percentile values in the bottom graph. These values are fit with a linear trendline per parameter, and the associated equation is shown on the plot. While the R-squared values (R^2) that indicate a goodness-of-fit measure for linear regression are low, the plots demonstrate generally increasing trends for all four parameters.

In order to reflect this increasing trend in the selection of the design flow range, using the linear regression equations shown in **Figure 2-2**, the future average, 50th percentile, maximum, and 95th percentile values were projected to 2032 and 2042 in **Table 2-2** to reflect 20 years of the service life for chemical system equipment. Minimum flows are also included in **Table 2-2** for comparison, current-day minimum flows were projected for the future but to be conservative, do not assume the same linear regression.

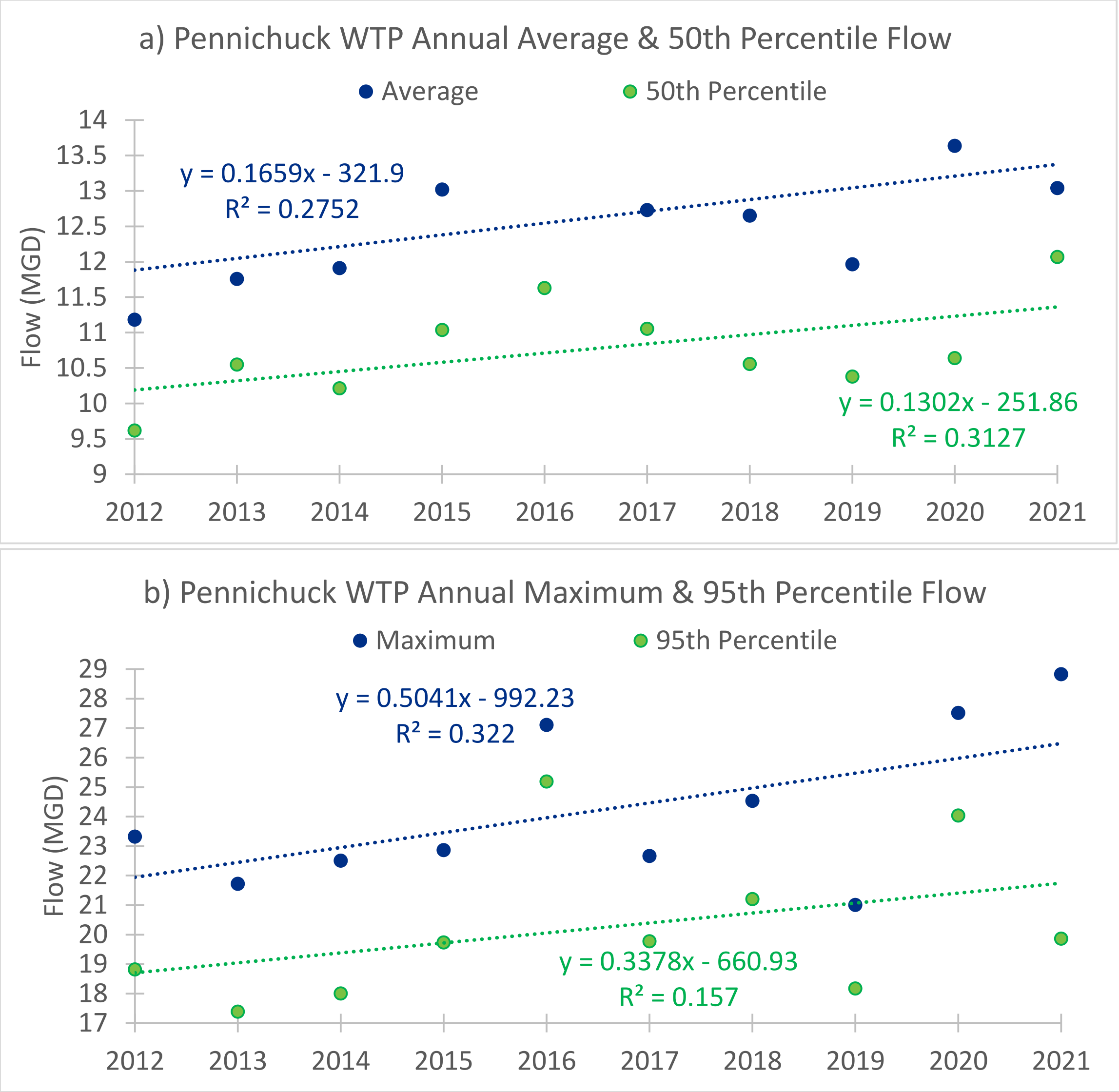


Figure 2-2. Annual Trending Plots for a) Average and 50th Percentile and b) Maximum and 95th Percentile Flows

Table 2-2. Raw Water Flow Projection Using Linear Regression of Historical Data

Flow	2021	2032	2042
Minimum	4.5	8	8
Average	13.0	15.1	16.9
50th Percentile	12.1	12.9	14.3

Flow	2021	2032	2042
95th Percentile	19.9	25.3	29.1
Maximum	28.8	32.1	37.4

With the following considerations, the design flow presented in **Table 2-3** for the chemical systems were determined as part of the Meeting No. 2 on August 19, 2022:

- Minimum flow of 8 mgd covers the minimum values identified in nine of the past eleven years. One of the two years with lower minimum values was 2012, reporting 4.5 mgd, and its winter flow data do not follow the typical operational trend.
- Average flow of 15 mgd was selected as a middle value between the projected 50th percentile value of 14.3 mgd and the projected average value of 16.9 mgd for 2042. This value represents a 2-mgd increase from the average flow of 13 mgd calculated from the most recent full year's worth of data in 2021.
- Maximum flow of 32 mgd represents the current plant capacity, which is greater than the projected 95th percentile value of 29.1 mgd in 2042.

Table 2-3. Design Flows

Flow (mgd)	Minimum	Average	Maximum
Design	8	15	32

2.2 Source Water Quality

Specific source water quality parameters were analyzed to aid in the understanding of the demands of specific chemicals - ferric chloride (ferric) and sodium permanganate. The water quality parameters that are potentially associated with ferric were reviewed due to the reports of its insufficient storage volumes that have resulted in significant operational issues by PWW. As a result, historical total organic carbon (TOC) and turbidity data were reviewed for their relationship with coagulant demand. Local precipitation records were obtained from the United States Geological Survey (USGS) to evaluate TOC and turbidity's potential relationship with rain events.

Sodium permanganate demands were investigated as this chemical system was installed in preparation of manganese spikes in the source water, it has never been used, and therefore, historical dosing data are not available. Therefore, historical manganese and iron data were analyzed.

2.2.1 Total Organic Carbon

Figure 2-3 plots the historical TOC data in raw water collected daily from July 8, 2012 to July 6, 2022 in green data points using the right y-axis. The TOC data represent the overall raw water quality without differentiating the two sources. Overall, the source water experiences a range of 3 mg/L and 6 mg/L of TOC with occasional spikes up to 8-10 mg/L. The TOC spikes seem to occur irregularly either in warm or cold weather. The trend lines are relatively flat, indicating TOC is not increasing over time.

Figure 2-3 also presents the historical ferric doses recorded daily from January 1, 2012 to May 31, 2022, in blue data points using the left y-axis. In this report, chemical usage values for ferric are presented as active chemical (e.g. dose as active chemical or mg/L as $FeCl_3$). While detailed discussion on historical ferric consumption at the WTP is included in Section 2.3, the overall coagulant dosing trend correlates well with the raw water TOC trend, with TOC spikes leading to higher ferric dosing and comparably lower ferric doses being used when lower TOC levels are measured.

However, while the overall increase in ferric dosing is observed as indicated by the positive linear trendline, average and peak TOC levels have not necessarily increased over the ten-year period as previously noted. This demonstrates that while there is a relationship between source water TOC and ferric usage indicated by the correlation between the two datasets, the numerical concentrations of TOC do not directly translate to the specific ferric dose (e.g. the TOC peak of approximately 9 mg/L measured in July 2013 required approximately 60 mg/L of ferric while the same TOC peak level 8 years later in August 2021 required 80 mg/L of ferric). This may represent that the nature and components of the natural organic matter (NOM) measured by TOC are changing, leading to different coagulation reactions and demand over time. In addition, it may be due to the increased usage of the Merrimack River as the primary source water in more recent years and the different organic demand of the two water sources.

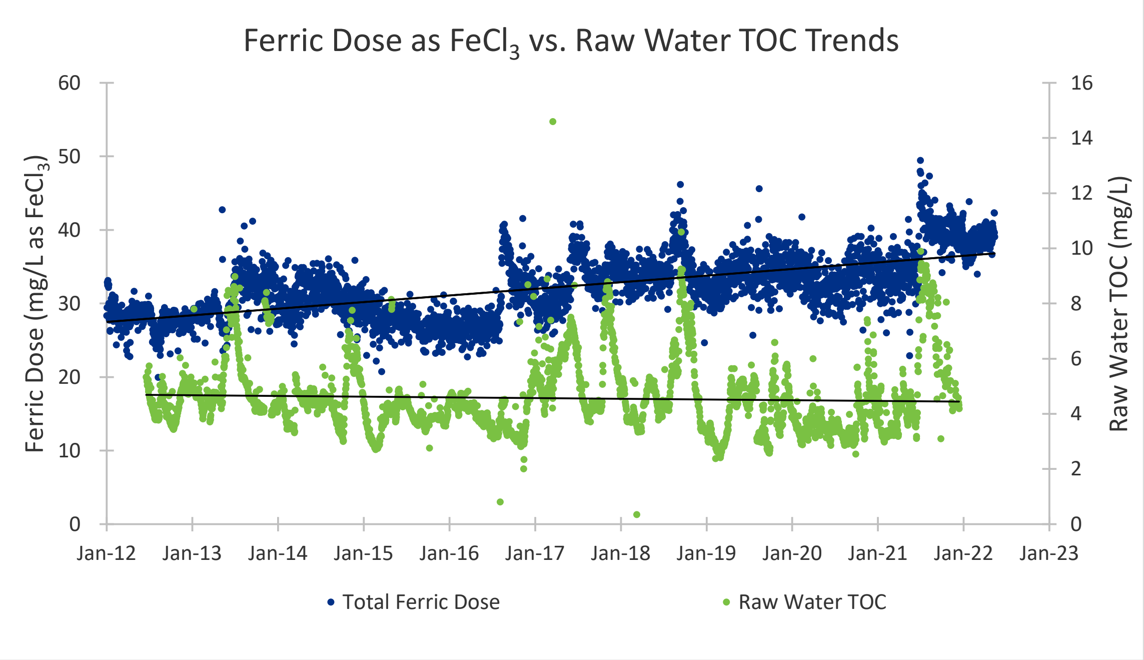


Figure 2-3. Ferric Dose as $FeCl_3$ vs. Raw Water TOC

2.2.2 Turbidity

Similar to the analysis performed with TOC, raw water turbidity levels collected daily from July 8, 2012 to July 6, 2022 were evaluated along with the ferric dosage data, as shown in **Figure 2-4**. The turbidity results are plotted in green data points using the right y-axis. The turbidity data represent the overall raw water quality without differentiating the two sources. Overall, the source water experiences turbidity levels from 0.2 NTU up to 5 NTU. The turbidity spikes seem to occur irregularly, but as suggested by the positive linear trendline, the historical data indicate an increasing trend of turbidity levels in the source water, which could be attributed by the degradation of the source water quality or the different turbidity contents of the two water sources as the WTP has relied increasingly more on the Merrimack River. The treatment goal for the Nashua WTP is a combined filter effluent level of less than 0.1 NTU, which has been historically achieved. This treatment objective is well below the regulatory goal of 0.3 NTU, to ensure the Nashua WTP continues to remain in full compliance with drinking water regulations.

Figure 2-4 also plots the ferric doses from January 1, 2012 to May 31, 2022 in blue data points using the left y-axis. There may be some correlation between turbidity and ferric usage, even though it is not as visually clear as the relationship between TOC and ferric usage. However, the overall turbidity increase may have been contributing more directly to the increasing ferric dosage, as the coagulant process achieves both removal of NOM as indicated by TOC and particulates as indicated by turbidity.

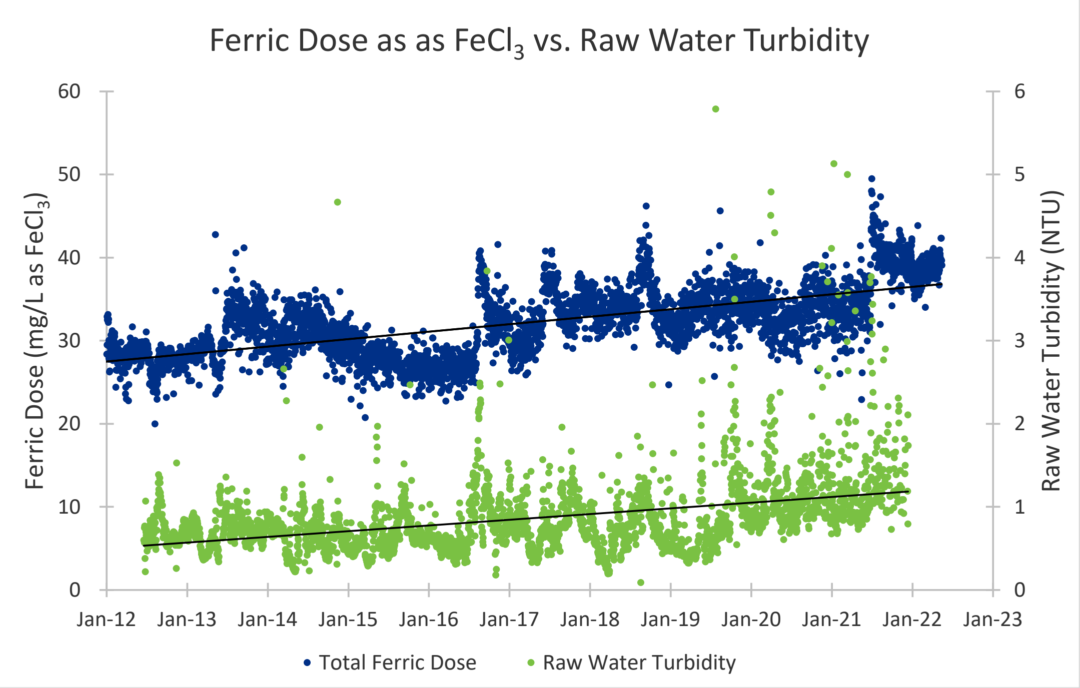


Figure 2-4. Ferric Dose as $FeCl_3$ vs. Raw Water Turbidity

2.2.3 Precipitation

Daily precipitation data collected at the USGS rain gauge Nashua 2 NNW (USC00275712), which is located right on the WTP property, were downloaded from the USGS website and evaluated for any potential correlation with raw water TOC and turbidity levels as well as ferric dosage data.

Figure 2-5 presents the precipitation data and raw water TOC levels. The data suggest that during rain events when the precipitation increases, TOC also generally increases. There seems to be also some correlation between precipitation and raw water turbidity levels with some turbidity spikes overlapping with high precipitation events, as indicated in **Figure 2-6**. The coagulant dosing also has strong correlation with rain events as on the days with higher precipitation levels, increased ferric usage was reported in **Figure 2-7.**

In addition to the overall increase in the coagulant usage, this correlation between the precipitation and ferric dosing as well as water quality raises long-term sustainability concerns for the existing ferric chemical system. With the future rain events likely increasing in intensity and frequency due to climate change, the findings of the desktop evaluation with respect to ferric warrants that sufficient chemical storage and feed capacity is provided at the WTP for reliable operation throughout the year.

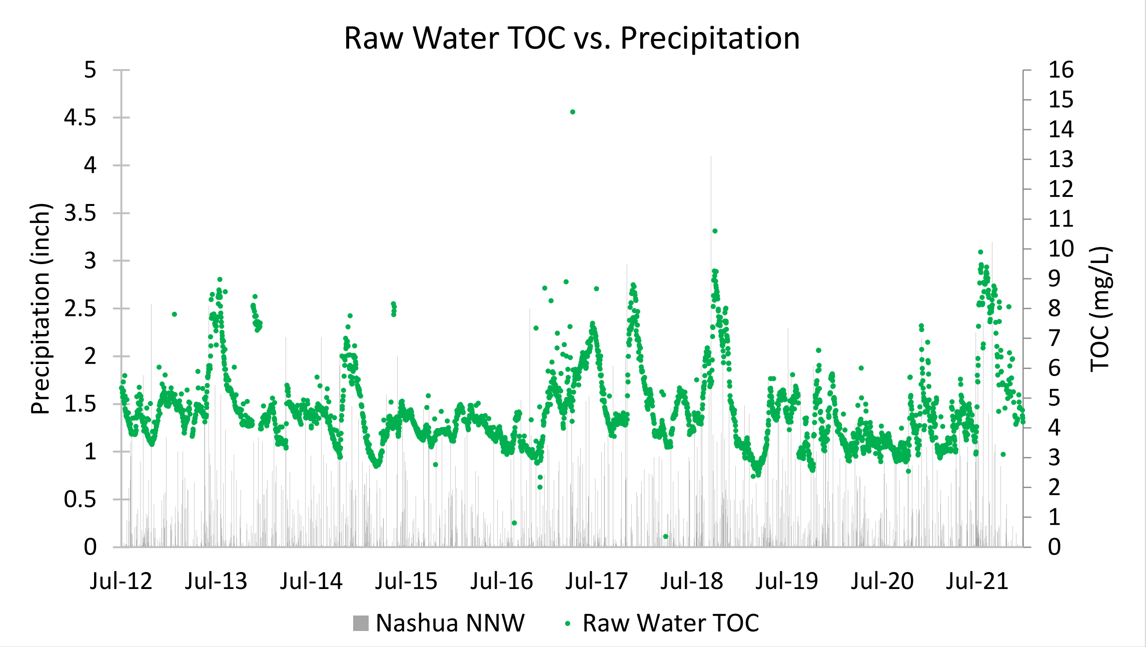


Figure 2-5. Raw Water TOC vs. Precipitation

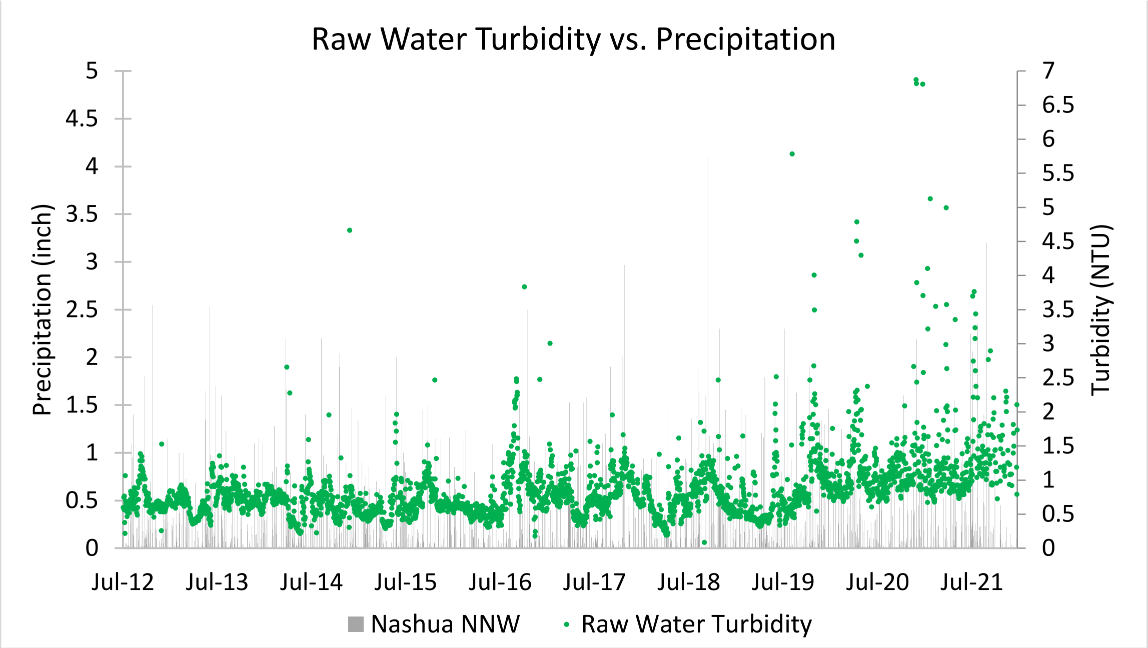


Figure 2-6. Raw Water Turbidity vs. Precipitation

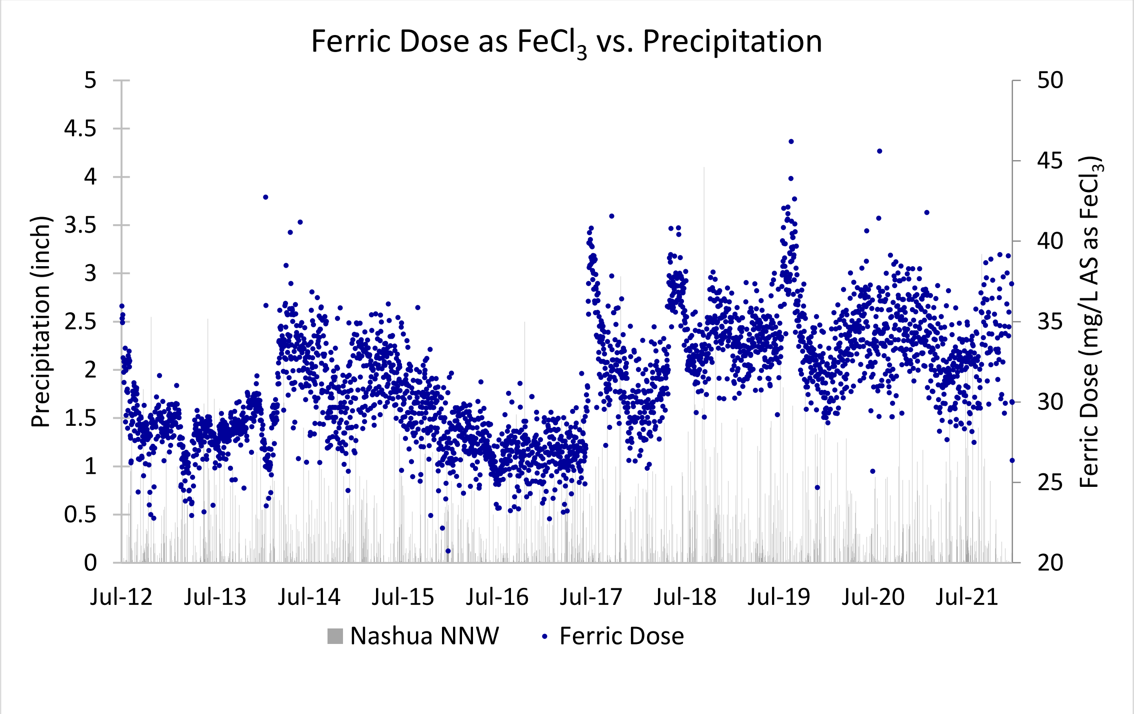


Figure 2-7. Ferric Dose as $FeCl_3$ vs. Precipitation

2.2.4 Manganese and Iron

In order to compute the demand for sodium permanganate that will be used in case of manganese spikes in the source water, total manganese and total iron data collected daily from October 11, 2012, to October 7, 2022 were reviewed and plotted in **Figure 2-8**. Only total manganese and iron data were available for this analysis. Since sodium permanganate will only oxidize dissolved iron and manganese, using the total manganese and iron values that likely include the particulate forms of these inorganics provide conservative estimates of the sodium permanganate demand.

Per PWW's recommendation, the statistics for manganese and iron were calculated only for the last five years from October 7, 2017, to October 7, 2022, as summarized in **Table 2-4**. Single measurements of 213 mg/L of total iron reported on July 10, 2018 and 5.94 mg/L of total manganese reported on February 24, 2020 were considered outliers and removed from the plots and calculations. Overall, iron levels look consistent throughout the ten-year period while manganese levels have increased slightly over the past three years.

For evaluating the capacity of the existing sodium permanganate, based on the data plots and statistics below, the following concentrations were selected as a basis of the sodium permanganate demand and dose calculations in Section 2.3.6:

- Minimum concentrations of 0.11 mg/L for total iron and 0.011 mg/L for total manganese were selected from the 5th percentile values. However, minimum concentrations are almost irrelevant to the sodium permanganate design as the chemical system would not be turned on at such low levels in raw water.
- Average concentrations of 0.32 mg/L for total iron and 0.059 mg/L for total manganese were selected from the average values, which were higher than the 50th percentile values.
- Maximum concentrations of 3.0 mg/L for total iron and 1.0 mg/L for total manganese were selected as the design basis. The true maximum values reported in **Table 2-4** are likely unrepresentative and these levels would not sustain over a period of time triggering operation of the sodium permanganate system. However, considering the sodium permanganate system will only be online when substantial iron and manganese levels are present in the source water, 99th percentile values were computed, rather than 95th percentile, and **Figure 2-8** was visually evaluated to select the above maximum levels that will cover potential increase in extended manganese events in the future.

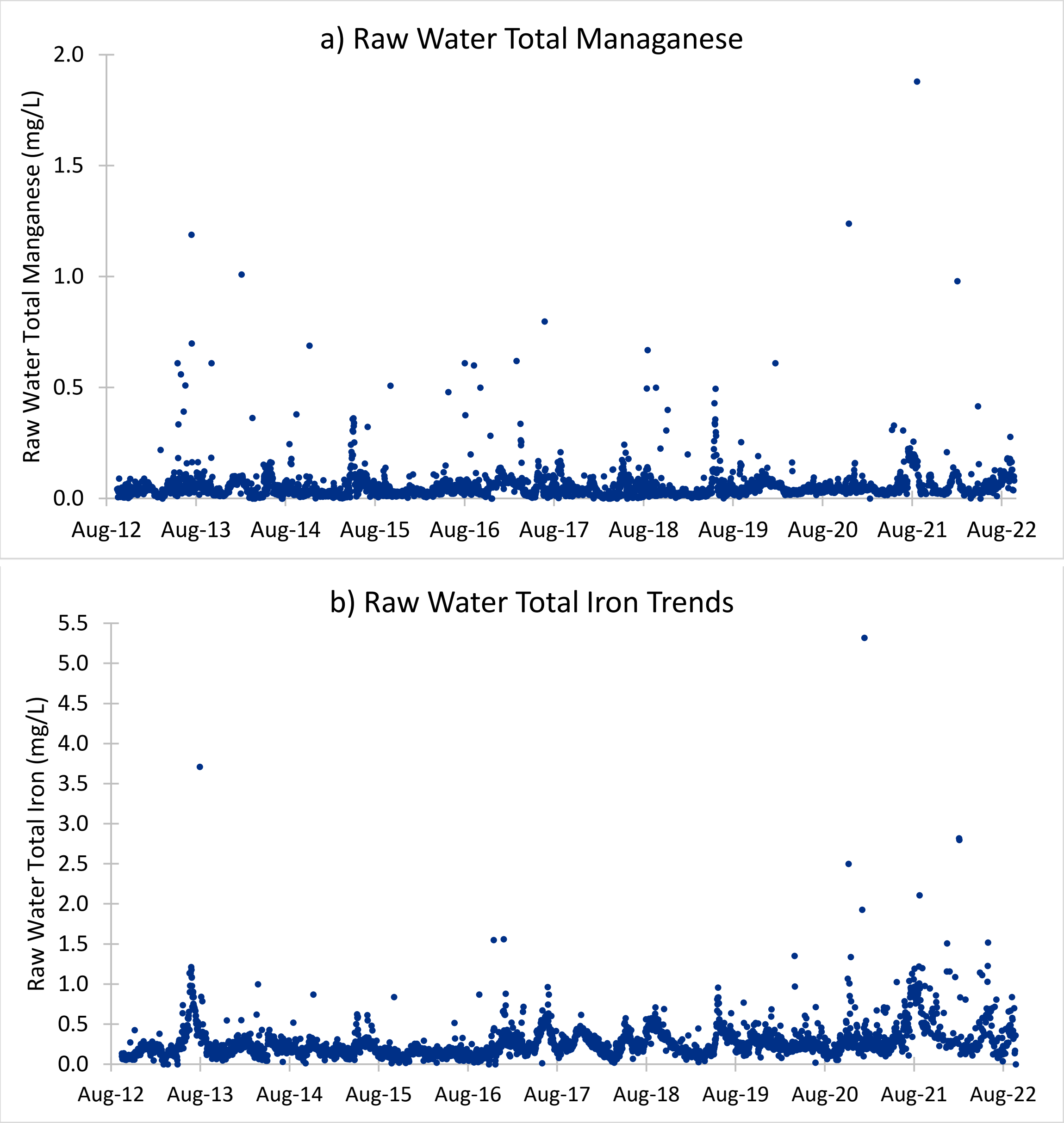


Figure 2-8. a) Total Manganese and b) Total Iron Levels in Raw Water

Table 2-4. Summary of Total Iron and Manganese in Raw Water (10/7/2017 to 10/7/2022)

Concentration (mg/L)	Total Iron	Total Manganese
Minimum	0	0
5th Percentile *(Used for Design)*	0.11	0.011
50th Percentile	0.26	0.040
Average *(Used for Design)*	0.32	0.059
99th Percentile	1.15	0.31

Concentration (mg/L)	Total Iron	Total Manganese
Maximum *(Used for Design)*	3.00	1.00
Maximum	5.32	5.94

2.3 Chemical Consumption

Historical chemical dose data were analyzed to predict future chemical usage at the WTP and because the basis of the capacity evaluation of the existing chemical storage and feed systems.

2.3.1 Chemical Dose Calculation

In order to determine the historical chemical dosing range, CDM Smith reviewed the dataset received from PWW, which included the daily plant flow (mgd) as presented in Section 2.1.1, gallons of each chemical used per day (gpd), and calculated dosing data in parts per million (ppm). Upon further reviewing the calculations for the dosing data in ppm, CDM Smith determined that doses were calculated using the following standard equation:

$$\frac{gallons\ of\ chemical}{day} = \frac{mgd \times dose\ in\ ppm \times 8.34}{chemical\ density \times chemical\ concentration}$$

Solving for dose in ppm:

$$dose\ in\ ppm = \frac{\frac{gallons\ of\ chemical}{day} \times chemical\ density \times chemical\ concentration}{mgd \times 8.34}$$

CDM Smith confirmed the factors used in PWW's dosing calculation using the following assumptions presented in **Table 2-5**. As a result, the following remarks are provided for the chemical dosing data provided by PWW:

- The data for ferric chloride, sodium hypochlorite, and sodium hydroxide represent dosing as active chemical.
- The data for zinc orthophosphate represent dosing data as product (not as phosphate or phosphorus).
- The data for tetrapotassium pyrophosphate (TKPP) represent dosing data as fully mixed solution at 3% strength.

In this report, chemical usage values are presented in either dose as active chemical (e.g. dose as active chemical or mg/L as $FeCl_3$), as product (neat chemical) or as mixed solution (dry chemical mixed in water).

Table 2-5. Summary of Chemical Calculation Factors

Chemical	Chemical Specific Gravity	Chemical Density (lb/gal) [1]	Chemical Concentration	Factor Used in PWW Dosing Calculation	Calculated Factor [2]
Ferric Chloride	1.44	12.0	41%	4.92	4.92
Sodium Hypochlorite	1.17	9.76	12.5%	1.22	1.22
Sodium Hydroxide	1.53	12.7	50%	6.38	6.38
Zinc Orthophosphate	1.53	12.8	100%	12.76	12.76
Tetrapotassium Pyrophosphate	N/A [3] (dry chemical)	8.34 [4]	N/A	0.25	0.25

[1] Calculated by multiplying the chemical specific gravity with the density of water, 8.34 lb/gal.

[2] Calculated by multiplying the chemical density with the chemical concentration.

[3] N/A = Not applicable

[4] Current practice is dosing 50 pounds of dry chemical in 200 gallons, representing 3% solution, and thus the mixed solution is assumed to have the same density as water.

2.3.2 Ferric Chloride

Ferric is used at the WTP as a primary coagulant to achieve removal of turbidity and organics primarily. It is dosed at the headworks with a dedicated injection point upstream of each of the two traveling screens.

Historical dose data for ferric collected daily at the WTP from January 1, 2012, to May 31, 2022, are presented in **Figure 2-9**, representing the average values of the two dosing datasets received from PWW. The statistics for this dataset are summarized for all years as well as each year in **Table 2-6**. The doses are presented as active chemical or $FeCl_3$. Overall, an increase in ferric dosing is observed over the years with irregular peaks in usage often recorded in warmer weather.

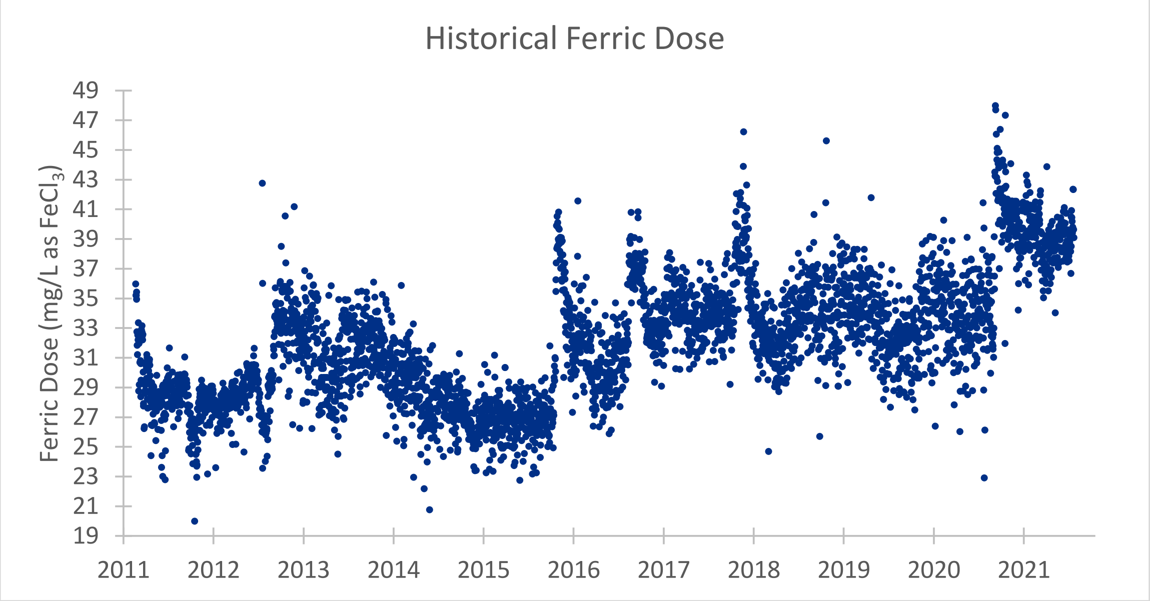


Figure 2-9. Historical Ferric Dose as $FeCl_3$ (1/1/2012-5/31/2022)

Table 2-6. Summary Historical Ferric Dose as $FeCl_3$ (1/1/2012-5/31/2022)

Ferric Dose (mg/L as $FeCl_3$)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022[2]	2012-2022
Minimum	20.0	23.6	24.5	20.8	22.8	25.9	29.2	24.7	26.4	22.9	34.0	**20.0**
5th PCTL[1]	24.8	26.3	27.3	24.9	25.0	28.1	31.3	29.6	29.6	30.7	36.3	**26.1**
Average	28.3	30.7	31.0	27.7	29.4	32.8	34.6	33.7	33.4	37.0	38.8	**32.1**
50th PCTL	28.2	29.9	30.9	27.5	27.8	32.5	34.1	33.7	33.4	36.9	38.8	**32.0**
95th PCTL	32.2	35.6	34.6	30.9	38.3	37.8	39.7	37.6	37.3	43.5	41.0	**39.7**
Maximum	36.0	42.8	36.1	33.3	41.6	40.8	46.2	45.6	41.8	49.5	43.9	**49.5**

[1] PCTL = percentile

[2] Represents statistics 5 months of data, not 12 months.

Based on this review, the historical coagulant doses are achieving the treatment objectives and it is unlikely that these doses will decrease over time, when climate change and the continued degradation of the source water quality are considered. Because of the increasing ferric usage trend observed in the past ten years, the future ferric dose was projected using the historical data trends. **Figure 2-10** plots the annual average and 50th percentile in the top graph and the annual maximum and 95th percentile values in the bottom graph. These values are fit with a linear trendline per parameter, and the associated equation is shown on the plot. While the R-squared values (R^2) that indicate a goodness-of-fit measure for linear regression are not high, the plots demonstrate generally increasing trends for all four parameters.

In order to reflect this increasing trend in the selection of the design flow range, using the linear regression equations shown in **Figure 2-10**, the future average, 50th percentile, maximum, and 95th percentile values were projected to 2032 and 2042 in **Table 2-7** to reflect 20 years of the service life for chemical system equipment.

With the following considerations, the design dose range in **Table 2-8** were determined for evaluating the ferric chemical storage and feed system:

- Minimum dose of 22 mg/L covers the minimum values identified in nine of the past eleven years. The plant has not reported a daily flow rate lower than 22 mg/L since 2015.
- Average dose of 53 mg/L represents the projected 50th percentile and average values for 2042.
- Maximum dose of 60 mg/L represents the projected 95th percentile value for 2042 and the projected maximum value for 2032.

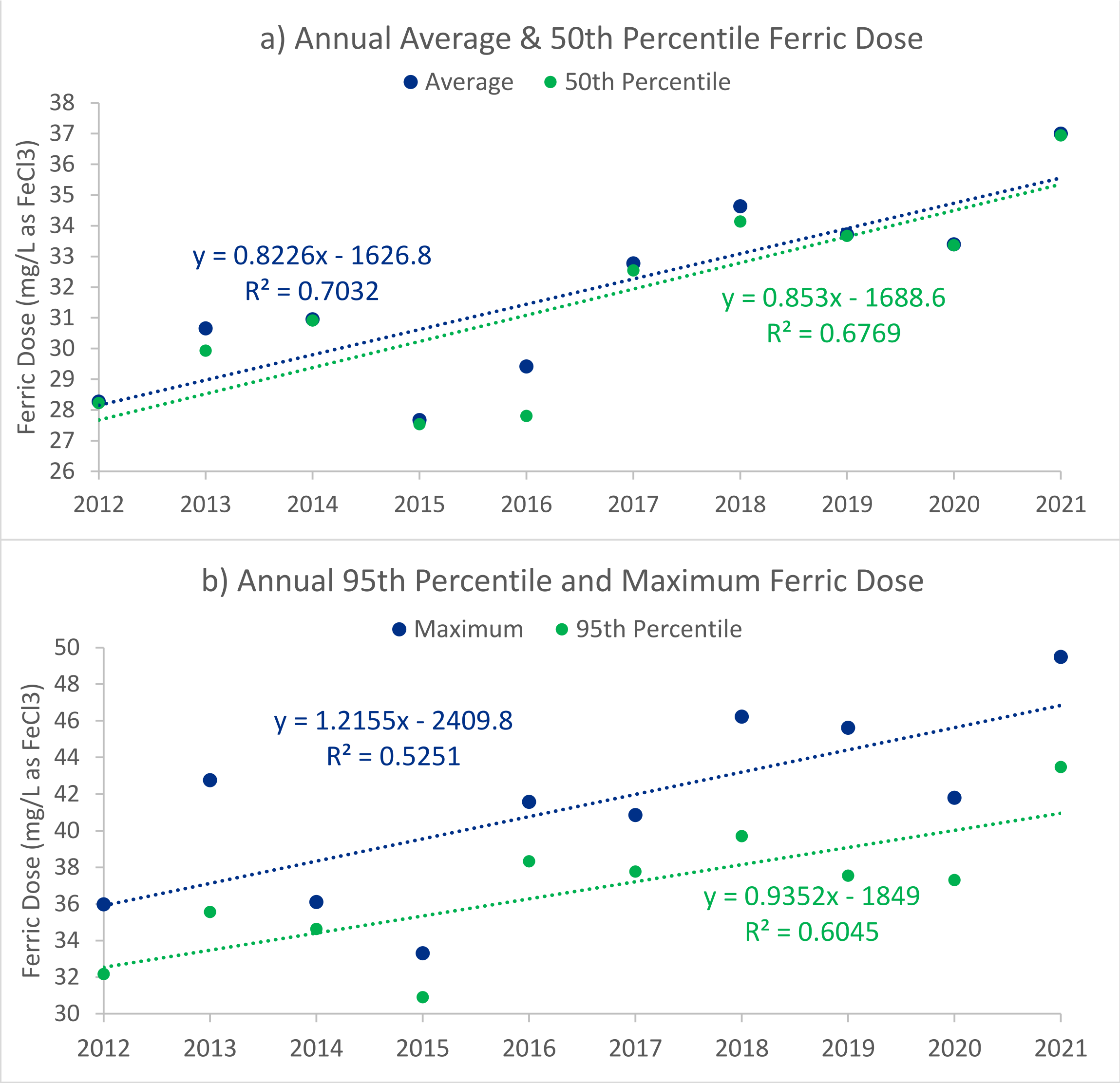


Figure 2-10. Trend Analysis with Ferric Dose as $FeCl_3$ for a) Annual 50th Percentile and Average Values and b) Annual 95th Percentile and Maximum Values (1/1/2012-5/31/2022)

Table 2-7. Ferric Dose Projection Using Linear Regression of Historical Data

Ferric Dose (mg/L as $FeCl_3$)	2021	2032	2042
Average	37.0	44.7	52.9
50th Percentile	36.9	44.7	53.2
95th Percentile	43.5	51.3	60.7
Maximum	49.5	60.1	72.3

Table 2-8. Design Dose for Ferric as $FeCl_3$

Dose (mg/L as $FeCl_3$)	Minimum	Average	Maximum
Design	22	53	60

2.3.3 Sodium Hypochlorite

Sodium hypochlorite (12.5% concentration) is used at the WTP as a disinfectant to achieve primary disinfection in the clearwell and carry a secondary disinfectant residual. It is dosed to the combined filtered water upstream of the clearwell, but alternate injection points are available to raw water and clearwell effluent. PWW aims to maintain 0.4 mg/L of chlorine residual in the distribution system and a range of 0.9 to 1.2 mg/L chlorine residual in the finished water.

Historical dose data for sodium hypochlorite collected daily at the WTP from January 1, 2012, to May 31, 2022, are presented in **Figure 2-11**. The statistics for this dataset are summarized for all years as well as each year in **Table 2-9**. The doses are presented as active chemical or Cl_2. Generally, seasonal peaks of sodium hypochlorite usage are observed during warmer months.

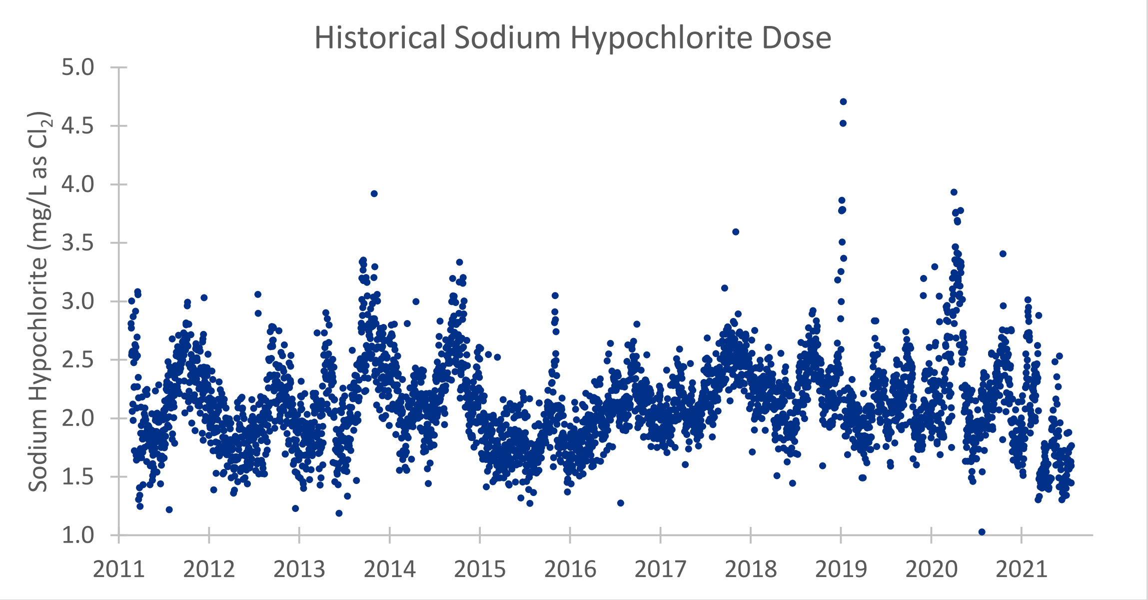


Figure 2-11. Historical Sodium Hypochlorite Dose Data (1/1/2012-5/31/2022)

Table 2-9. Summary Historical Sodium Hypochlorite Dose as Cl_2 (1/1/2012-5/31/2022)

Sodium Hypochlorite Dose (mg/L as Cl_2)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022[2]	2012-2022
Minimum	1.22	1.23	1.19	1.41	1.27	1.28	1.61	1.45	1.49	1.03	1.31	**1.03**
5th PCTL[1]	1.64	1.53	1.62	1.69	1.50	1.75	1.91	1.84	1.75	1.66	1.40	**1.58**
Average	2.15	1.94	2.27	2.20	1.81	2.07	2.29	2.26	2.11	2.28	1.71	**2.12**
50th PCTL	2.15	1.92	2.26	2.15	1.77	2.05	2.28	2.23	2.08	2.20	1.61	**2.09**
95th PCTL	2.71	2.51	2.95	2.83	2.18	2.46	2.70	2.75	2.59	3.24	2.42	**2.74**
Maximum	3.08	3.06	3.92	3.33	3.05	2.81	3.59	4.71	3.30	3.94	2.88	**4.71**

[1] PCTL = percentile

[2] Represents statistics 5 months of data, not 12 months.

A trend analysis was performed with the historical sodium hypochlorite usage data to evaluate if any dosing patterns should be accounted for in determining the future chemical dose range. **Figure 2-12** plots the annual average and 50th percentile in the top graph and the annual maximum and 95th percentile values in the bottom graph. These values are fit with a linear trendline per parameter, and the associated equation is shown on the plot. While the R-squared values (R^2) that indicate a goodness-of-fit measure for linear regression are low, the plots show slightly increasing trends for all four parameters.

In order to reflect this increasing trend in the selection of the design flow range, using the linear regression equations shown in **Figure 2-12**, the future average, 50th percentile, maximum, and 95th percentile values were projected to 2032 and 2042 in **Table 2-10** to reflect 20 years of the service life for chemical system equipment.

With the following considerations, the design dose range in **Table 2-11** were determined for evaluating the sodium hypochlorite chemical storage and feed system:

- Minimum dose of 1.0 mg/L covers the minimum values identified in all of the past eleven years.
- Average dose of 2.5 mg/L represents the projected 50th percentile and average values for 2042.
- Maximum dose of 5.0 mg/L comfortably covers the projected 95th percentile value for 2042 (3.3 mg/L) and close to the projected maximum value for 2042 (5.5 mg/L).

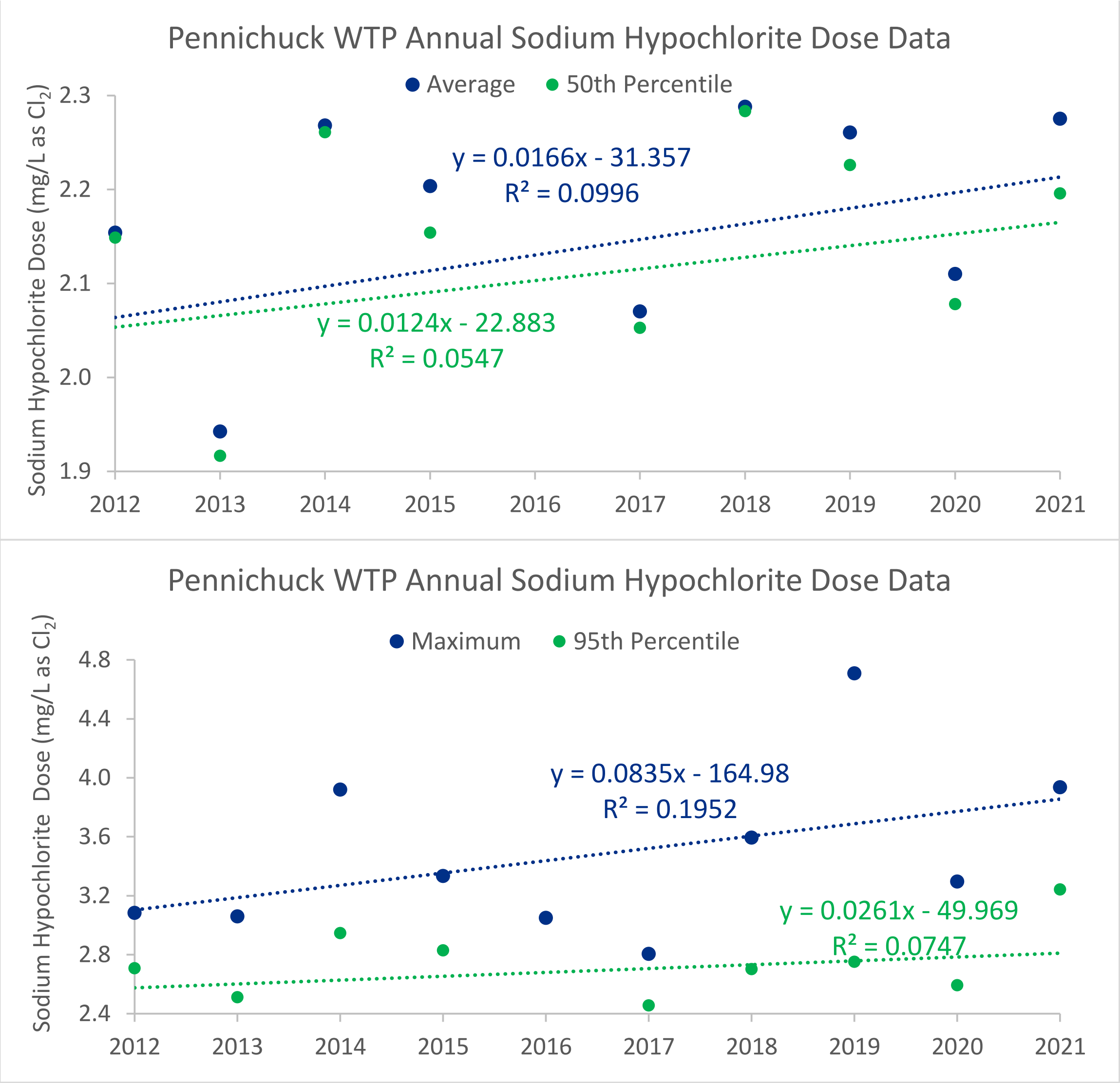


Figure 2-12. Trend Analysis with Sodium Hypochlorite Dose as Cl_2 for a) Annual 50th Percentile and Average Values and b) Annual 95th Percentile and Maximum Values (1/1/2012-5/31/2022)

Table 2-10. Sodium Hypochlorite Dose Projection Using Linear Regression of Historical Data

Sodium Hypochlorite Dose (mg/L as Cl_2)	2021	2032	2042
Average	2.3	2.5	2.6
50th Percentile	2.2	2.4	2.5
95th Percentile	3.2	3.0	3.3
Maximum	3.9	4.7	5.5

Table 2-11. Design Dose for Sodium Hypochlorite as Cl_2

Dose (mg/L as Cl_2)	Minimum	Average	Maximum
Design	1	2.5	5.0

2.3.4 Sodium Hydroxide

50% sodium hydroxide, also known as NaOH or caustic soda, is used to increase raw water pH to improve coagulation and reduce corrosivity after disinfection. First, it is dosed to the raw water to aid in the coagulation process (pre-feed). Next, it is used to adjust the pH of clearwell effluent prior to finished water entering the distribution system (post-feed). For pre-feed, there are two dosing points with each dedicated for injection upstream of each of the two traveling screens. The pre-feed caustic soda dosage goal is to achieve a pH of 5.5 to 6 for the coagulated water. The post-feed caustic soda dosage goal is to achieve a pH of 7.4 in the finished water to maintain between 7.0 to 7.2 in the distribution system. Pre-feed and post-feed caustic soda usages are analyzed separately in this section.

CDM Smith notes that 25% caustic soda is also purchased, stored and utilized at the WTP for treatment of the residual stream. The residual flow is injected with 25% caustic soda to achieve pH of 6.0 prior to discharging to sewer. This section only focuses on the usage of the 50% caustic soda utilized for major water treatment processes.

The use of 25% and 50% sodium hydroxide is common at water treatment plants, and both are used at the Nashua WTP. The 50% sodium hydroxide option has the benefit of a more concentrated solution that contains less water, requires less chemical, and costs less per gallon than 25% sodium hydroxide. However, 50% sodium hydroxide can be difficult to manage, as it will crystalize at temperatures in the mid-50s Fahrenheit. As PWW has demonstrated it is able to manage the chemical storage temperature to avoid crystallization, there appears to be no need for the Nashua WTP to incur additional chemical cost and change its practice of using 50% sodium hydroxide.

2.3.4.1 Pre-Feed Dose

Historical dose data for pre-feed caustic soda collected daily at the WTP from January 1, 2012, to May 31, 2022, are presented in **Figure 2-13**. The doses are presented as active chemical or NaOH and represent the total caustic usage between the two injection points. Generally, an increase of usage in pre-feed caustic soda is observed. However, the dosing trend starting November of 2019 is notably different than the previous years, characterized by significantly higher usage. This is likely influenced by the increasing usage of the Merrimack River as the WTP's water source over the Pennichuck Brook and their differences in the caustic soda demands. Therefore, the statistics for this dataset are summarized **Table 2-12** for each year as well as the duration between November 1, 2019, to May 31, 2022, in the last column to represent the most recent usage pattern.

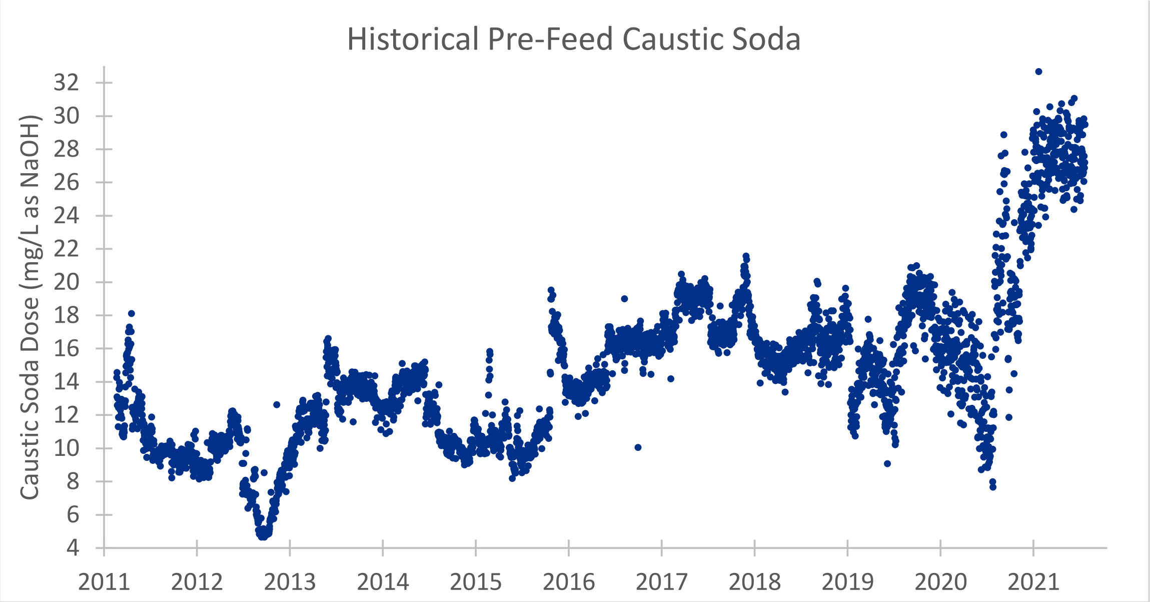


Figure 2-13. Historical Pre-Feed Caustic Soda Dose Data (1/1/2012-5/31/2022)

Table 2-12. Summary Historical Pre-Feed Caustic Soda Dose as NaOH (1/1/2012-5/31/2022)

Pre-Feed Caustic Soda Dose (mg/L as NaOH)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022[2]	2019-2022[3]
Minimum	8.2	4.7	10.0	9.0	8.2	10.1	13.9	10.7	9.1	7.7	24.4	**7.7**
5th PCTL[1]	8.6	5.0	11.3	9.5	9.1	13.6	15.8	12.6	12.0	10.3	25.4	**11.3**
Average	10.6	8.8	13.1	11.8	12.1	15.8	18.0	15.9	16.2	19.0	27.8	**19.0**
50th PCTL	9.8	9.4	13.1	11.0	11.3	16.3	18.3	16.0	16.0	18.2	27.8	**17.7**
95th PCTL	15.0	11.9	15.5	14.6	17.3	17.3	19.9	18.4	20.0	28.1	29.9	**29.0**
Maximum	18.1	12.6	16.6	15.2	19.5	19.0	21.6	20.1	21.0	32.7	31.1	**32.7**

[1] PCTL = percentile

[2] Represents statistics 5 months of data, not 12 months.

[3] Represents statistics from 11/1/2019 to 5/31/2022 to capture the most relevant and recent caustic soda usage trend.

Considering the most recent and relevant data from approximately the past three years are being utilized for caustic soda determination, they did not provide enough data points to perform a trend analysis using annual statistics. Therefore, the following considerations were incorporated in determining the design dose range presented in **Table 2-13** for evaluating the pre-feed caustic soda chemical storage and feed system:

- Minimum dose of 7.5 mg/L covers the minimum values identified in ten of the past eleven years and is used for both storage and chemical feed.

- In absence of the trend analysis, the average dose of 23 mg/L represents the average value calculated from total chemical usage recorded from November 1, 2019, to May 31, 2022, with a factor of 1.2 applied to represent 20% of a safety factor.
- In absence of the trend analysis, the maximum dose of 40 mg/L for storage represents the maximum value identified from total chemical usage recorded from November 1, 2019, to May 31, 2022, with a factor of 1.2 applied to represent 20% of a safety factor.

Table 2-13. Design Dose for Pre-Feed Caustic Soda as NaOH

Dose (mg/L as NaOH)	Minimum	Average	Maximum
Design	7.5	23	40

2.3.4.2 Post-Feed Dose

Historical dose data for post-feed caustic soda collected daily at the WTP from January 1, 2012, to May 31, 2022, are presented in **Figure 2-14**. The doses are presented as active chemical or NaOH. Generally, a general decrease of usage in post-feed caustic soda is observed. Similar to the pre-feed caustic soda data, the dosing trend starting November of 2019 is notably different than the previous years, characterized by significantly lower usage. However, the peak usage reaches a level as high as measured before November 2019. Similarly to the pre-feed dosing trend, this is also likely influenced by the shift from the Pennichuck Brook to the Merrimack River as the primary water source that may demand more hydroxide in the coagulation process and the subsequent impact of less pH adjustment needed in the finished water. Therefore, the statistics for this dataset are summarized **Table 2-14** for each year as well as the duration between November 1, 2019, to May 31, 2022, in the last column to represent the most recent usage pattern.

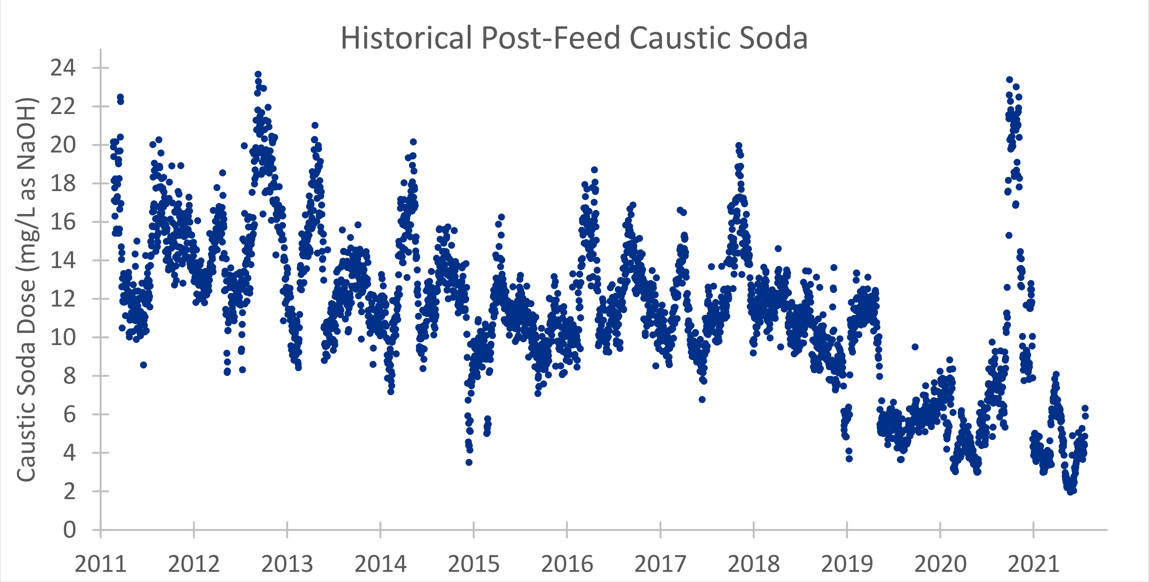


Figure 2-14. Historical Post-Feed Caustic Soda Dose Data (1/1/2012-5/31/2022)

Table 2-14. Summary Historical Post-Feed Caustic Soda Dose as NaOH (1/1/2012-5/31/2022)

Post-Feed Caustic Soda Dose (mg/L as NaOH)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022[2]	2019-2022[3]
Minimum	8.57	8.20	7.19	3.52	5.02	8.53	6.79	3.71	3.22	3.00	1.98	**1.98**
5th PCTL[1]	10.9	9.56	9.10	8.03	8.30	9.45	8.96	6.09	4.48	3.32	2.22	**3.13**
Average	14.4	14.8	12.8	12.3	10.6	12.4	12.3	10.3	6.99	7.96	4.36	**7.08**
50th PCTL	14.2	14.5	12.4	12.3	10.6	12.0	11.8	10.5	6.10	5.97	4.12	**5.89**
95th PCTL	18.9	20.9	18.0	17.1	13.0	16.3	17.0	12.9	11.9	21.1	7.0	**14.4**
Maximum	22.5	23.7	21.0	20.2	16.3	18.7	20.0	14.6	13.1	23.4	8.1	**23.4**

[1] PCTL = percentile

[2] Represents statistics 5 months of data, not 12 months.

[3] Represents statistics from 11/1/2019 to 5/31/2022 to capture the most relevant and recent caustic soda usage trend.

Considering the most recent and relevant data from approximately the past three years are being utilized for caustic soda determination, they did not provide enough data points to perform a trend analysis using annual statistics. Therefore, the following considerations were incorporated in determining the design dose range presented in **Table 2-15** for evaluating the post-feed caustic soda chemical storage and feed system:

- Minimum dose of 2.0 mg/L is very close to the most recent minimum value of 1.98 mg/L identified in 2022, which is the year that represents the lowest post-feed caustic demand.
- In absence of the trend analysis, the average dose of 8.5 mg/L represents the average value calculated from November 1, 2019, to May 31, 2022, with a factor of 1.2 applied to represent 20% of a safety factor.
- In absence of the trend analysis, the maximum dose of 28 mg/L represents the maximum value identified from November 1, 2019, to May 31, 2022, with a factor of 1.2 applied to represent 20% of a safety factor.

Table 2-15. Design Dose for Post-Feed Caustic Soda as NaOH

Dose (mg/L as NaOH)	Minimum	Average	Maximum
Design	2	8.5	28

2.3.5 Polymer

A non-ionic polymer, specifically Harcros PWT 3920, is used as a coagulant and flocculation aid at the WTP. The dry polymer is diluted up to a desired concentration between 0.25% and 1.0%, mixed, and dosed to the raw water after ferric is added. Since dry polymer is added to the water to create the mixed solution for direct dosing to raw water, no liquid storage is provided. Dry polymer comes in 55-pound bags, and each pallet can deliver up to 40 bags. Therefore, the chemical storage required for the polymer system occurs in bags on pallets.

While no dosing data as mixed solution are recorded operationally, plant staff indicate the maximum polymer dose to be approximately 0.3 mg/L. The dose range as the mixed solution is known to be between 0.2 mg/L and 1.0 mg/L, and this is reflected as the design doses in **Table 2-16.** In addition, **Table 2-17** summarizes the number of dry chemical bags that were used per month, recorded daily from January 1, 2012, to May 31, 2022. Overall, there is an increasing polymer usage in the warmer months, but one pallet of 40 bags still can sufficiently store and supply enough chemical needed for each month throughout the year. Based on these data, pounds of polymer dosed per day are estimated in **Table 2-18.**

Table 2-16. Design Dose for Polymer (mg/L as Mixed Solution)

Dose (mg/L as Mixed Solution)	Minimum	Average	Maximum
Design	0.2	0.5	1.0

Table 2-17. Polymer Bag Usage Records (1/1/2012-5/31/2022)

	Polymer Bags Used Per Month										
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	12	13	12	12	8	4	6	10	9	7	13
Feb	19	15	9	8	8	7	6	10	9	6	11
Mar	14	14	8	13	9	6	9	11	10	9	12
Apr	15	13	14	7	7	7	8	11	9	9	13
May	21	23	19	21	15	9	10	11	15	17	16
Jun	20	13	21	12	18	13	15	15	24	20	
Jul	20	18	24	15	20	14	17	18	21	15	
Aug	24	17	17	18	18	11	13	18	19	20	
Sept	19	17	17	14	4	9	10	20	16	16	
Oct	15	12	15	12	4	11	10	11	12	15	
Nov	14	8	10	9	2	9	10	8	8	12	
Dec	15	12	12	9	3	8	9	9	9	13	

Table 2-18. Summary of Polymer Usage (1/1/2012-5/31/2022)

Statistics	lb/day
Minimum	4
5th percentile	11
Average	23
50th percentile	22
95th percentile	38
Maximum	44

2.3.6 Sodium Permanganate

The sodium permanganate chemical system is available to provide dissolved manganese treatment in raw water, but it has not been used since its installation, and therefore, chemical usage data are not available. However, based on the historical raw water manganese and iron data presented in Section 2.2.4, potassium permanganate demands were estimated in **Table 2-19** with the following considerations:

- 0.84 mg/L of sodium permanganate is required for 1 mg/L soluble iron while 1.71 mg/L of sodium permanganate is required for 1 mg/L soluble manganese. Using this relationship, the 5th percentile, average, and maximum concentrations identified in **Table 2-4** were used to estimate the minimum, average, and maximum design doses, respectively, for iron and manganese. Without availability of the dissolved iron and manganese data, total iron and manganese levels were used, which represent conservative estimates as some iron and manganese in the raw water will be in the particulate form.

- Per interview conducted with the sodium permanganate manufacturer (Carus), sodium permanganate dosing between 0.25 mg/L and 0.5 mg/L should be accounted for organic demand in raw water. As a result, 0.5 mg/L was applied to all design doses.

Table 2-19. Design Dose for Sodium Permanganate (mg/L $NaMnO_2$)

Dose (mg/L as Mixed Solution)	Minimum	Average	Maximum
Design	0.6	0.9	4.7

2.3.6.1 Comparison with Potassium Permanganate

As part of the desktop evaluation, potassium permanganate was evaluated as a potential alternative for oxidation and treatment of manganese. This evaluation is summarized as follows:

- Potassium permanganate has similar oxidation capability, material compatibility, and shelf life as sodium permanganate.

- While sodium permanganate is delivered in liquid and can be fed neat, potassium permanganate is purchased in a dry power form and therefore requires additional equipment dedicated for mixing and dilution as well as higher operational complexity.

- Sodium permanganate is approximately 20-30% more expensive.

- There is an overall increasing industry trend for potassium permanganate users to switch to sodium permanganate.

Therefore, considering the infrequent need for manganese oxidation as well as higher equipment and operational complexity, continuing with sodium permanganate is recommended.

2.3.7 Zinc Orthophosphate

Zinc orthophosphate is dosed to the clearwell effluent for corrosion control treatment to mitigate lead and copper release in the distribution system. Historical dose data for zinc orthophosphate collected daily at the WTP from January 1, 2012, to May 31, 2022, are presented in **Figure 2-15**. The doses are presented as product. Overall, zinc orthophosphate is dosed consistently throughout the years between 1.5 mg/L and 3.0 mg/L. The statistics for this dataset are summarized for each year in **Table 2-20**. In addition, the dosing data are summarized from approximately the last four years from January 1, 2018, to May 31, 2022 in the last column. Considering the relative consistency in the feed operation, these statistics were computed to represent the most recent usage.

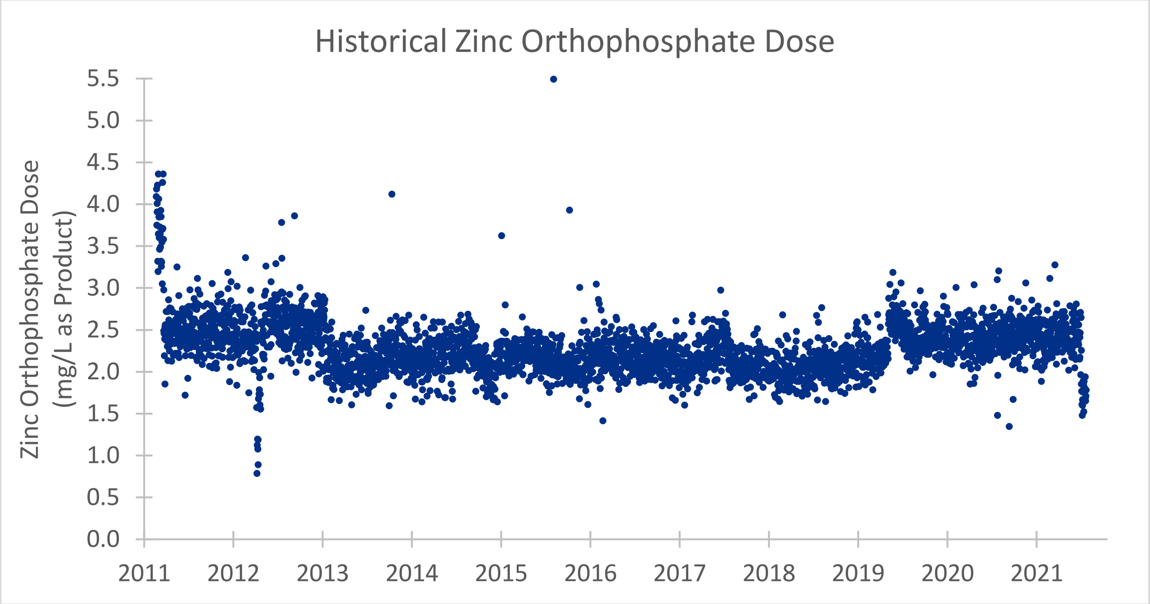


Figure 2-15. Historical Zinc Orthophosphate Dose as Product (1/1/2012-5/31/2022)

Table 2-20. Summary Historical Zinc Orthophosphate Dose as Product (1/1/2012-5/31/2022)

Zinc Ortho-phosphate Dose (mg/L as Product)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022[2]	2018-2022
Minimum	1.72	0.79	1.60	1.64	1.61	1.42	1.65	1.65	1.79	1.35	1.48	**1.35**
5th PCTL[1]	2.14	1.81	1.86	1.79	1.89	1.89	1.87	1.80	2.11	2.09	1.74	**1.87**
Average	2.59	2.45	2.15	2.18	2.17	2.15	2.13	2.08	2.40	2.41	2.35	**2.26**
50th PCTL	2.49	2.49	2.15	2.17	2.14	2.15	2.11	2.07	2.38	2.42	2.39	**2.26**
95th PCTL	3.64	2.89	2.46	2.51	2.45	2.45	2.51	2.41	2.75	2.71	2.71	**2.68**
Maximum	4.36	3.86	4.12	3.63	5.50	2.65	2.98	2.77	3.19	3.21	3.28	**3.28**

[1] PCTL = percentile

[2] Represents statistics 5 months of data, not 12 months.

The same trend analysis as used with the previously presented chemical dosing data was performed with the historical zinc orthophosphate usage data to evaluate if any dosing patterns should be accounted for in determining the future chemical dose range. This analysis did not identify any increasing trend.

With the following considerations, the design dose range in **Table 2-21** were determined for evaluating the zinc orthophosphate chemical storage and feed system:

- Minimum dose of 1.3 mg/L covers the minimum values identified in ten of the past eleven years.

- Average dose of 2.5 mg/L represents the 50th percentile and average values calculated from January 2018 to May 2022.
- Maximum dose of 3.5 mg/L is higher than the maximum value of 3.28 mg/L as well as the 95th percentile value of 2.68 mg/L calculated from January 2018 to May 2022.

Table 2-21. Design Dose for Zinc Orthophosphate as Product

Dose (mg/L as Product)	Minimum	Average	Maximum
Design	1.3	2.5	3.5

2.3.8 Tetrapotassium Pyrophosphate (TKPP)

Tetrapotassium Pryophosphate (TKPP), also known as pyrophosphoric acid or tetrapotassium salt, is dosed to the clearwell effluent prior to the finished water entering the distribution system. TKPP was selected as a more effective chemical for manganese sequestration when compared to sodium hexametaphosphate (HXDP) which was previously used. The introduction of TKPP has reduced color complaints from customers and lowered manganese levels in the finished water. Historical dose data for TKPP collected daily at the WTP from January 1, 2012, to May 31, 2022, are presented in **Figure 2-16**. The doses are presented as active chemical or TKPP. Overall, the plot shows some peaks of usage that may have taken place during warmer months, but they are inconsistent. Moreover, since 2019, the dosing practice has been consistent between 0.4 mg/L and 0.6 mg/L. The statistics for this dataset are summarized for each year in **Table 2-22**. In addition, the dosing data are summarized from approximately the last four years from January 1, 2018, to May 31, 2022 in the last column. Considering the relative consistency in the feed operation, these statistics were computed to represent the most recent usage.

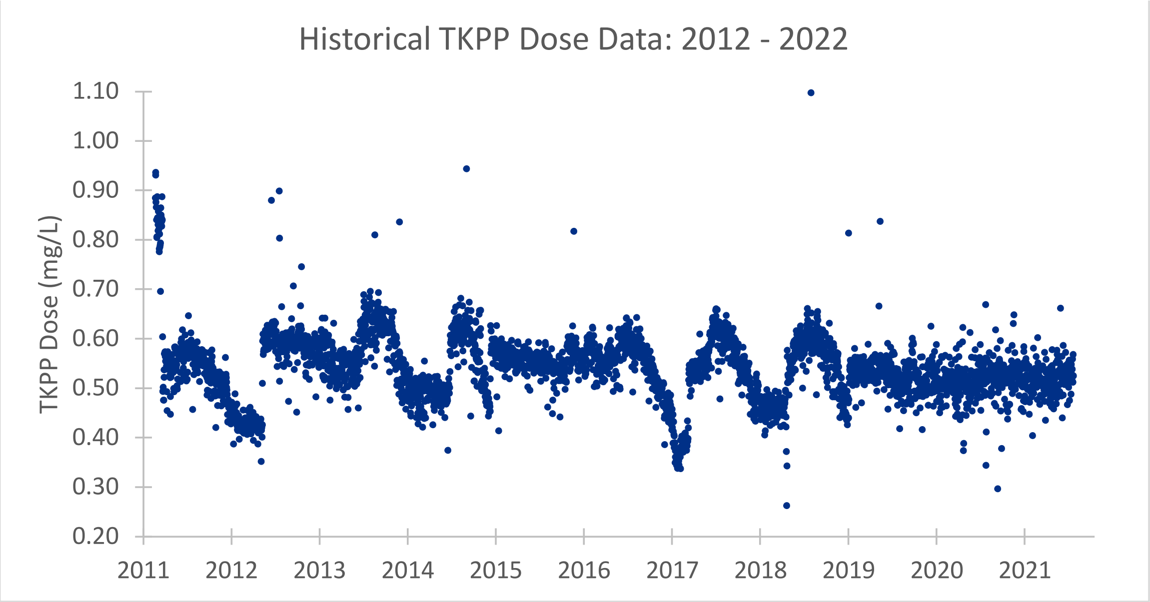


Figure 2-16. Historical TKPP Dose Data (1/1/2012-5/31/2022)

Table 2-22. Summary Historical TKPP Dose as TKPP (1/1/2012-5/31/2022)

TKPP Dose (mg/L as Product)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022[2]	2018-2022
Minimum	0.39	0.35	0.43	0.37	0.44	0.34	0.37	0.26	0.42	0.30	0.44	**0.26**
5th PCTL[1]	0.43	0.42	0.48	0.46	0.52	0.37	0.43	0.44	0.47	0.46	0.47	**0.45**
Average	0.55	0.55	0.57	0.55	0.56	0.52	0.53	0.54	0.52	0.52	0.52	**0.53**
50th PCTL	0.54	0.59	0.57	0.55	0.56	0.54	0.54	0.55	0.52	0.52	0.52	**0.53**
95th PCTL	0.83	0.63	0.66	0.64	0.60	0.61	0.63	0.62	0.57	0.57	0.57	**0.61**
Maximum	0.94	0.90	0.84	0.94	0.82	0.64	0.66	1.10	0.84	0.67	0.66	**1.10**

[1] PCTL = percentile

[2] Represents statistics 5 months of data, not 12 months.

The same trend analysis as used with the previously presented chemical dosing data was performed with the historical TKPP usage data to evaluate if any dosing patterns should be accounted for in determining the future chemical dose range. This analysis did not identify any increasing trend.

With the following considerations, the design dose range in **Table 2-23** were determined for evaluating the TKPP chemical storage and feed system:

- Minimum dose of 0.3 mg/L covers the minimum values identified in ten of the past eleven years.
- Average dose of 0.5 mg/L represents the 50th percentile and average values calculated from January 2018 to May 2022.

- Maximum dose of 0.8 mg/L is higher than the 95th percentile value of 0.61 mg/L reported from January 2018 to May 2022 and also generally higher than the annual maximum values measured during that time period.

Table 2-23. Design Dose for TKPP as TKPP

Dose (mg/L as Product)	Minimum	Average	Maximum
Design	0.3	0.5	0.8

In addition, **Table 2-24** summarizes the number of dry chemical bags (50 pounds of TKPP per bag) that were used per month, recorded daily from January 1, 2012, to May 31, 2022. Overall, there is an increasing TKPP usage in the warmer months, but one pallet of 40 bags still can sufficiently store and supply enough chemical needed for each month for most of the year. Based on these data, pounds of TKPP dosed per day are estimated in **Table 2-25**.

Table 2-24. TKPP Bag Usage Records (1/1/2012-5/31/2022)

TKPP Bags Used Per Month											
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	21	19	24	19	26	27	20	19	22	17	27
Feb	19	18	18	18	25	24	22	19	19	19	26
Mar	19	19	23	20	29	22	20	24	23	23	34
Apr	28	30	24	29	29	24	23	26	24	25	33
May	33	33	38	43	40	31	36	32	40	43	48
Jun	35	34	53	46	56	43	53	36	53	44	
Jul	43	40	47	46	64	52	53	51	53	38	
Aug	36	42	46	49	60	47	43	42	50	42	
Sept	23	39	39	47	46	34	32	37	35	36	
Oct	24	31	31	34	31	30	18	23	28	33	
Nov	22	26	22	26	30	21	18	20	21	29	
Dec	18	24	20	29	23	19	15	19	23	31	

Table 2-25. Summary of TKPP Usage (1/1/2012-5/31/2022)

Statistics	lb/day
Minimum	25
5th percentile	30
Average	53
50th percentile	48
95th percentile	88
Maximum	107

2.3.9 Carbon Dioxide

The Nashua WTP has an onsite carbon dioxide chemical system to boost raw water alkalinity, when necessary. PWW intends to retain this chemical system for times when a raw water alkalinity adjustment may be necessary to optimize downstream treatment processes. It is recommended that this system be evaluated and tested for functionality as it has not been used recently. This system and its design capacity were not thoroughly assessed as part of this work, considering chemical usage information was not available due to the system remaining offline.

2.4 Chemical Supply Chain Considerations

A number of chemical suppliers from the water industry were interviewed to verify the availability of the specific chemical products used at the WTP, obtain current pricing information and standard delivery volume, and discuss any present and future supply chain issues that should be considered in the chemical system evaluation. The information obtained from these interviews are presented in **Table 2-26** and summarized below:

- The transport concerns were raised by almost all suppliers. Sufficient storage capacity to account for the uncertainty with delivery challenges should be considered.
- The availability with chlorine may become an issue with availability and pricing for chemicals that use chlorine as a source material, such as sodium hypochlorite and ferric chloride.
- There have been recent concerns in the United States regarding the potential for rail strikes, which could cause significant supply chain delays.

Table 2-26. Summary of Chemical Supplier Interviews

Chemical	a) Pricing (October 2022) b) Standard Delivery Volumes c) Current Lead Time	General Availability and Supply Chain Considerations	Chemical Supplier Interviewed
Ferric Chloride	a) $1,100-$1,300 per dry ton when delivered in truck load b) 4,000 gallons or up to 45,000 pounds per truck c) 7 days	• The lead time has increased over time mostly due to transportation issues. PVS railcars ferric into their distributor, Borden and Remington, in Fall River, MA who makes the truck deliveries. Previously the rail transport / staffing availability was an issue, which has improved, but still not fully resolved. The trucking issue on the distributor side persists, hence the increased lead time. The lead time is not projected to get longer at the moment. • A potential supply chain issue on the horizon is the availability of chlorine. Manufactures of chlorine producing the raw material needed for ferric production has either limited production. Two major chlorine producers are Olin and Westlake, and Olin who is the largest producer with 40% of US chlorine market decided to stop one of their plants. PVS is also confirmed with chlorine manufacturers strategically increasing chlorine sales to more high value industries. • Another supply chain issue is the impact from the steel industry. PVS' primary method of producing ferric is by using ferrous chloride that comes from the pickle liquor product by the steel industry and chlorine gas. The steel industry has been slowed down by 10% due to the decreased sales, but this is projected to improve in 2023. PVS has been using a supplemental production method by PVS is using ferric oxide and hydrochloric acid. • It is recommended to have plenty storage capacity split between multiple tanks and include backup supply.	PVS Chemicals

Chemical	a) Pricing (October 2022) b) Standard Delivery Volumes c) Current Lead Time	General Availability and Supply Chain Considerations	Chemical Supplier Interviewed
Ferric Chloride	N/A	• While Holland Company is a supplier of aluminum-based coagulants, not ferric, they were interviewed for industry insights. They confirmed the ferric industry's shortage due to the decreased flow of source materials from the steel process. • Holland Company also expressed the concerns for chlorine supply issue. There is significant pricing pressure for the municipal market from the two large chlorine producers as they get more profits from using chlorine in a market such as PVC and vinyls. However, if there's an economic recession, they may want to prioritize the municipal market. Westlake has reported manufacturing issues. • Holland has worked with a larger WTP in NY who used to alternate between ferric and PACl due to the ferric coating issues on the downstream UV lamps. The WTP only uses UV in the summer, so during summer, they typically use PACl, but their latest upgrades included dedicated PACl storage and feed pumps to have the capacity to feed PACl all year long, due to the ferric shortage.	Holland Company
12.5% Sodium Hypochlorite	a) $3.01/gallons (most recent bid price for PWW) b) 5,000 gallons per truck, but PWW's delivery has been 1,000 gallons c) 5-7 days	• Univar's lead time has been fairly stable as they make their own sodium hypochlorite in Providence. While the logistical challenges have existed to make deliveries from Providence, they own their own trucks, so they are in a better spot than other suppliers. • No specific current and future supply chain considerations were reported but the industry is changing daily, so it is subject to change. • It was recommended that the chemical system design considers the degradation issue and maximize the usage to use the chemical within 1-1.5 months. In addition, utilities should maximize the pricing by order the maximum truck volume to make as few deliveries as possible, since much of the cost and lead time issues lie in the delivery/trucking.	Univar
Zinc Ortho-phosphate	a) $0.90/pound (most recent bid price for PWW) b) 4,000 gallons per truck c) 3-4 weeks	• The lead time used to be 1-2 weeks but increased now because freight is a significant issue for bulk delivery. The lead time is not projected to change soon due to the continued shortage of drivers. They have a warehouse with a lot of storage, but the lead time is driven by trucking. They have their own trucking company for bulk loads but have a distributor for totes/drum delivery, so they struggle most with orders with a small number of pallets. Hacros is a local distributor for them. • The bid contracts help them plan the demands ahead, but if there is a very short lead time requirement, they would not bid on that job.	Carus

Chemical	a) Pricing (October 2022) b) Standard Delivery Volumes c) Current Lead Time	General Availability and Supply Chain Considerations	Chemical Supplier Interviewed
Sodium Permanganate	a) $10-$12/gallon b) 55-gallon drum, 275-gallon intermediate bulk container, or 3,000-3,800 gallon bulk shipping c) 3-4 weeks	• Same supply chain considerations apply as zinc orthophosphate. • There is a general industry shift to switch from dry chemical (potassium permanganate) to liquid chemical (sodium permanganate). They are working on increasing the capacity of sodium permanganate for this reason - they have a new facility to start in December this year or January 2023.	Carus

CDM Smith recommends PWW consider adding a chemical supply delivery guarantee to its next request for bids for all chemicals.

2.5 Capacity Evaluation of the Existing Chemical Systems

2.5.1 Approach

The current capacities of the chemical storage and feed systems were evaluated using the design raw water flow range presented in Section 2.1 and chemical dosage ranges determined in Section 2.3. All the existing storage and feed capacity information available to CDM Smith is summarized in **Table 2-27**. For each chemical system, the required chemical usage and feed rates computed using the design flows and chemical doses were compared against the existing storage and metering capacities. The capacities were evaluated for:

- At minimum 30 days of bulk chemical storage at average demand (i.e., average dose at average flow) per New Hampshire Department of Environmental Services (NHDES) requirement, which adopts by reference the “Ten States Standards”, formally titled “Recommended Standard for Water Works” published by the Great Lakes – Mississippi River Board of State and Provincial Health and Environmental Managers, 2018 edition.
- At minimum 7 days of bulk storage under any demand to avoid truck delivery frequency greater than once a week (i.e., maximum dose at maximum flow),
- At minimum 30 hours of day tank storage at average demand (i.e., average dose at average flow) per NHDES requirement, and
- The maximum feed rate calculated with a safety factor of 1.2 (i.e., the pump can operate at the 120% of the required feed rate) is lower than the existing metering pump capacity without accounting for the standby pump capacity.

Table 2-27. Summary of the Existing Chemical System Equipment

Chemical System	Ferric Chloride (40%)	Sodium Hypochlorite (12.5%)	Sodium Hydroxide (50%)	Sodium Hydroxide (50%)	Sodium Hydroxide (25%)	Sodium Permanganate (20%)	TKPP	Zinc Orthophosphate	Polymer
Chemical Delivery Volume (gal)									
Pre/Post	Pre	Pre	Pre	Post	Residual	Pre	Post	Post	Pre
Bulk Tanks	FCBT-1, 2, 3	SHBT-1, 2, 3, 4, 5	CSBT-1, 2, 3	CSBT-1, 2	CSBT	SPBT-1	HXBT	ZOBT-1, 2	
Vendor/Make/Model	Poly Processing Company	Poly Processing Company	Poly Processing Company	Poly Processing Company	Poly Processing Company	Poly Processing Company	Poly Processing Company	Poly Processing Company	Not applicable - no mixed solution bulk storage
Existing Bulk Tank Capacity (Gal), Manufacturer listed	6,600	2000	4,550	6,010		4550	1100	3,000	
Existing Bulk Tank Capacity (Gal), shop drawing straight wall volume	6,639	2,035	4,580	6,115	2,035	4,580	1,122	3,031	
Existing Bulk Tank Capacity (Gal), to overflow (*visual observation)*	-	1,800		5,800	1,800		900	2,800	
Existing # of Bulk Tanks	3	5	3	2	1	1	1	2	
Day Tanks	FSDT-1,2	SHDT-1, 2, 3	CSDT-1, 2	CSDT-1	Not Available	SPDT-1	HXDT	ZODT-1	
Existing Day Tank Capacity (Gal), Manufacturer listed	475	233	475	400	This is the daytank for the waste flows to the WWTP - no volume specified	230	400	100	Not applicable - no mixed solution day storage
Existing Day Tank Capacity (Gal), shop drawing straight wall volume	478	230	478	399		233	399	103	
Existing Day Tank Capacity (Gal), to overflow (*visual observation)*	400	-	400	-		-	-	-	
	2	3	2	1		1	1	1	
Metering Pumps	FCMP-1,2,3	SHMP-1, 2, 3, 4	CSMP-1, 2,3	CSMP-1, 2	Not Available	SPMP-1,2	HXMP-1, 2	ZOMP-1,2	NPMP-1, 2
Vendor/Make/Model	Pulsafeeder Pulsar 55H	Watson Marlow/Bredel SPX10	Pulsafeeder Pulsar Series Model #25HJ	Pulsafeeder Pulsar Series Model #25HJ	LMI	Pulsafeeder Pulsar Series Model #25H	Pulsafeeder Pulsar Series Model #25HJ	Pulsafeeder Pulsar Series Model #25HJ	Pulsafeeder Pulsar Series Model #25HJ
Existing Pump Capacity (gph)	46.9 @ 150 psi	1.8-18 @ 85 psi	27.76	45.10 @ 150 psi	Not Available	15.9 @ 250 psi	23.40 @ 150 psi	3.57 @ 150 psi	100 (117.7 max.) @ 56 psi
Existing # of Pumps	3	4	3	2		2	2	2	2
Transfer Pumps	FCTP-1,2	SHTP-1, 2	CSTP-1, 2	CSTP	Not Available	SPTP	HXTP	ZOTP	
Vendor/Make/Model	Not Available	Not Available	March TE-7K-MD	March MFG. TE-5.5C-MX-115V	Not Available	Not Available	March MFG. TE-5.5C-MX-115V	March MFG. TE-5.5C-MX-115V	Not applicable - no transfer pumping required
Existing Pump Capacity (gpm)			Likely between 47.5 gpm and 53 gpm per manufacturer information	30 @ 41 ft		Not Available	30 @ 41 ft	30 @ 41 ft	
Existing # of Pumps			1	1		Not Available	1	1	

2.5.2 Ferric Chloride

Table 2-28 presents the current storage and feed capacities of the ferric chemical system. The existing system cannot meet the required 30 days of bulk storage at average demand. The day tanks also cannot meet the required 30 hours of storage, and the metering pump capacity cannot meet the maximum demand. Considering this storage and feed capacity deficiencies and the supply chain concerns raised by the chemical suppliers in Section 2.4 and confirmed by PWW's experience, a new chemical storage and feed system for ferric is recommended to be installed as soon as possible.

Table 2-28. Ferric Chloride Storage and Feed Capacity Evaluation

Process Unit	Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8	15	32
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Ferric Chloride				
Bulk Storage Tanks	Dose Range, mg/L as $FeCl_3$	22	53	60
	Dose Range, mg/L as Product	39	94	106
	Usage, lb/day as Product	2,603	11,756	28,391
	Bulk Density, lb/gal		11.8	
	Concentration as FeCl3		40%	
	Usage, gph (as Product)	9.2	41.6	100.5
	Usage, gpd (as Product)	221	999	2,413
	Truck Delivery Volume, gal		4,000	
	Storage Capacity per Tank, gal		6,600	
	Days of Storage per Tank, days	30	7	3
	Number of Tanks		3	
	Total Storage, gal		19,800	
	Days of Storage, days	90	20	8
Day Tanks	Number of Day Tanks		2	
	Day Tank Capacity, gal		400	
	Total Day Tank Storage, gal		800	
	Usage, gph, per Pretreatment Train (gph)	4.6	20.8	50.3
	Hours of Day Tank Storage, hours	87	19	8
Metering Pumps	Feed Rate Required, gph	4.6	20.8	50.3
	Required Feed Pump Capacity (Individual), gph		60.3	
	Number of Duty Feed Pumps, Total		2	
	Number of Standby Feed Pumps		1	
	Existing Pump Feed Capacity (Individual), gph		46.9 @ 150 psi	
	Existing Pumps Suitable for Future?		No	

2.5.3 Sodium Hypochlorite

Table 2-29 presents the current storage and feed capacities of the sodium hypochlorite chemical system. While the chemical system uses a 12.5% product, to reflect degradation of sodium hypochlorite over time, a 10% strength was used for the calculation. The existing system can provide exactly the required 30 days and 7 days of bulk storage at average and maximum demands, respectively. However, each bulk tank cannot receive a full truck load of 5,000 gallons, which introduces unnecessary operational complexity and pricing disadvantage. The day tanks can provide 55 hours of storage between all three tanks, exceeding the required 30 hours of storage when the metering pumps are pumping from at least two tanks. The metering pump capacity cannot meet the maximum demand. Considering the supply chain concerns raised by chemical suppliers in Section 2.4, a new chemical storage and feed system for sodium hypochlorite is recommended to be installed to provide greater chemical storage and operational flexibility as soon as possible.

Table 2-29. Sodium Hypochlorite Storage and Feed Capacity Evaluation

Process Unit	Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8.0	15.0	32.0
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Sodium Hypochlorite				
Bulk Storage Tanks	Dose Range, mg/L as Cl_2	1.0	2.5	5.0
	Usage, lb/day as Cl_2	67	313	1,334
	Bulk Density, lb/gal		10	
	Concentration		12.5%	
	Concentration Assumed with Degradation		10%	
	Chlorine equivalent, lb Cl_2 per gallon		0.8	
	Usage, gph (as Product)	2.7	12.5	53.3
	Usage, gpd (as Product)	64	300	1,280
	Truck Delivery Volume, gal		5,000	
	Storage Capacity per Tank, gal		1,800	
	Days of Storage per Tank, days	28	6	1
	Number of Tanks		5	
	Total Storage, gal		9,000	
	Days of Storage, days	141	30	7
Day Tanks	Number of Day Tanks		3	
	Day Tank Capacity, gal		230	
	Total Day Tank Storage, gal		690	
	Hours of Day Tank Storage, hours	259	55	13
Metering Pumps	Feed Rate Required, gph	2.7	12.5	53.3
	Required Feed Pump Capacity (Individual), gph		64.0	
	Number of Duty Feed Pumps, Total		3	
	Number of Standby Feed Pumps		1	
	Existing Pump Feed Capacity (Individual), gph		1.8-18 @ 85 psi	
	Existing Pumps Suitable for Future?		No	

2.5.3.1 Onsite Sodium Hypochlorite Generation System

Due to the concerns with the availability of sodium hypochlorite as well as the degradation potential of the currently used 12.5% product, onsite generation (OSG) was investigated as a potentially more reliable alternative for the plant's disinfectant supply. A low-strength OSG (defined as generating <1% solution) system requires 3 pounds of salt, 15 gallons of water, and 2 kilowatts (kW) of electricity to produce 15 gallons of 0.8% solution or 1 pounds of chlorine as Cl_2. The low-strength OSG systems can be operated in either a batch mode or an on-demand process and typically requires the following list of equipment components:

- Sodium hypochlorite generators
- Bulk chemical storage tanks/dissolvers and feed pumps for salt / brine
- Bulk chemical storage, day tanks, transfer pumps, and metering pumps for 0.8% sodium hypochlorite
- Softeners to remove hardness from the plant water to prevent deposits on generator electrolytic cell
- Hydrogen mitigation system to provide vent for removing the byproduct hydrogen gas outside of a building
- Cell cleaning system to remove deposits off the electrolytic cell
- Central control panel

Sizing of an OSG system for sodium hypochlorite is different than the conventional chemical system with bulk storage as the chemical can be used as it is generated, requiring a small amount of chemical to be stored onsite. Manual 65 (M65) for On-Site Generation of Hypochlorite published by American Water Works Association (AWWA) in 2015 states providing chemical storage for a minimum of three days at average flow and average dose condition is a commonly accepted practice. However, the storage of salt plays a more crucial role in sustaining the OSG operation and is recommended to provide 15 to 30 days at average chlorine demand per M65. Salt must be dissolved in a brine saturation tank to form a saturated sodium chloride solution to be used a supply to the generators.

Table 2-30 presents the preliminary design of an OSG system for sodium hypochlorite, which includes the generators, bulk and day tanks for 0.8% solution, and brine dissolver tanks. Two sodium hypochlorite generators are produced for redundancy, and two bulk storage tanks are provided for 0.8% sodium hypochlorite to provide four days of storage at average demand and one day of storage at maximum demand. Three day tanks, three primary metering pumps and one spare metering pump are provided to match the current operation. The design also includes two brine tanks with a 36-ton capacity that can provide storage for 153 days at average demand and 36 days at maximum demand.

Table 2-30. Onsite Sodium Hypochlorite Generation System – Future

Process Unit	Design Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8.0	15.0	32.0
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Sodium Hypochlorite				
Generators	Number of Onsite Sodium Hypochlorite Generators		2	
	Generator Capacity, lb of Cl_2 /day		1,200	
	Total Generator Capacity, lb of Cl_2/day		2,400	
Bulk Storage Tanks	Dose Range, mg/L as Cl_2	1.0	2.5	5.0
	Usage, lb/day as Cl_2	67	313	1,334
	Concentration		0.8%	
	Available Chlorine, lb/gal of 0.8% NaOCl Solution		0.07	
	Usage, gph (as Product)	41.7	195.5	834.0
	Usage, gpd (as Product)	1,001	4,691	20,016
	Storage Capacity per Tank, gal		10,000	
	Days of Storage per Tank, days	10	2	0.5
	Number of Tanks		2	
	Total Storage, gal		20,000	
	Days of Storage, days	20	4.3	1.0
Day Tanks	Number of Day Tanks		3	
	Day Tank Capacity, gal		800	
	Hours of Storage per Tank, hours	19	4	1
	Total Day Tank Storage, gal		2,400	
	Hours of Total Day Tank Storage, hours	58	12	3
Metering Pumps	Feed rate required, gph	41.7	195.5	834.0
	Number of Duty Feed Pumps, total		3	
	Required Feed Pump Capacity (Individual), gph		1,001	
	Number of Standby Feed Pumps		1	
	Total Feed Capacity, gph, one unit out of service		3,002	
Salt Brine Tanks	Weight of Salt Required to Produce 1 Gal of 0.8% NaOCl Solution	0.2	0.2	0.2
	Usage, lb/day	200	938	4,003
	Number of Bulk Tanks		2	
	Truck Delivery Volume, Ton		25	
	Bulk Tank Capacity, Ton		36	

Process Unit	Design Criteria	Minimum	Average	Maximum
	Bulk Tank Capacity, lb		72,000	
	Days of Storage per Tank, days	360	77	18
	Total Tank Storage, lb		144,000	
	Days of Total Storage, days	719	153	36

In addition, the existing sodium hypochlorite bulk tank and day tank storage capacities were evaluated for suitability for integration with the OSG system, as presented in **Table 2-31**. If the existing tanks are to be replaced with new tanks of the same capacity, bulk tank storage will provide approximately 2 days at average demand and 0.4 day at maximum demand, which may be acceptable. The day tanks likely will not provide enough storage capacity at 4 hours at average demand and 1 hour at maximum demand. At 0.8% solution generated, the existing metering pumps being used for 12.5% solution will not have enough capacity to be used for the OSG system.

Table 2-31. Sodium Hypochlorite Storage and Feed Capacity Evaluation for OSG System

Process Unit	Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8.0	15.0	32.0
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Sodium Hypochlorite				
Bulk Storage Tanks	Dose Range, mg/L as Cl_2	1.0	2.5	5.0
	Usage, lb/day as Cl_2	67	313	1,334
	Concentration		0.8%	
	Available Chlorine, lb/gal of 0.8% NaOCl Solution		0.07	
	Chlorine equivalent, lb Cl_2 per gallon		0.1	
	Usage, gph (as Product)	41.7	195.5	834.0
	Usage, gpd (as Product)	1,001	4,691	20,016
	Storage Capacity per Tank, gal		1,800	
	Days of Storage per Tank, days	1.8	0.4	0.1
	Number of Tanks		5	
	Total Storage, gal		9,000	
	Days of Storage, days	9	1.9	0.4
Day Tanks	Number of Day Tanks		3	
	Day Tank Capacity, gal		230	
	Hours of Storage per Tank, hours	6	1	0
	Total Day Tank Storage, gal		690	
	Hours of Total Day Tank Storage, hours	17	4	1

2.5.4 Sodium Hydroxide

Table 2-32 presents the current storage and feed capacities of the pre-feed caustic soda chemical system. The existing system can provide 46 days of bulk storage at average demand and 12 days at maximum demand, exceeding the requirements. The day tanks can provide 65 hours of storage between the two tanks, exceeding the required 30 hours of storage when the metering pumps are pumping from both tanks. The metering pump capacity can meet the maximum demand. However, the existing feed pump capacity is just barely in exceedance of the required capacity and could restrict future performance. Therefore, in-kind replacement for storage tanks and upgrades to metering pumps with increased capacities are recommended for the caustic soda chemical system in the future before they approach the end of their useful service life. Further, PWW and CDM Smith discussed an existing hydraulic imbalance between application points. During design of plant improvements piping modifications can be incorporated to address such concerns.

Table 2-32. Pre-Feed Caustic Soda Storage and Feed Capacity Evaluation

Process Unit	Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8	15	32
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Pre-Feed Caustic Soda				
Bulk Storage Tanks	Dose Range, mg/L as NaOH	7.5	23	40
	Dose Range, mg/L as Product	10	30	52
	Usage, lb/day as Products	654	3,761	13,955
	Bulk Density, lb/gal	12.8		
	Concentration as NaOH	50%		
	Usage, gph (as Product)	2.1	12.3	45.5
	Usage, gpd (as Product)	51	295	1,093
	Storage Capacity per Tank, gal	4,550		
	Days of Storage per Tank, days	89	15	4
	Number of Tanks	3		
	Total Storage, gal	13,650		
	Days of Storage, days	266	46	12
Day Tanks	Number of Day Tanks	2		
	Day Tank Capacity, gal	400		
	Total Day Tank Storage, gal	800		
	Hours of Day Tank Storage, hours	375	65	18
Metering Pumps	Dose Range, mg/L as NaOH	7.5	23	40
	Dose Range, mg/L as Product	10	30	52
	Usage, lb/day as Products	654	3,761	13,955
	Feed Rate Required per Pretreatment Train, gph	1.1	6.1	22.8
	Required Feed Pump Capacity (Individual), gph	27.3		
	Number of Duty Feed Pumps, total	2		
	Number of Standby Feed Pumps	1		
	Existing Pump Feed Capacity (Individual), gph	27.7		
	Existing Pumps Suitable for Future?	No		

Table 2-33 presents the current storage and feed capacities of the post-feed caustic soda chemical system. The existing system can provide 107 days of bulk storage at average demand and 15 days at maximum demand, exceeding the requirements. The day tanks can provide 88 hours of storage, also exceeding the requirement. The metering pump capacity can meet the maximum demand. Therefore, in-kind replacement for storage tanks and metering pumps are recommended for the post-feed caustic soda chemical system in the future before they approach the end of their useful service life.

Table 2-33. Post-Feed Caustic Soda Storage and Feed Capacity Evaluation

Process Unit	Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8	15	32
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Post-Feed Caustic Soda				
Bulk Storage Tanks	Dose Range, mg/L as NaOH	2	8.5	28
	Dose Range, mg/L as Product	3	11	37
	Usage, lb/day as Product	174	1,390	9,803
	Bulk Density, lb/gal	12.8		
	Concentration as NaOH	50%		
	Usage, gph (as Product)	0.6	4.5	32.0
	Usage, gpd (as Product)	14	109	768
	Storage Capacity per Tank, gal	5,800		
	Days of Storage per Tank, days	425	53	8
	Number of Tanks	2		
	Total Storage, gal	11,600		
	Days of Storage, days	849	107	15
Day Tanks	Number of Day Tanks	1		
	Day Tank Capacity, gal	400		
	Total Day Tank Storage, gal	400		
	Hours of Day Tank Storage, hours	703	88	13
Metering Pumps	Feed Rate Required, gph	0.6	4.5	32.0
	Required Feed Pump Capacity, gph	38.4		
	Number of Duty Feed Pumps, total	1		
	Number of Standby Feed Pumps	1		
	Existing Pump Feed Capacity, gph	45.10 @ 150 psi		
	Existing Pumps Suitable for Future?	Yes, pending confirmation of turndown capabilities additional pumps may be required		

2.5.5 Polymer

Table 2-34 presents the current storage and feed capacities of the polymer chemical system. Since dry polymer is added to the water to create the mixed solution for direct dosing to raw water, no liquid storage is provided. Each pallet of 40 bags can provide 96 days of storage at average demand, and the metering pump capacity can meet the maximum demand. Therefore, in-kind replacement for metering pumps is recommended for the polymer chemical system in the future before they approach the end of their useful service life.

Table 2-34. Polymer Storage and Feed Capacity Evaluation

Process Unit	Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8	15	32
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Polymer				
Bag/Pallet Storage	Dose Range, mg/L as Mixed Solution	0.2	0.5	1.0
	Usage, lb/day as Mixed Solution	13	63	267
	Actual 10-year usage data, lb/day as Polymer	4	23	44
	Nominal Polymer Bag Size, lb	55		
	Number of Bags per Pallet	40		
	Storage Quantity per Pallet, lb	2,200		
	Days of Storage per Pallet, days	550	96	50
	Bulk Density, lb/gal	8.34		
	Usage, gph (as Mixed Solution)	0.1	0.3	1.3
	Usage, gpd (as Mixed Solution)	2	7	32
Metering Pumps	Feed Rate Required, gph	0.1	0.3	1.3
	Required Feed Pump Capacity (Individual), gph	1.6		
	Number of Duty Feed Pumps, total	1		
	Feed Pump Capacity, gph	1		
	Existing Pump Feed Capacity (Individual), gph	100 (117.7 max.) @ 56 psi		
	Existing Pumps Suitable for Future?	Yes		

2.5.6 Sodium Permanganate

Table 2-35 presents the current storage and feed capacities of the sodium permanganate chemical system. Since this chemical system has never been used, and thus no historical usage data are available, chemical demands estimated in Section 2.3.6 are used for capacity evaluation. The existing system can provide 80 days of bulk storage at average demand, and the day tanks can provide 65 hours of storage at average demand, both exceeding the requirements. However, the maximum demand is critical to consider with this system that has never been online, and sodium permanganate feed will be needed likely only at high manganese levels. At maximum, the bulk storage is estimated to provide 7 days, representing weekly chemical deliveries if the manganese events are sustained for over a week, and the day tank storage can provide 8 hours of storage. In addition, the metering pump capacity does not meet the estimated maximum demand. However, the maximum dose is estimated conservatively using total iron and manganese levels, not the dissolved form. Therefore, it is recommended that monitoring of manganese and iron is performed to determine the dissolved inorganic levels to refine the design dose range and confirm the results of the capacity evaluation.

Table 2-35. Sodium Permanganate Storage and Feed Capacity Evaluation

Process Unit	Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8	15	32
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Sodium Permanganate				
Bulk Storage Tanks	Dose Range, mg/L as $NaMnO_4$	0.6	0.9	4.7
	Dose Range, mg/L as Product	3.1	4.3	23.7
	Usage, lb/day as Product	205	543	6,312
	Bulk Density, lb/gal		9.6	
	Concentration as $NaMnO_4$		20%	
	Usage, gph (as Product)	0.9	2.4	27.4
	Usage, gpd (as Product)	21	57	658
	Storage Capacity per Tank, gal		4,550	
	Days of Storage per Tank, days	213	80	7
	Number of Tanks		1	
	Total Storage, gal		4,550	
	Days of Storage, days	213	80	7
Day Tanks	Number of Day Tanks		1	
	Day Tank Capacity, gal		230	
	Total Day Tank Storage, gal		230	
	Hours of Day Tank Storage, hours	259	98	8
Metering Pumps	Feed Rate Required, gph	0.9	2.4	27.4
	Number of Feed Pumps, total		2	
	Number of Standby Feed Pumps		1	
	Existing Feed Pump Capacity (Individual), gph		15.9 @ 250 psi	
	Existing Pumps Suitable for Future?		No	

2.5.7 Zinc Orthophosphate

Table 2-36 presents the current storage and feed capacities of the zinc orthophosphate chemical system. The existing system can provide more than sufficient storage capacity of 229 days of bulk storage at average demand and 77 days at maximum demand. The day tanks can provide 98 hours of storage, exceeding the requirement. The metering pump capacity does not meet the maximum demand when a safety factor of 1.2 is applied, Therefore, in-kind replacement for storage tanks and metering pumps with increased capacities are recommended for the zinc orthophosphate chemical system in the future before they approach the end of their useful service life.

Table 2-36 Zinc Orthophosphate Storage and Feed Capacity Evaluation

Process Unit	Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8	15	32
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Zinc Orthophosphate				
Bulk Chemical Tanks	Dose Range, mg/L as Product	1.3	2.5	3.5
	Dose Range, mg/L as Orthophosphate	0.5	0.9	1.3
	Usage, lb/day as Product	87	313	934
	Bulk Density, lb/gal	12.8		
	Concentration as Orthophosphate	36%		
	Usage, gph (as Product)	0.3	1.0	3.0
	Usage, gpd (as Product)	7	24	73
	Storage Capacity per Tank, gal	2,800		
	Days of Storage per Tank, days	412	114	38
	Number of Tanks	2		
	Total Storage, gal	5,600		
	Days of Storage, days	824	229	77
Day Tanks	Number of Day Tanks	1		
	Day Tank Capacity, gal	100		
	Total Day Tank Storage, gal	100		
	Hours of Day Tank Storage, hours	306	98	33
Metering Pumps	Feed Rate Required, gph	0.3	1.0	3.0
	Required Feed Pump Capacity (Individual), gph	3.7		
	Number of Duty Feed Pumps, total	1		
	Number of Standby Feed Pumps	1		
	Existing Feed Pump (Individual), gph	3.57 @ 150 psi		
	Existing Pumps Suitable for Future?	No		

2.5.8 TKPP

Table 2-37 presents the current storage and feed capacities of the TKPP chemical system. Since the TKPP mixed solution tank represents a liquid chemical processing vessel, not a bulk storage tank, dry chemical storage is assessed for providing the required chemical storage capacity. Each pallet can provide 32 days of dry chemical storage at average demand and 9 days at maximum demand, and more pallets can be stored at the WTP if needed. The day tanks can provide 40 hours of storage, which exceeds the requirement. The metering pump capacity cannot meet the maximum demand. Therefore, in-kind replacement for mixed storage tank and upgrades to metering pumps with increased capacities are recommended for the TKPP chemical system in the future before they approach the end of their useful service life.

Table 2-37. TKPP Storage and Feed Capacity Evaluation

Process Unit	Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8	15	32
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft3/sec	12.4	23.2	49.5
TKPP				
Mixed Solution Tank & Bag/Pallet Storage	Dose Range, mg/L as TKPP	0.3	0.5	0.8
	Dose Range, mg/L as Mixed Solution	10	17	27
	Usage, lb/day as Mixed Solution	668	2,087	7,122
	Usage, lb/day as TKPP	20	63	214
	TKPP Bag Size, lb	50		
	Number of Bags per Pallet	40		
	Storage Quanity per Pallet, lb	2,000		
	Days of Storage per Pallet, days	100	32	9
	Weight of TKPP Added to 200 Gallons of Water, lb	50		
	Bulk Density, lb/gal [1]	8.6		
	Usage, gph (as Mixed Solution)	3.2	10.1	34.5
	Usage, gpd (as Mixed Solution)	78	243	829
	Storage Capacity per Tank, gal	1,100		
	Days of Storage per Tank, days	14	5	1
	Number of Tanks	1		
	Total Storage, gal	1,100		
	Days of Storage, days	14	5	1
Day Tanks	Number of Day Tanks	1		
	Day Tank Capacity, gal	400		
	Total Day Tank Storage, gal	400		
	Hours of Day Tank Storage, hours	123	40	12
Chemical Feed Pumps	Feed Rate Required, gph	3.2	10.1	34.5
	Required Feed Pump Capacity (Individual), gph	41.5		
	Number of Duty Feed Pumps, total	1		
	Number of Standby Feed Pumps	1		
	Existing Total Feed Capacity (Individual), gph	23.40 @ 150 psi		
	Existing Pumps Suitable for Future?	No		

[1] Density of the mixed solution was calculated by adding 50 pounds per 200 gallons water into the density of water to reflect the current operating practice.

2.6 Basis of Design for New Chemical Systems

As recommended in Section 2.5, basis of design for the new chemical storage and feed systems for ferric and sodium hypochlorite are presented in this section.

2.6.1 Ferric Chloride

Preliminary design criteria for the ferric chloride system are presented on **Table 2-38**. The design includes five bulk storage tanks with a storage capacity of 10,000 gallons per tank, which exceeds the maximum chemical delivery truck volume. Two day tanks with a storage capacity of 850 gallons per tank are provided, which requires the filling of the day tanks once a day at average demand. Total three metering pumps are provided with two feed pumps, one dedicated to each of the two pretreatment trains, and one standby pump, which represents the same metering pump configuration as the current operation. The metering pump design included a safety factor that will allow pumping 120% of the maximum feed rate. While water quality data examined as part of this evaluation do not indicate lower ferric chloride doses are anticipated in the future, the projected future maximum dose may be conservative. During final design, the feed pump design criteria may consider a larger quantity of pumps, low range and high range feed pumps, or other alternatives to incorporate flexibility for long-term operation.

Table 2-38 Proposed Preliminary Design Criteria for Ferric Chloride

Process Unit	Design Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8	15	32
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Ferric Chloride				
Bulk Storage Tanks	Dose Range, mg/L as $FeCl_3$	22	53	60
	Dose Range, mg/L as Product	39	94	106
	Usage, lb/day as Product	2,603	11,756	28,391
	Bulk Density, lb/gal	11.8		
	Concentration as $FeCl_3$	40%		
	Usage, gph (as Product)	9.2	41.6	100.5
	Usage, gpd (as Product)	221	999	2,413
	Truck Delivery Volume, gal	4,000		
	Storage Capacity per Tank, gal	10,000		
	Days of Storage per Tank, days	45	10	4
	Number of Tanks	5		
	Total Storage, gal	50,000		
	Days of Storage, days	226	50	21
Day Tanks	Number of Day Tanks	2		
	Day Tank Capacity, gal	850		
	Total Day Tank Storage, gal	1,700		
	Usage, gph, per Filter Train (gph)	4.6	20.8	50.3
	Hours of Storage per Tank, hours	184	41	17
Metering Pumps	Feed Rate Required, gph	4.6	20.8	50.3
	Number of Feed Pumps, total	3, pending confirmation of turndown capabilities additional pumps may be required.		

Process Unit	Design Criteria	Minimum	Average	Maximum
	Feed Pump Capacity (Individual), gph	60		
	Number of Standby Feed Pumps	1		
	Total Feed Capacity, gph, one unit out of service	121		

2.6.2 Sodium Hypochlorite

Preliminary design criteria for the sodium hypochlorite system are presented on **Table 2-39**. The design includes three bulk storage tanks with a storage capacity of 6,000 gallons per tank, which exceeds the maximum chemical delivery truck volume. Three day tanks with a storage capacity of 475 gallons per tank are provided, which requires the filling of each day tank once a day at average demand. Total four metering pumps are provided with three feed pumps, one dedicated to each of current injection locations, and one standby pump, which represents the same metering pump configuration as the current operation. The metering pump design included a safety factor that will allow pumping 120% of the maximum feed rate.

Table 2-39. Proposed Preliminary Design Criteria for Sodium Hypochlorite

Process Unit	Design Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8.0	15.0	32.0
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Sodium Hypochlorite				
Bulk Storage Tanks	Dose Range, mg/L as Cl_2	1.0	2.5	5.0
	Usage, lb/day as Cl_2	67	313	1,334
	Bulk Density, lb/gal	10		
	Concentration as Cl_2	0.10		
	Chlorine equivalent, lb Cl_2 per gallon	0.8		
	Usage, gph (as Product)	2.7	12.5	53.3
	Usage, gpd (as Product)	64	300	1,280
	Truck Delivery Volume, gal	5,000		
	Storage Capacity per Tank, gal	6,000		
	Days of Storage per Tank, days	94	20	5
	Number of Tanks	3		
	Total Storage, gal	18,000		
	Days of Storage, days	281[1]	60[1]	14
Day Tanks	Number of Day Tanks	3		
	Day Tank Capacity, gal	475		
	Total Day Tank Storage, gal	1,425		
	Hours of Storage per Tank, hours	178	38	9
	Hours of Day Tank Storage, hours	534	114	27
Metering Pumps	Feed Rate Required, gph	2.7	12.5	53.3
	Number of Feed Pumps, total	4		
	Feed Pump Capacity (Individual), gph	64.0		
	Number of Standby Feed Pumps	1		

Process Unit	Design Criteria	Minimum	Average	Maximum
	Total Feed Capacity, gph, one unit out of service	192.0		

[1] CDM Smith recommends PWW manage chemical inventory such that the potential for degradation is minimized.

Section 3

Condition Assessment

This section presents CDM Smith's condition assessment approach and findings relative to the Nashua WTP's chemical storage and feed systems.

3.1 Approach

In conjunction with the preliminary design criteria development described in Section 2 of this report, CDM Smith assessed the condition of the chemical systems and key ancillary systems through a field assessment and interviews with Pennichuck Water Works personnel. The work included the following tasks:

- Review of available drawings and records furnished by Pennichuck Water Works.
- August 8, 2022 deployment of CDM Smith's core team members to assess existing conditions and proposed improvements at the plant. The observations from this assessment were used to formulate the overall recommendations and planning-level costs presented within this report.
- September 28, 2022 interview with Pennichuck instrumentation and control personnel to discuss instrumentation and control, automation, and analyzer age, condition, and reliability.

The condition assessment reviewed bulk chemical loading stations, storage, transfer pumping, metering pumps, HVAC, instrumentation, and electrical systems against industry best practices. The goal of this assessment was tailored to aid in Pennichuck future planning and implementation of improvements.

In consideration of resiliency, CDM Smith evaluated redundancy, reliability, and considered the increased likelihood of flooding from more intense storms and rainfall volume, as well as changes in water quality from both flooding and increased water temperatures.

CDM Smith's assessments were performed by referencing the New Hampshire Department of Environmental Services (NHDES) requirements for chemical storage and feed systems at water treatment plants. NHDES adopts by reference the "Ten States Standards", formally titled "Recommended Standard for Water Works" published by the Great Lakes – Mississippi River Board of State and Provincial Health and Environmental Managers, 2018 edition.

3.2 Condition Assessment Findings

This section aims to serve as the summary of the most critical findings and deficiencies from the August 8, 2022 and September 28, 2022 visits and organized by discipline – process mechanical, HVAC, electrical, and instrumentation and control. The technical memorandum attached to this report as **Appendix A** records the detailed findings of the condition assessment from the August 8, 2022 field visit.

3.2.1 Process Mechanical

Table 3-1 summarizes the major process mechanical findings of the August 8, 2022 visit that may require attention for corrective actions at the existing plant and/or should be incorporated in the design of the new chemical storage and feed facilities.

Table 3-1 Summary of the Critical Process Mechanical Findings from Condition Assessment

Item	Finding	Applicable Chemical Rooms
1	Transfer Pumps are located on the floor without an equipment pad and therefore susceptible to flooding.	▪ Sodium Hypochlorite Bulk Tank Room ▪ Caustic Soda Room
2	The bulk tanks cannot accommodate a full truckload's delivery, requiring significant efforts to equalize the multiple bulk tanks.	▪ Sodium Hypochlorite Bulk Tank Room
3	The overflow pipes do not have mineral oil pails to neutralize the chemical.	▪ Sodium Hypochlorite Bulk Tank Room
4	Concrete floor deterioration and corrosion were observed (**Figure 3-1**)	▪ Sodium Hypochlorite Bulk Tank Room ▪ Sodium Hypochlorite Day Tank Room
5	Sump pump size and floor sloping to the sumps were inadequate.	▪ Sodium Hypochlorite Bulk Tank Room ▪ Sodium Hypochlorite Day Tank Room ▪ Caustic Soda Room
6	The caustic soda piping labeling did not include the concentration to differentiate between 25% and 50% products.	▪ Sodium Hypochlorite Bulk Tank Room ▪ Ferric Chloride Bulk Tank Area
7	Access around, to the back, to the top center flange, or to instruments of the tanks was limited.	▪ Sodium Hypochlorite Bulk Tank Room ▪ Sodium Permanganate Bulk Tank Area
8	Some parts of operation that may lead to leaks were not in secondary containment area, such as filling carboys for use at remote sites and location of the metering pumps.	▪ Sodium Hypochlorite Bulk Tank Room (carboy filling) ▪ Sodium Hypochlorite Day Tank Room (metering pumps)
9	Both 25% caustic soda and sodium hypochlorite share the same containment area, while both alkaline pH chemicals, is not best practice.	▪ Sodium Hypochlorite Bulk Tank Room
10	The access steps in and out of the containment area are steep, which may pose a hazard if carrying tools and equipment.	▪ Sodium Hypochlorite Bulk Tank Room
11	The day tanks are located in a separate room from the bulk tanks and transfer pumps.	▪ Sodium Hypochlorite Bulk Tank Room ▪ Sodium Hypochlorite Day Tank Room
12	Metal tank stands are deteriorating with corrosion, likely due to material incompatibility with sodium hypochlorite. (**Figure 3-2**)	▪ Sodium Hypochlorite Day Tank Room
13	Corrosion is present on the drain plumbing pipes.	▪ Sodium Hypochlorite Bulk Tank Room ▪ Sodium Hypochlorite Day Tank Room

Item	Finding	Applicable Chemical Rooms
14	Tanks are missing overflow pipes.	▪ Sodium Hypochlorite Day Tank Room ▪ Caustic Soda Day Tank Area ▪ Ferric Chloride Day Tank Area
15	Emergency eye wash and showers are missing.	▪ Caustic Soda Bulk Tank Area ▪ Sodium Permanganate Bulk Tank Area ▪ Ferric Chloride Bulk Tank Area ▪ Finished Water Chemical Room Bulk Tank Area ▪ 25% Caustic Soda Area
16	There is crystallization at a connection on Bulk Tank 2, suggesting a leak. (**Figure 3-3**)	▪ Caustic Soda Room
17	A transfer pump is absent.	▪ Sodium Permanganate Area
18	There are no guardrails between the day tank area to the depressed bulk tank area, posing a safety hazard. (**Figure 3-4**)	▪ Sodium Permanganate Area ▪ Ferric Chloride Area
19	Sodium hydroxide (base) piping is going through the ferric chloride (acid) bulk tank area. (**Figure 3-5**)	▪ Ferric Chloride Bulk Tank Area
20	No secondary containment is provided.	▪ 25% Caustic Soda Area ▪ Blended Orthophosphate Area
21	Large hole on the floor below the residual piping posing a fall risk into the residual basin.	▪ 25% Caustic Soda Area
22	The disconnect for the transfer pump is below the height of the secondary containment wall, susceptible to flooding. (**Figure 3-6**)	▪ Finished Water Chemical Room Bulk Tank Area
23	Expansion joint on bulk tanks not in correct location.	▪ Finished Water Chemical Room
24	TKPP is labeled incorrectly as HXDT.	▪ Finished Water Chemical Room
25	Tanks are not labeled with volumetric tank capacities.	▪ Sodium Hypochlorite Bulk Tank Room ▪ Sodium Hypochlorite Day Tank Room ▪ Sodium Permanganate Bulk Tank Area ▪ Finished Water Chemical Room (for day tanks only)

Figure 3-1. Floor Deterioration in Sodium Hypochlorite Bulk Storage Room

Figure 3-2. Deterioration of Sodium Hypochlorite Day Tank Metal Stands

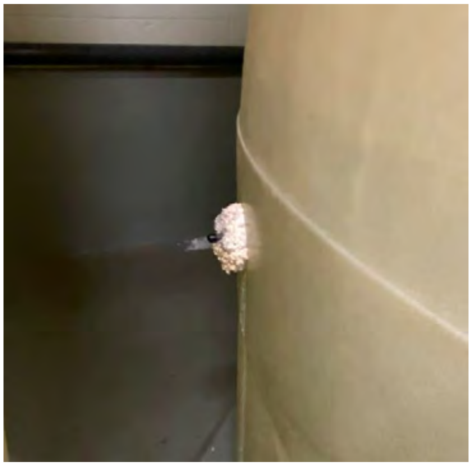


Figure 3-3. Crystallization at Caustic Soda Bulk Tank 2

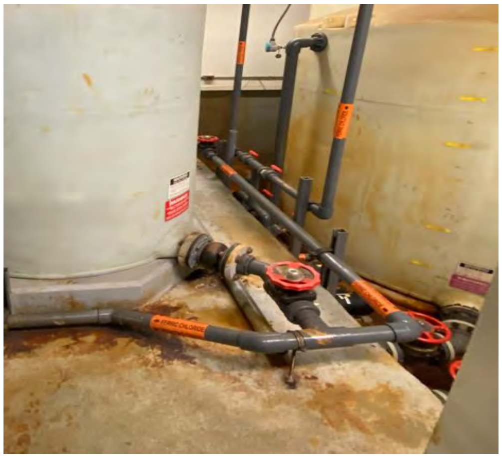


Figure 3-4. Lack of Fall Protection Between the Day Tank Area and the Depressed Bulk Tank Area

Figure 3-5. Caustic Soda Piping in the Ferric Chloride Bulk Tank Storage Area

Figure 3-6. Transfer Pump Disconnect Partly Inside the Secondary Containment Area

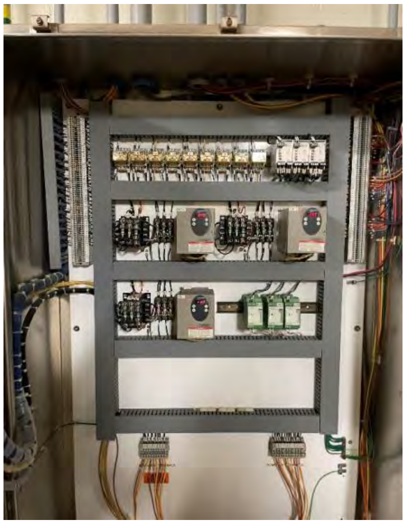
3.2.2 HVAC

Chemical storage and feed systems require careful heating, ventilation, and air conditioning (HVAC) design consideration to ensure the requirements of applicable building and mechanical codes are met or exceeded. Proper ventilation leads to worker safety, mitigates the effect of inherently corrosive environments, decreases the deterioration of certain chemicals susceptible to warm conditions (e.g. 12.5% sodium hypochlorite), and guards against chemicals which are prone to freezing or crystallization at certain temperatures (e.g. 50% sodium hydroxide). The planning-level scope of this chemical system evaluation and condition assessment did not include a detailed review of HVAC systems. However, during the condition assessment visit, CDM Smith noted that ventilation appeared to be not available or turned off in the majority of the chemical rooms and areas. CDM Smith recommends a final design phase of chemical systems upgrades include a review of existing HVAC systems. Given the 2007 vintage of the HVAC systems, and the likelihood of deterioration due to age and corrosion, CDM Smith recommends and has included a construction allowance for HVAC system upgrades be included in the planning-level Opinion of Probable Construction Cost.

3.2.3 Electrical

A variety of electrical panelboards, lighting panels, and transformers are located within the existing chemical areas and distribute power to the pre- and post-treatment chemical systems. CDM Smith interviewed PWW staff to discuss the disposition of this equipment.

Overall, the majority of the electrical equipment in these areas was installed in 2007, and as of 2022, has been in service for 15 years. While the electrical equipment remains functional, visual signs of corrosion are evident, and corrosion on contacts and other internal components is likely given the corrosive environmental conditions inherent with chemical storage and feed areas. While the typical service life for electrical equipment is on the order of 20 years, it is typically less than 20 years in corrosive environments.



This photograph from PWW's Pre-Treatment Chemical Area depicts the interior of an electrical cabinet housing three chemical pump variable frequency drives.

Upgrades to chemical transfer and metering pumps will need to be coordinated with the motor starters and variable frequency drives that are associated with individual pumps. This will require electrical systems coordination and necessitate work within existing electrical enclosures.

Lighting, intrusion alarms, and video surveillance systems are examples of other ancillary electrical system components that will warrant

This photograph from PWW's Pre-Treatment Chemical Area depicts electrical panels and transformers exhibiting age and corrosion.

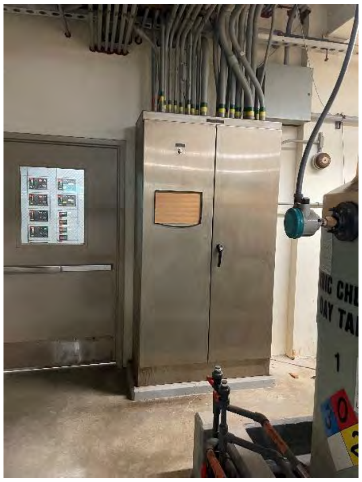
review in a future phase of work.

The electrical systems are a critical component of the plant's chemical storage and feed systems. CDM Smith recommends all panelboards, lighting panels, and transformers within the pre- and post-treatment chemical areas be replaced in full as part of a chemical systems upgrade to restore the plant's chemical system reliability and resiliency. Replacing this equipment will ensure these components are serviceable with readily available replacement parts, compliant with the latest edition of the National Electrical Code (NEC) and conform with modern arc flash requirements.

3.2.4 Instrumentation and Control

The plant's chemical storage and feed systems transmit operating status, real-time data, and receive control commands via programmable logic controllers (PLCs).

The PLCs for the pre-treatment chemicals are housed within a free-standing NEMA enclosure located within the pre-treatment chemical storage and feed areas. For the post-treatment chemical systems, the related PLC enclosure is located within an adjacent room, wherein PLCs for the finished water pumping system and the post-treatment chemical systems are co-located. The network topology consists of a fiber optic ring that facilitates a redundant communication link throughout the facility.



This photograph depicts the PLC enclosure within PWW's pre-treatment chemical area. It houses a number of PLC modules which are outdated, and its screen has been removed and replaced with a cardboard cover.

The majority of the PLCs described above are Allen Bradley Model SLC 5/05, which is an obsolete and has been officially discontinued by Rockwell Automation. Modern automation design would call for CompactLogix or ControLogix PLCs, consistent with other more modern, standardized Pennichuck Water Works facilities.

Additional PLCs and controls exist elsewhere within the chemical storage and feed areas. For example, the existing polymer system is controlled by MicroLogix 1100 PLCs. The polymer system PLCs and associated screens are outdated, and past-generation replacement screens are difficult to obtain. The polymer system controls have required service and repair in the period from approximately 2019 to present, resulting in 2- to 3-week downtime periods, during which only one of the two polymer feed units was available and in service.

This photograph shows the inside of the post-treatment chemical area control cabinet. The PLC modules (along the top row within this cabinet) are obsolete and should be replaced. For the post-treatment PLC, the replacement of both chemical and finished water pump PLCs will require greater coordination than replacement of the PLCs serving the pre-treatment chemical systems.

A variety of primary instruments and analytical devices such as ultrasonic level elements and contacts sensing high day tank fluid levels are also of 2007 vintage and have exhibited performance and reliability issues. CDM Smith recommends instruments such as those be replaced as part of a chemical storage and feed upgrade project.

The instrumentation, control and automation systems are a critical component of the plant's chemical storage and feed systems. Operating a discontinued family of PLCs leads to increased expense and difficulty to find working replacement parts. Some parts are only available as refurbished, and the scarcity can lead to unplanned or increased downtime. CDM Smith recommends PLCs and instrumentation serving the pre- and post-treatment chemical areas be replaced in full as part of a chemical systems upgrade to restore the plant's chemical system reliability and resiliency. Further, as the drinking water supply industry faces increasing aging workforce issues, robust and reliable remote monitoring, alarming, and control systems become more critical.

3.2.5 Fire Protection

CDM Smith observed that fire sprinklers exist in both chemical storage and feed areas. A detailed assessment of these systems should be conducted as part of a future improvements project.

Section 4

Conceptual Design of Chemical System Upgrades

This section describes the design concept for a new chemical storage building, recommended improvements within the existing chemical storage and feed areas, potential implementation schedule for improvements, opinions of probable project costs, and recommendations for future phases of work.

4.1 New Chemical Storage Building

Section 2 of this report describes the limitations in storage volume within the ferric chloride coagulant and sodium hypochlorite systems. These chemicals are arguably the most critical chemicals in the plant – without coagulant and primary disinfectant, effective, regulatory-compliant water treatment operations cannot occur.

Given the increased dosing demand for (and in turn increased consumption of) ferric chloride, the critical nature of ferric chloride and sodium hypochlorite, the relatively limited quantity of existing storage capacity, and chemical supply availability challenges experienced from 2020 to present, greater storage volumes of ferric chloride and sodium hypochlorite are required.

Figures 4-1, 4-2, and **4-3** depict plan view, isometric, and site location views for a new ferric chloride and sodium hypochlorite storage building. Key features of the design concept include:

- Five 10,000 gallon ferric chloride storage tanks, or 50,000 gallons of total storage, representing nearly a 2.5-fold increase from the existing 19,800 gallons of storage in the existing building.
- Three 6,000 gallon sodium hypochlorite bulk storage tanks, or 18,000 gallons of total storage, representing a 2-fold increase from the existing 9,000 gallons of storage in the exiting building.
- With an elevated finished floor mimicking the existing building's loading dock provisions, the building features a depressed secondary containment with concrete stairs provided to allow access into and egress out of the 42-inch depressed containment areas.
- Transfer pumps will be located local to the new bulk storage tanks, for conveyance to new day tanks in the existing building. This will allow metering pumps to be installed where the existing metering pumps are located, thus making feed pump piping runs no longer than they are at present. This is beneficial as a design objective in chemical systems design is to minimize the metering pump discharge pipe length to the extent possible.

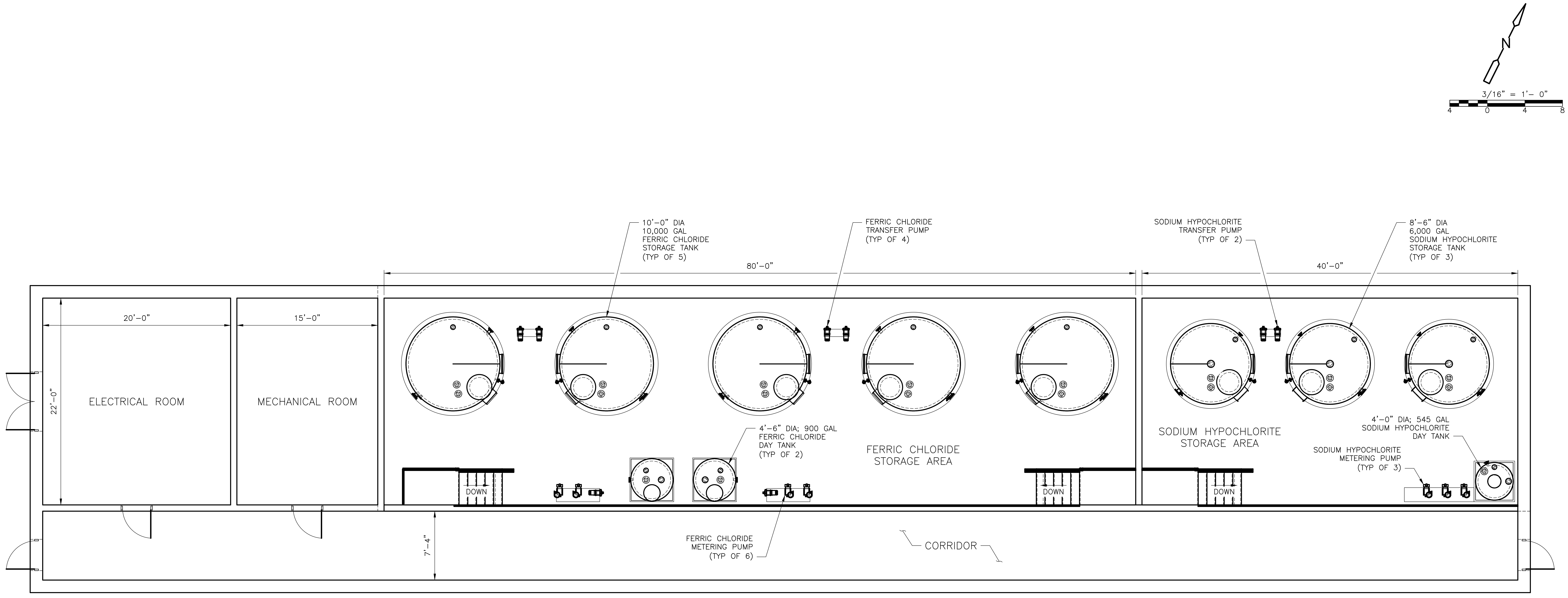
The new chemical storage building architecture presents an opportunity to mimic the adjacent Snow Building, to blend the new building into the existing site in keeping with the attractive architectral theme on this side of the site.

- The new building will include spill sumps, and eye wash units, which are not shown in the conceptual drawings herein.
- The site plan shows that the proposed building will fit on site, with utility pole and power line relocation required.
- The building should have provisions for removal of tanks and installation of new tanks in the future. These provisions should allow Pennichuck to perform such activities without destructive actions to open the building walls or roof to enable tank removal and installation. CDM Smith has provided translucent panels and "storefront glass" in recent chemical system designs. These approaches provide natural light, and functionality in the form of a removable wall system.

Storefront glass at chemical storage areas, such as the example in this photograph, has the functional benefit of visual connection from the outside. This can aid operations personnel in detecting bulk loading over-fill or other anomalies from the outside.

CDM Smith and Pennichuck Water Works have discussed the concept of an elevated walkway connecting the second floor of the existing WTP with the new ferric chloride and sodium hypochlorite bulk storage building. Benefits and features of this walkway concept include the following:

- The elevated walkway will be designed to be above the elevation of bulk chemical delivery trucks, consistent with the clearance provided under bridges on highways.
- The walkway will provide a mechanism to support and freeze-protect chemical transfer piping, service water piping, communications, and power conductors across the roadway. Above-grade crossings are beneficial, as underground natural gas line, power lines, and two large water pipes exist beneath the road between the existing and proposed buildings.
- This feature will allow convenient and efficient access by plant operator staff, avoiding outdoor pedestrian travel. This is particularly beneficial in inclement weather, in winter conditions, and at night during second and third shift operations. Should Pennichuck Water Works continue to operate with only one staff member during second and third shifts, the safety benefit of indoor pedestrian travel will become more pronounced.
- The walkway is shown and is aligned with the exterior stairs to the existing facility. The details of the walkway's connection to the existing facility will require detailed review by an architect and structural engineer, to be sure that new lateral loads are not transferred to the existing structure, that code-required egress from the existing building is not unacceptably reduced, and to determine details of connection to the existing building and transition to the new building. Concept-level review is recommended as an early pre-design activity to identify any "fatal flaws" with this concept, and to define the concept to a greater degree in preparation for the final design phase.
- The walkway can be eliminated and an above-ground utility chase can be provided instead, to simplify the work and reduce cost, if desired by PWW at the beginning of final design.



PLAN
3/16" = 1'-0"

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C:\Users\rv\AppData\Local\Autodesk\AutoCAD Plant 3D\CollaborationCache\0246_275436\Orthos\DWGs\FIGURE 4-1.dwg

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. LEDOUX
DRAWN BY: R. VIGNESH
SHEET CHK'D BY: J. IM
CROSS CHK'D BY: A. LEBLANC
APPROVED BY: A. LEBLANC
DATE: MARCH 2023

CDM Smith
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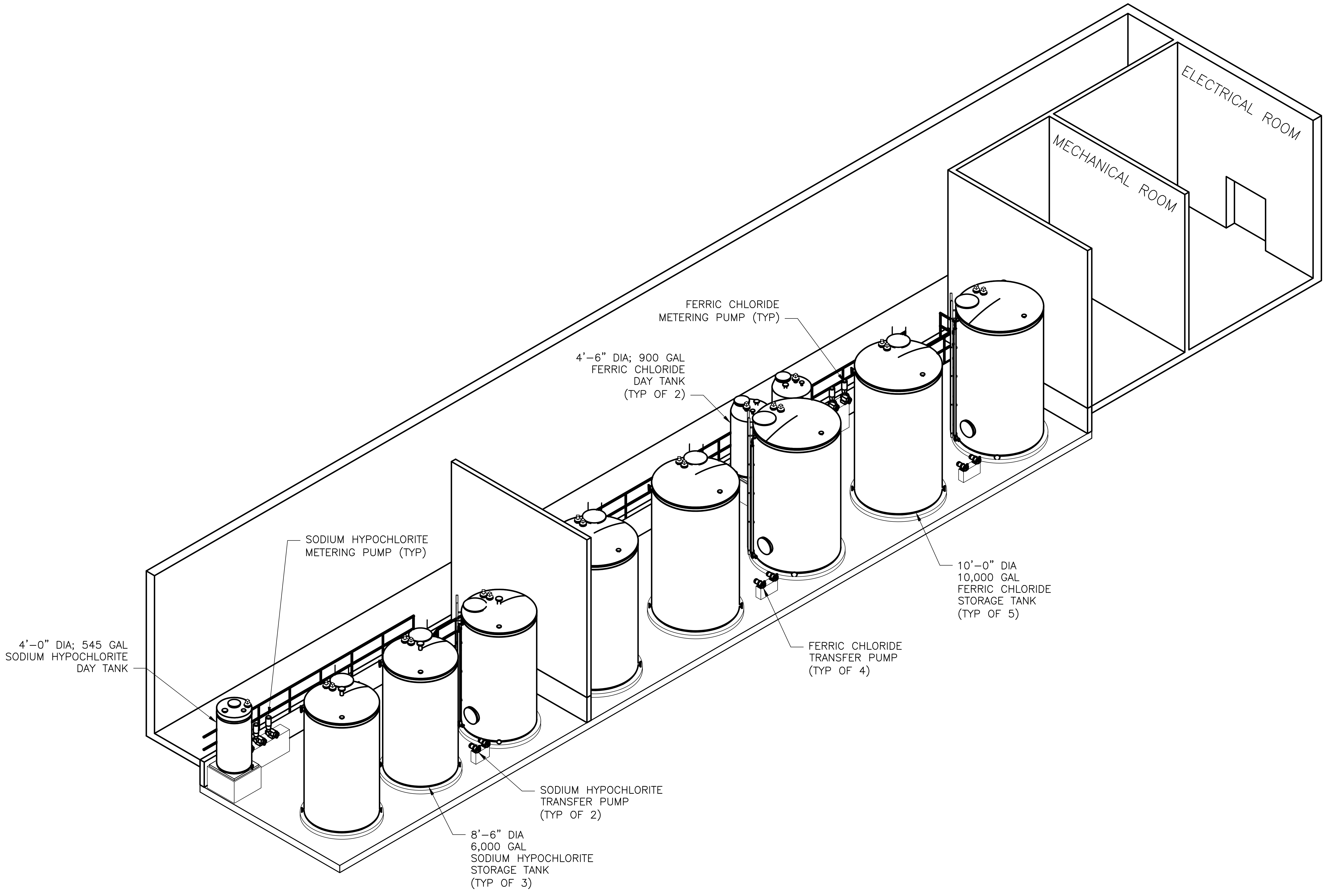
PENNICHUCK WATER WORKS

NASHUA WATER TREATMENT PLANT
CHEMICAL SYSTEMS UPGRADE

NEW CHEMICAL BUILDING
PLAN

PROJECT NO. 0246-275436
FILE NAME: FIGURE 4-1.DWG
SHEET NO.
FIGURE 4-1

30% SUBMITTAL - NOT FOR CONSTRUCTION



ISOMETRIC

NTS

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. LEDOUX
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APPROVED BY: A. LEBLANC
DATE: MARCH 2023

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PENNICHUCK WATER WORKS

NASHUA WATER TREATMENT PLANT
CHEMICAL SYSTEMS UPGRADE

NEW CHEMICAL BUILDING
ISOMETRIC

PROJECT NO. 0246-275436
FILE NAME: FIGURE 4-2.DWG
SHEET NO.
FIGURE 4-2

30% SUBMITTAL - NOT FOR CONSTRUCTION

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CDM Smith

FIGURE 4-3. CONCEPTUAL SITE PLAN
OCTOBER 5, 2022

4.2 Improvements in the Existing Building

Figure 4-4 and **Figure 4-5** show the proposed work associated with the existing chemical systems, including:

- Demolition of the bulk storage tanks and transfer pumps for ferric chloride and sodium hypochlorite that will be replaced with new systems described in Section 4.1,
- Demolition and installation of new day tanks and metering pumps for ferric chloride and sodium hypochlorite, and
- Replacement of the bulk storage tanks, day storage tanks, metering pumps, and transfer pumps for pre- and post-caustic soda, sodium permanganate, zinc orthophosphate, and TKPP.

After removal of the ferric chloride and sodium hypochlorite bulk tanks, the newly available area can be used for any space demand in the future (e.g. new chemical systems, storage, etc.)

The findings and recommendations identified for the existing ferric chloride and sodium hypochlorite rooms in Section 3.2 will be reviewed and incorporated in the design of the new replacement storage and feed systems. Therefore, many deficiencies identified in those two existing rooms will be addressed as part of that process. The remaining deficiencies in the other existing chemical rooms and areas should be reviewed and corrected as soon as possible.

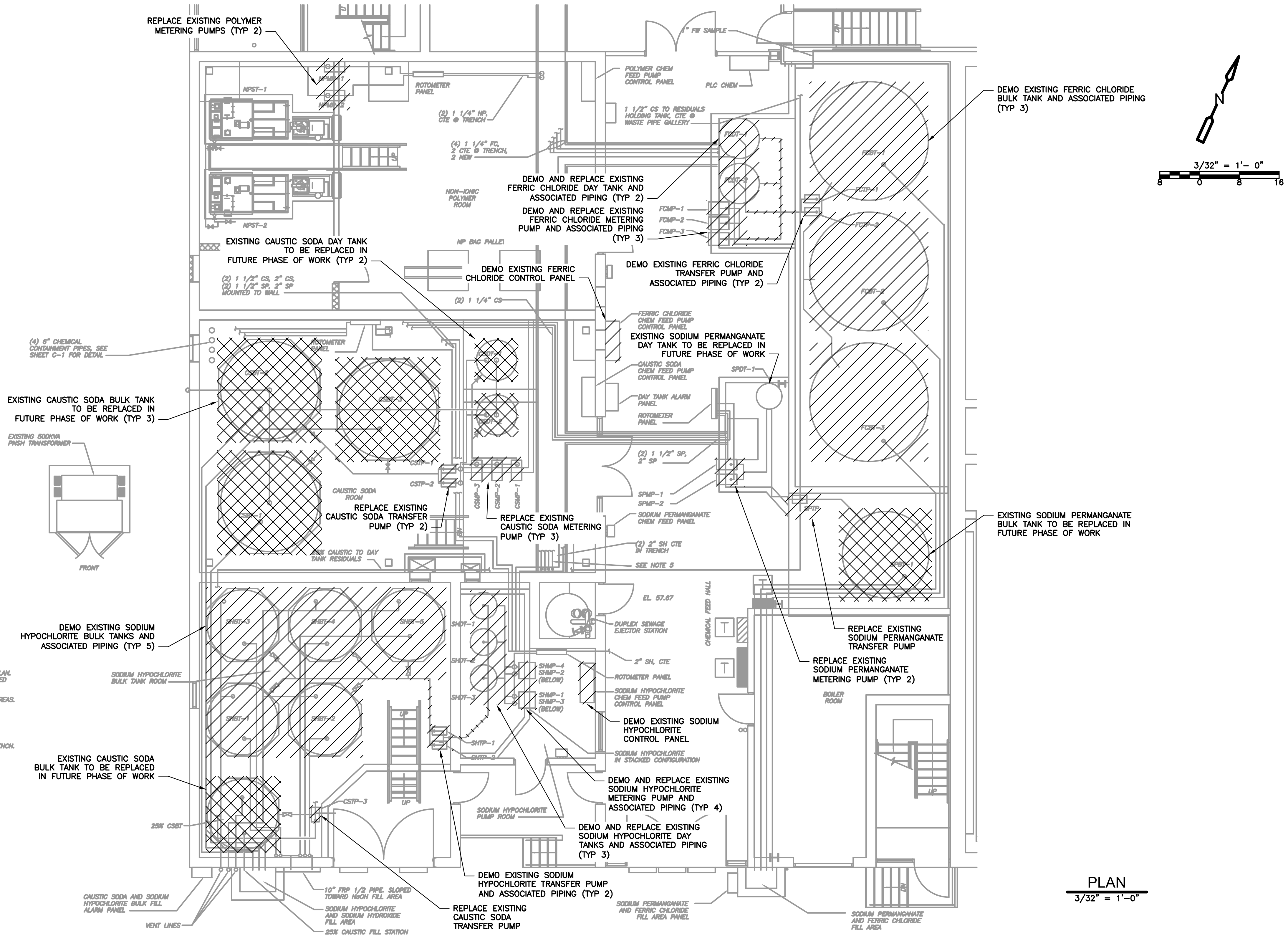
4.3 Implementation Schedule

The most pressing need identified in this study is to remedy the shortfall in ferric chloride coagulant bulk storage, followed by the need for additional sodium hypochlorite bulk storage on site.

Secondarily, within all chemical storage and feed systems, the electrical, instrumentation and control, HVAC, and mechanical components throughout are reaching the end of their useful service life. Other needs identified in the condition assessment require near-term action. Customarily the service life for these components is on the order of 20 years, though within the inherently corrosive environment typical of chemical storage areas, these 2007-vintage items (16 years old as of 2023) are recommended for replacement as soon as possible.

The above categories are recommended for implementation in the near-term, with ferric chloride bulk storage augmentation being necessary as soon as possible. The implementation schedule depicted in **Figure 4-6** shows the design, permitting, bidding, construction and startup of all of the above-noted work in the near-term.

Finally, beyond the ferric chloride and sodium hypochlorite bulk and storage tanks, the other chemical systems' tanks are not exhibiting visual signs of failure as of 2022. As a service life for tanks containing relatively non-aggressive chemicals of 25 years is possible, CDM Smith notes that replacement of these remaining bulk and day tanks should be planned for approximately 2032, unless condition assessments before that date warrant more rapid action.



NOTES:

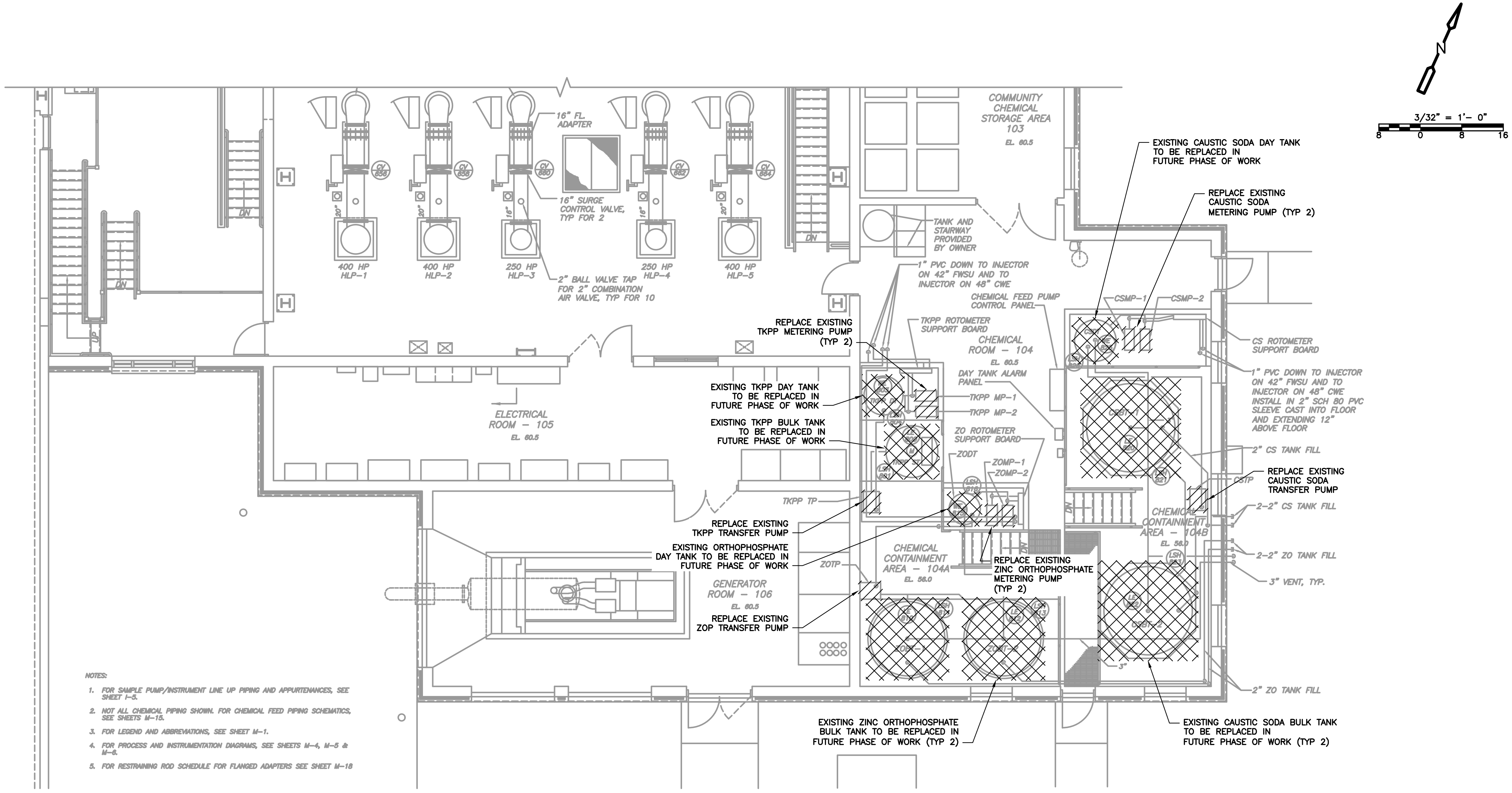
1. NOT ALL PIPING, FITTINGS, APPURTENANCES ARE SHOWN ON THIS PLAN. SEE CHEMICAL FEED SCHEMATIC FOR DETAILS ON THE CHEMICAL FEED SYSTEMS.
2. SEE STRUCTURAL DRAWINGS FOR MODIFICATIONS TO CONTAINMENT AREAS.
3. SEE ELECTRICAL DRAWINGS FOR NUMBER AND LOCATION OF INSTRUMENTS ON THE TANKS.
4. RESUME EXISTING VENT AND FILL PIPING WHERE POSSIBLE.
5. CONNECT SAMPLE LINES TO EXISTING LINES TO LAB AT END OF TRENCH.

LEGEND:

▨ TO BE DEMOLISHED
▩ TO BE REPLACED IN FUTURE PHASE OF WORK

CDM Smith

FIGURE 4-4
EXISTING CHEMICAL FEED AREA DEMOLITION PLAN PART 1
MARCH 2023



NOTES:

1. FOR SAMPLE PUMP/INSTRUMENT LINE UP PIPING AND APPURTENANCES, SEE SHEET I–5.
2. NOT ALL CHEMICAL PIPING SHOWN. FOR CHEMICAL FEED PIPING SCHEMATICS, SEE SHEETS M–15.
3. FOR LEGEND AND ABBREVIATIONS, SEE SHEET M–1.
4. FOR PROCESS AND INSTRUMENTATION DIAGRAMS, SEE SHEETS M–4, M–5 & M–6.
5. FOR RESTRAINING ROD SCHEDULE FOR FLANGED ADAPTERS SEE SHEET M–18

PLAN
3/32" = 1'–0"

LEGEND:

▨ TO BE DEMOLISHED

▩ TO BE REPLACED IN FUTURE PHASE OF WORK

CDM Smith

FIGURE 4-5
EXISTING CHEMICAL AREA DEMOLITION PLAN PART 2
MARCH 2023

Pennichuck Water Works Chemical Feed Systems Design and Construction Schedule

Last Revised April 27, 2023

	2022							2023												2024												2025												2026											
	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PROJECT DEVELOPMENT ACTIVITY																																																							
Chemical Systems Evaulation		🟦	🟦	🟦	🟦	🟦																																																	
Land Survey and Wetlands Flagging						🟦																																																	
Geotechnical Investigation							🟦																																																
Permitting																			🟦	🟦	🟦	🟦	🟦	🟦	🟦																														
10 Percent Design																	🟦	🟦																																					
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60 Percent Design																					🟦	🟦																																	
90 Percent Design																							🟦	🟦																															
NHDES Review and Approval																									🟦																														
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Bidding and Award																											🟦	🟦																											
Construction																															🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦							
Startup																																															🟦	🟦							
Milestone - Near Term Chemical System Improvements Constructed and Operating																																											🟥					🟥							
COORDINATION ACTIVITY																																																							
Design-Phase Progress Meetings with Owner																	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																											
Opinions of Probable Construction Cost																				🟦				🟦																															
General Project Management																	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦							

Figure 4-6
Revised Implementation Schedule

4.4 Opinion of Probable Project Costs

Table 4-1 and **Table 4-2** present CDM Smith's Opinions of Probable Project Cost (OPCC) for near-term and longer-term improvements, on the implementation timeline described in Section 4.3 above. The construction contingency used in these tables is based on a Class 4 estimate per the recommendations of the American Association of Cost Estimators (AACE) for projects at this level of design. AACE recommends the construction contingency be lessened as the design is further developed.

Table 4-1 Opinion of Probable Project Cost for Near-Term Improvements

Cost Element	Cost
Furnish and Install All Work	$5,000,000
General Contractor Overhead & Profit, Taxes, Insurance and Permits	$2,100,000
Subtotal October 2022 Dollars, ENR 20-City Index = 13,175	$7,100,000
Construction Contingency (30%)	$2,100,000
Subtotal	$9,200,000
Escalation to August 2024 midpoint of construction at 7%/year	$1,200,000
Opinion of Probable Construction Cost	$10,400,000
Engineering and Implementation Allowance (25%)	$2,600,000
Opinion of Probable Project Cost (rounded)	$13,000,000

Table 4-2 Opinion of Probable Project Cost for Longer-Term Improvements

Cost Element	Cost
Furnish and Install All Work	$800,000
General Contractor Overhead & Profit, Taxes, Insurance and Permits	$350,000
Subtotal October 2022 Dollars, ENR 20-City Index = 13,175	$1,150,000
Construction Contingency (30%)	$350,000
Subtotal	$1,500,000
Escalation to August 2032 midpoint of construction at 7%/year	$950,000
Opinion of Probable Construction Cost	$2,450,000
Engineering and Implementation Allowance (25%)	$600,000
Opinion of Probable Project Cost (rounded)	$3,000,000

4.5 Considerations for Final Design

Several aspects of the work need to be investigated in the early portion of the final design phase. These topics have the potential to add cost or otherwise add complexity to the project.

- The detailed review by an architect and structural engineer for the feasibility of the walkway as described in Section 4.1 should commence as early as possible to define the concept further.

- Updated surveys to be performed and completed by the end of spring 2023 and will confirm the existing conditions and will be used in the site civil design during the final design phase.
- A geotechnical investigation of the site including new borings within the proposed plant area should be completed as early as possible for civil and structural design of the final design phase.
- The conceptual design does not include a bathroom or shower and assumes any floor drains of the new chemical building will be discharged in the same manner as the existing plant, and therefore, no provision of a holding tank or "Tight Tank" is necessary. These items can be investigated early in the final design phase.
- The early final design phase will investigate the impact of the added impervious area from the new chemical building and adequacy of the existing stormwater lagoon capacity. The conceptual design and OPCC did not include any new work associated with upgrading the existing stormwater system.
- Maintenance of plant operation during the construction and startup will be planned carefully in the final design. The design of the new chemical systems will ensure that their installation will minimize the existing chemical system shutdown and that the existing chemical systems can operate normally until the new chemical systems can be online continuously.

Section 5

Updated Conceptual Design of Chemical System Upgrades – March 2023

This Section 5 augments and re-presents appreciable portions of Section 4 of this report, in that it presents an alternative location for the new chemical storage building. Following the fourth project workshop (October 27, 2022), PWW advised CDM Smith that an alternate building location should be evaluated for feasibility, functionality, and cost criteria. This Section 5 presents work that culminated in March 2023, featuring a modified building location on site, an adjusted floor plan, and updated opinions of probable project costs. The basis for other recommendations remain consistent and are repeated in this section from Section 4.

This section describes the criteria impacted resulting from the alternate building location.

5.1 New Chemical Storage Building Placement

Section 2 of this report describes the limitations in storage volume within the ferric chloride coagulant and sodium hypochlorite systems. Additionally, Section 4 of this report describes the design basis for ferric chloride coagulant and sodium hypochlorite systems. The design criteria for these chemical systems remain unchanged but the configuration of these systems have been updated in response to the new building location onsite. The new building will now abut the existing Nashua WTP via a vestibule that will be constructed at an exterior access door on the south side of the WTP. This door is currently used as a form of egress from the WTP, allowing access to the chemical unloading areas and external access to chemical storage and feed areas, making the location optimal for a future chemical addition.

Figures 5-1, 5-2, and **5-3** depict plan view, isometric, and site location views for a new ferric chloride and sodium hypochlorite storage building. Key features of the design concept include:

- Five 10,000 gallon ferric chloride storage tanks, or 50,000 gallons of total storage, representing nearly a 2.5-fold increase from the existing 19,800 gallons of storage in the existing building.
- Three 6,000 gallon sodium hypochlorite bulk storage tanks, or 18,000 gallons of total storage, representing a 2-fold increase from the existing 9,000 gallons of storage in the exiting building.
- With an elevated finished floor mimicking the existing building's loading dock provisions, the building features a depressed secondary containment with concrete stairs provided to allow access into and egress out of the 42-inch depressed containment areas.
- Transfer pumps, metering pumps, and day tanks will be located local to the new bulk storage tanks, for ease of operation. This configuration differs from what was presented with the original building location. With localized storage and feed equipment housed in

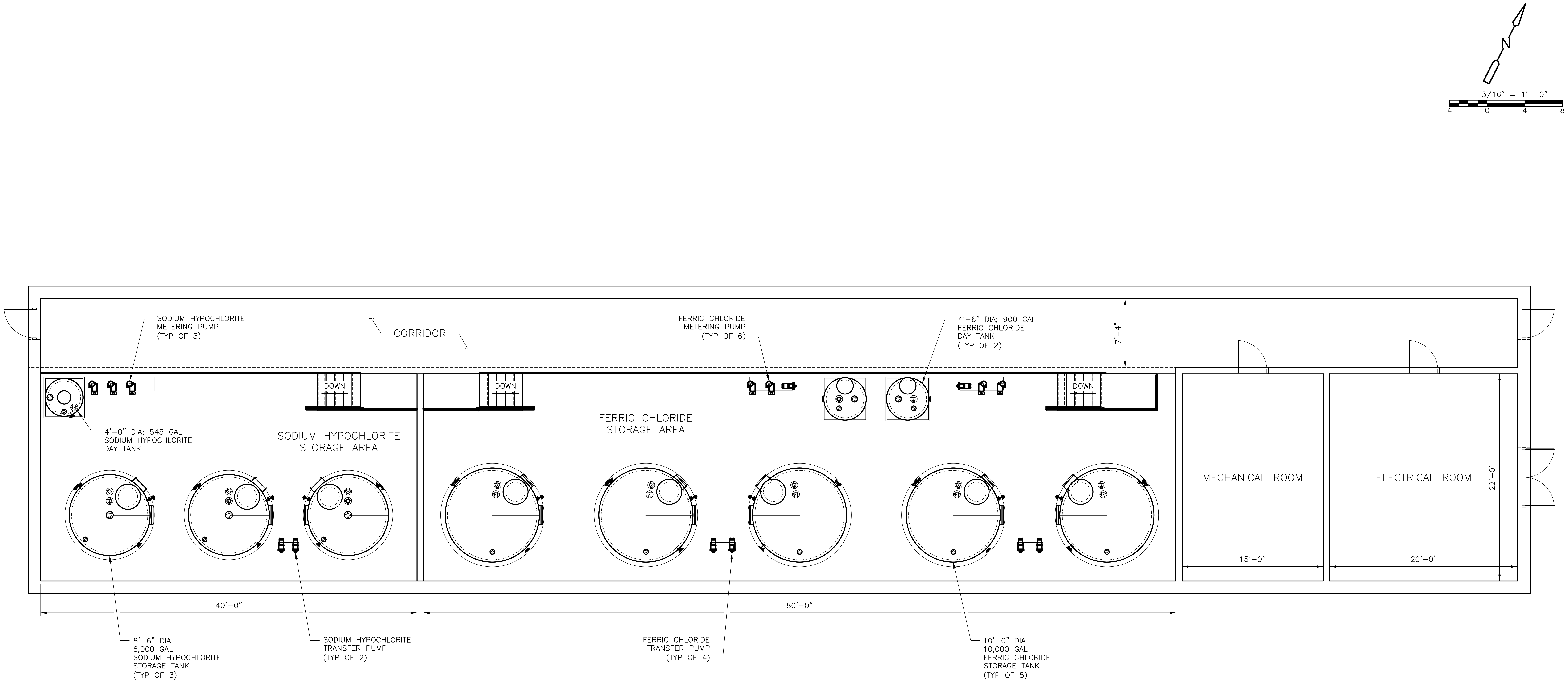
one area this will allow for a more streamlined chemical unloading, feed, and O&M approach as opposed to the original concept. The new building location allows metering pumps to be installed in a location where the feed pump piping runs no longer than they are at present. This is beneficial as a design objective in chemical systems design is to minimize the metering pump discharge pipe length to the extent possible. Additionally, staff will now be able to visually observe bulk and day tank filling procedures from a localized space which should limit the potential for overfilling tanks.

- The new building will include spill sumps, and emergency shower / eye wash units, which are not shown in the conceptual drawings herein.
- The site plan shows that the proposed building will fit on site adjacent to the existing WTP, with utility pole, power line, and finished water pipeline (24-inch and 30-inch diameter) relocation required. Reconfiguration of the existing paved access driveway will also be required for this new building location.
- The building should have provisions for removal of tanks and installation of new tanks in the future. These provisions should allow Pennichuck to perform such activities without destructive actions to open the building walls or roof to enable tank removal and installation. CDM Smith has provided translucent panels and "storefront glass" in recent chemical system designs. These approaches provide natural light, and functionality in the form of a removable wall system.

Storefront glass at chemical storage areas, such as the example in this photograph, has the functional benefit of visual connection from the outside. This can aid operations personnel in detecting bulk loading over-fill or other anomalies from the outside.

As described in Section 4, CDM Smith and Pennichuck Water Works had discussed the concept of an elevated walkway connecting the second floor of the existing WTP with the new ferric chloride and sodium hypochlorite bulk storage building. The modified location described in this Section 5 eliminates the need for the walkway. Benefits of the new building location include the following:

- Convenient and efficient access by plant operator staff, avoiding outdoor pedestrian travel. This enhances the accessibility of the new building, facilitating visual observation and daily maintenance. This is particularly beneficial in inclement weather, in winter conditions, and at night during second and third shift operations.
- Eliminates the need for an elevated walkway, suspended piping, conduit and wire, and the associated costs.
- Consolidates chemical storage and feed equipment near existing systems and requires minimal increase in chemical feed piping lengths.
- Consolidates chemical fill station locations, requiring no change in the general path of travel for chemical delivery trucks.



PLAN

3/16" = 1'-0"

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C:\Users\rv\AppData\Local\Autodesk\AutoCAD Plant 3D\CollaborationCache\0246_275436\Orthos\DWGs\FIGURE 4-1.dwg

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. LEDOUX
DRAWN BY: R. VIGNESH
SHEET CHK'D BY: J. IM
CROSS CHK'D BY: A. LEBLANC
APPROVED BY: A. LEBLANC
DATE: MARCH 2023

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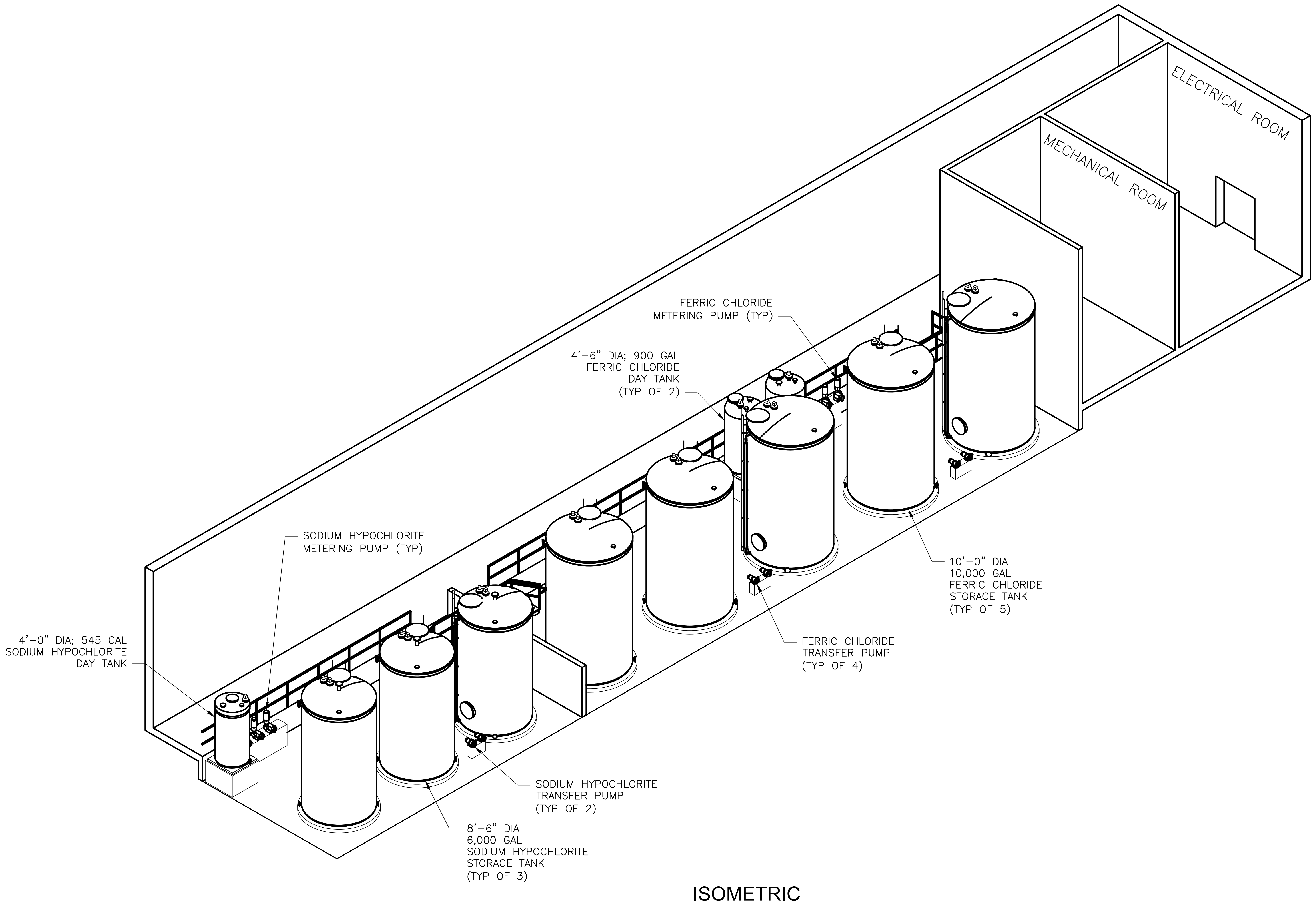
PENNICHUCK WATER WORKS

NASHUA WATER TREATMENT PLANT
CHEMICAL SYSTEMS UPGRADE

NEW CHEMICAL BUILDING
PLAN

PROJECT NO. 0246-275436
FILE NAME: FIGURE 5-1.DWG
SHEET NO.
FIGURE 5-1

30% SUBMITTAL - NOT FOR CONSTRUCTION



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PENNICHUCK WATER WORKS

NASHUA WATER TREATMENT PLANT
CHEMICAL SYSTEMS UPGRADE

NEW CHEMICAL BUILDING
ISOMETRIC

PROJECT NO. 0246–275436
FILE NAME: FIGURE 5–2.DWG
SHEET NO.
FIGURE 5-2

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C:\Users\rv\AppData\Local\Autodesk\AutoCAD Plant 3D\CollaborationCache\0246_275436\Orthos\DWGs\FIGURE 4-2.dwg

FIGURE 5-3. PENNICHUCK WATER
CONCEPTUAL SITE PLAN
MARCH 2, 2023

5.2 Improvements in the Existing Building

Section 4 presents the improvements to the existing building, the only modification expected from the new chemical building location is that the ferric chloride and sodium hypochlorite day tanks and metering pumps will be demolished and not replaced in the existing spaces. **Figure 5-4** and **Figure 5-5** show the proposed work associated with the existing chemical systems, including:

- Demolition of the bulk storage tanks, day tanks, metering pumps, and transfer pumps for ferric chloride and sodium hypochlorite that will be replaced with new systems described in Section 4.1.
- Replacement of the bulk storage tanks, day storage tanks, metering pumps, and transfer pumps for pre- and post-caustic soda, sodium permanganate, zinc orthophosphate, and TKPP.

After removal of the ferric chloride and sodium hypochlorite systems, the newly available area can be used for any space demand in the future (e.g. new chemical systems, storage, etc.)

The findings and recommendations identified for the existing ferric chloride and sodium hypochlorite rooms in Section 3.2 will be reviewed and incorporated in the design of the new replacement storage and feed systems. Therefore, many deficiencies identified in those two existing rooms will be addressed as part of that process. The remaining deficiencies in the other existing chemical rooms and areas should be reviewed and corrected as soon as possible.

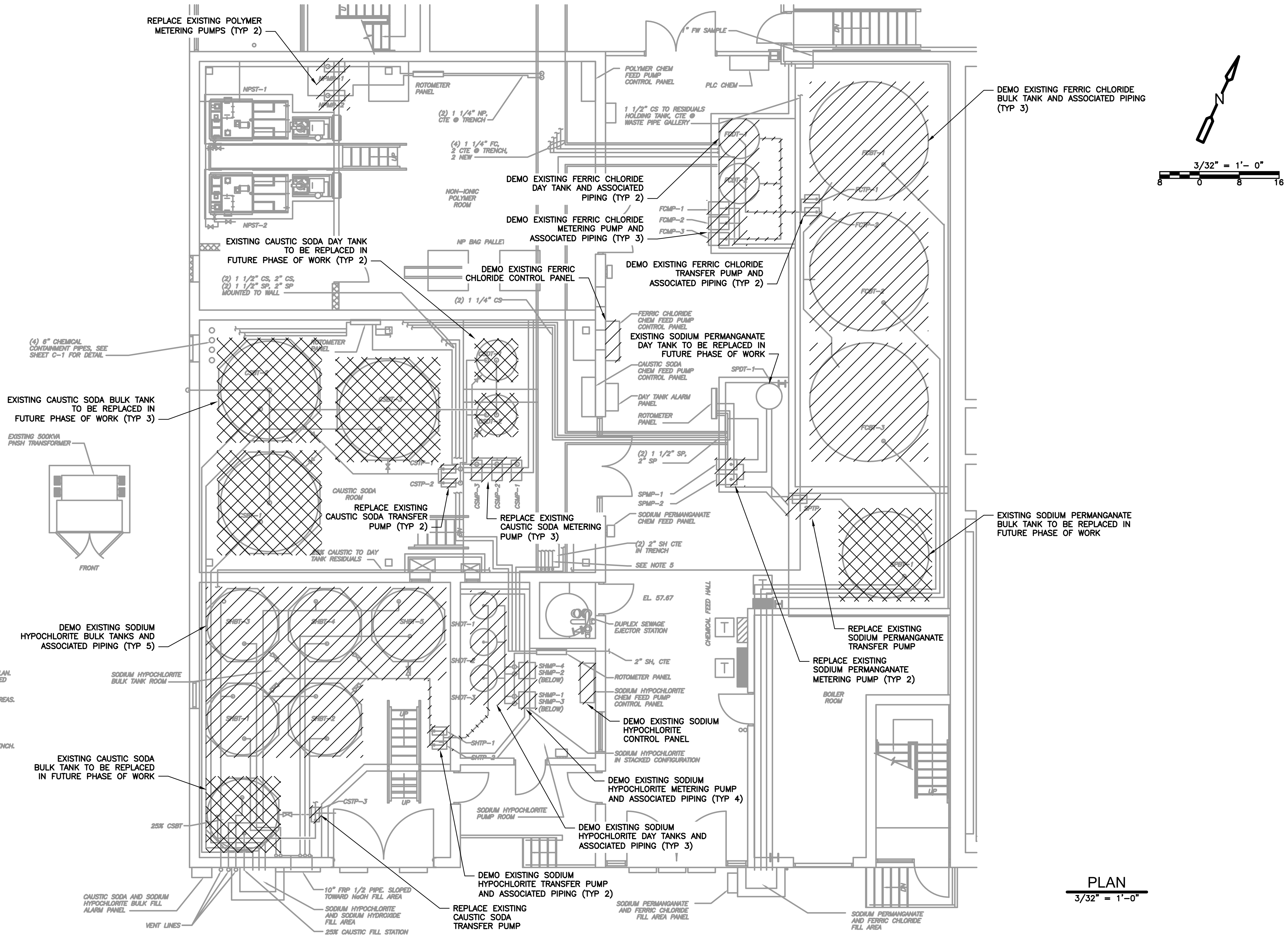
5.3 Implementation Schedule

The most pressing need identified in this study is to remedy the shortfall in ferric chloride coagulant bulk storage, followed by the need for additional sodium hypochlorite bulk storage on site.

Secondarily, within all chemical storage and feed systems, the electrical, instrumentation and control, HVAC, and mechanical components throughout are reaching the end of their useful service life. Other needs identified in the condition assessment require near-term action. Customarily the service life for these components is on the order of 20 years, though within the inherently corrosive environment typical of chemical storage areas, these 2007-vintage items (16 years old as of 2023) are recommended for replacement as soon as possible.

The above categories are recommended for implementation in the near-term, with ferric chloride bulk storage augmentation being necessary as soon as possible. **Figure 4-6** shows the design, permitting, bidding, construction, and startup of all of the above-noted work in the near-term.

Finally, beyond the ferric chloride and sodium hypochlorite bulk and storage tanks, the other chemical systems' tanks are not exhibiting visual signs of failure as of 2022. As a service life for tanks containing relatively non-aggressive chemicals of 25 years is possible, CDM Smith notes that replacement of these remaining bulk and day tanks should be planned for approximately 2032, unless condition assessments before that date warrant more rapid action.



PLAN
3/32" = 1'-0"

NOTES:

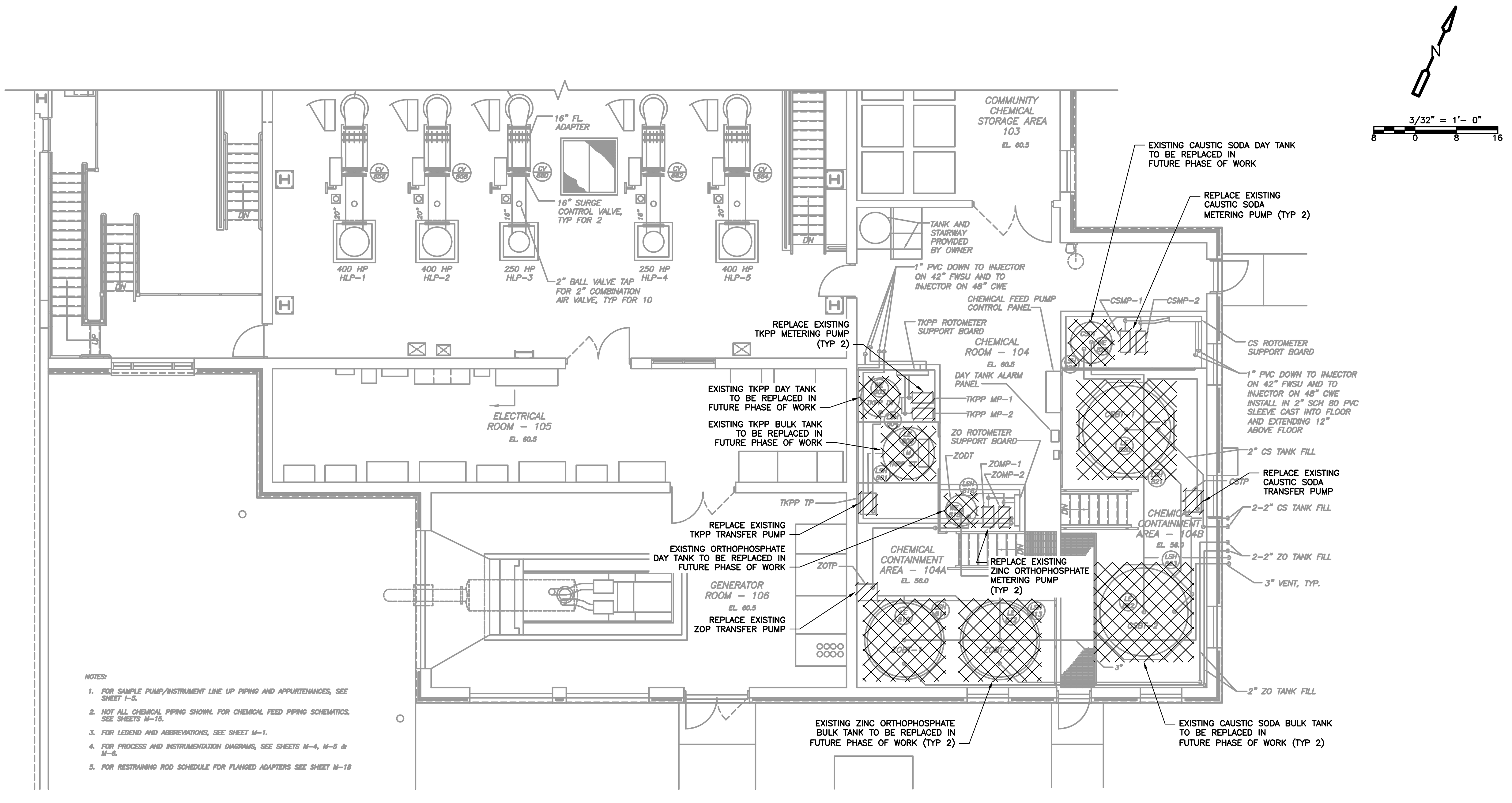
1. NOT ALL PIPING, FITTINGS, APPURTENANCES ARE SHOWN ON THIS PLAN. SEE CHEMICAL FEED SCHEMATIC FOR DETAILS ON THE CHEMICAL FEED SYSTEMS.
2. SEE STRUCTURAL DRAWINGS FOR MODIFICATIONS TO CONTAINMENT AREAS.
3. SEE ELECTRICAL DRAWINGS FOR NUMBER AND LOCATION OF INSTRUMENTS ON THE TANKS.
4. RESUME EXISTING VENT AND FILL PIPING WHERE POSSIBLE.
5. CONNECT SAMPLE LINES TO EXISTING LINES TO LAB AT END OF TRENCH.

LEGEND:

▨ TO BE DEMOLISHED
▩ TO BE REPLACED IN FUTURE PHASE OF WORK

CDM
Smith

FIGURE 5-4
EXISTING CHEMICAL FEED AREA DEMOLITION PLAN PART 1
MARCH 2023



NOTES:

1. FOR SAMPLE PUMP/INSTRUMENT LINE UP PIPING AND APPURTENANCES, SEE SHEET I-5.
2. NOT ALL CHEMICAL PIPING SHOWN. FOR CHEMICAL FEED PIPING SCHEMATICS, SEE SHEETS M-15.
3. FOR LEGEND AND ABBREVIATIONS, SEE SHEET M-1.
4. FOR PROCESS AND INSTRUMENTATION DIAGRAMS, SEE SHEETS M-4, M-5 & M-6.
5. FOR RESTRAINING ROD SCHEDULE FOR FLANGED ADAPTERS SEE SHEET M-18

PLAN
3/32" = 1'-0"

LEGEND:

▨ TO BE DEMOLISHED
▩ TO BE REPLACED IN FUTURE PHASE OF WORK

CDM Smith

FIGURE 5-5
EXISTING CHEMICAL AREA DEMOLITION PLAN PART 2
MARCH 2023

5.4 Opinion of Probable Project Costs

Table 4-1 and **Table 4-2** present CDM Smith's Opinions of Probable Project Cost (OPCC) for near-term and longer-term improvements, on the implementation timeline described in Section 4.3 assuming the October 2022 design approach. **Table 5-1** presents CDM Smith's OPCC assuming the revised March 2023 design approach for the chemical building addition. The OPCC presented as **Table 4-2** and **5-2** for longer-term improvements remains unchanged. **Table 5-3** offers a comparison between the two OPCCs for near-term improvements. The construction contingency used in these tables is based on a Class 4 estimate per the recommendations of the American Association of Cost Estimators (AACE) for projects at this level of design. AACE recommends the construction contingency be lessened as the design is further developed.

Table 5-1 Opinion of Probable Project Cost for Near-Term Improvements

Cost Element	Cost
Furnish and Install All Work	$5,300,000
General Contractor Overhead & Profit, Taxes, Insurance and Permits	$2,200,000
Subtotal March 2023 Dollars, ENR 20-City Index = 13,176	$7,500,000
Construction Contingency (30%)	$2,200,000
Subtotal	$9,700,000
Escalation to August 2024 midpoint of construction at 7%/year	$1,200,000
Opinion of Probable Construction Cost	$10,900,000
Engineering and Implementation Allowance (25%)	$2,700,000
Opinion of Probable Project Cost (rounded)	$13,600,000

Table 5-2 Opinion of Probable Project Cost for Longer-Term Improvements (Identical to Table 4-2)

Cost Element	Cost
Furnish and Install All Work	$800,000
General Contractor Overhead & Profit, Taxes, Insurance and Permits	$350,000
Subtotal October 2022 Dollars, ENR 20-City Index = 13,175	$1,150,000
Construction Contingency (30%)	$350,000
Subtotal	$1,500,000
Escalation to August 2032 midpoint of construction at 7%/year	$950,000
Opinion of Probable Construction Cost	$2,450,000
Engineering and Implementation Allowance (25%)	$600,000
Opinion of Probable Project Cost (rounded)	$3,000,000

Table 5-3 Opinion of Probable Project Cost Comparison for Near-Term Improvements

Cost Element	Cost October 2022 *Detached Building*	Cost March 2023 *New Building Addition Abutting Existing WTP*
Furnish and Install All Work	$5,000,000	$5,300,000
General Contractor Overhead & Profit, Taxes, Insurance and Permits	$2,100,000	$2,200,000
Subtotal	$7,100,000	$7,500,000
Construction Contingency (30%)	$2,100,000	$2,200,000
Subtotal	$9,200,000	$9,700,000
Escalation to August 2024 midpoint of construction at 7%/year	$1,200,000	$1,200,000
Opinion of Probable Construction Cost	$10,400,000	$10,900,000
Engineering and Implementation Allowance (25%)	$2,600,000	$2,700,000
Opinion of Probable Project Cost (rounded)	$13,000,000	$13,600,000

5.5 Considerations for Final Design

Several aspects of the work need to be investigated in the early portion of the final design phase. These topics have the potential to add cost or otherwise add complexity to the project.

- Updated surveys to be performed and completed by spring 2023 and will confirm the existing conditions and will be used in the site civil design during the final design phase.
- A geotechnical investigation of the site including new borings with consideration of the October 2022 proposed building location was conducted. The geotechnical memorandum is included in this report as **Appendix B** and was written with a focus on the original building location in October 2022, across the driveway from the existing WTP. If the new chemical building is ultimately designed and built adjacent to and abutting the existing building, the geotechnical memorandum should be updated for inclusion in the final design documents, but the recommendations would not significantly change. The current version of the geotechnical memorandum should be sufficient for civil and structural preliminary design purposes.
- The conceptual design does not include a bathroom or shower and assumes any floor drains of the new chemical building will be discharged in the same manner as the existing plant, and therefore, no provision of a holding tank or “Tight Tank” is necessary. These items can be investigated early in the final design phase.
- The early final design phase will investigate the impact of the added impervious area from the new chemical building and adequacy of the existing stormwater management systems. The conceptual design and OPCC did not include any new work associated with upgrading the existing stormwater system.
- Maintenance of plant operation during the construction and startup will be planned carefully in the final design. The design of the new chemical systems will ensure that their installation will minimize the existing chemical system shutdown and that the existing chemical systems can operate normally until the new chemical systems can be online continuously.

Section 6

Finalized Conceptual Design of Chemical System Upgrades – September 2023

This Section 6 presents the finalized conceptual design of the chemical system upgrades based on the discussion and decisions that took place during an August 1, 2023 meeting between CDM Smith and PWW. PWW sought approaches that optimize the existing facilities and reduce the footprint of the new chemical storage. This Section 6 presents the results of this assessment, which includes a review of additional design items considered, updated basis of design criterion, an adjusted floor plan with a reduced building footprint, and updated opinions of probable project cost.

6.1 Assessment of Additional Design Items

With the objective of optimizing the footprints of the existing WTP as well as the new chemical building, the following design considerations were discussed and investigated.

Sodium hypochlorite:

- The alternative of reusing the existing space for the sodium hypochlorite systems was revisited. However, the deficiencies related to the existing bulk storage remain. Due to the restrictions in the existing room, the tanks, which will be required eventually due to the corrosive nature of sodium hypochlorite, cannot be replaced in a manner that allows continuous plant operation. The bulk storage tanks are too small to receive a full chemical truck load individually, which adds unnecessary operational complexities.

  The Ten States Standards require at least 30 days of chemical supply in bulk tanks. CDM Smith recommends 30 days of chemical supply at average plant flow and average chemical dosage and 14 days of bulk storage at maximum plant flow and maximum chemical dosage. As calculated in Section 2.5.2, the existing bulk storage volume offers the minimum threshold of 30 days of chemical supply at the average condition and only 7 days at the maximum condition, which is not protective of the chemical supply chain concerns discussed in Section 2.4.

  The existing room that houses the day tanks and metering pumps allows for replacement of the equipment. The existing day tanks have sufficient storage capacity and while the metering pumps may require upsizing, the existing room is sufficiently sized. Therefore, the existing room with sodium hypochlorite day tanks and metering pumps is recommended for continued use.

  Considering the critical role that sodium hypochlorite plays in disinfection of the finished water and continuous plant operation and infeasibility of reusing the existing space for the bulk storage, the design approach will continue with the new building to house a new sodium hypochlorite system with bulk storage tanks and transfer pumps to transfer from the new bulk storage tanks to the day tanks located in the existing plant.

Ferric chloride:

- *Design approach*: PWW recommended an update to the design approach that the ferric chloride upgrade serves to supplement the existing ferric chloride system rather than replace it entirely. This includes continuing to utilize the existing space for bulk tanks, day tanks, and metering pumps. The new ferric chloride system will supplement the crucial gap in the bulk storage volume by providing additional bulk storage and transfer pumps in the new building to transfer from the new bulk storage tank to the existing chemical system. Keeping the day tanks and metering pumps in the current locations also eliminate the concerns associated with the increased travel time with chemical dosing from the new building. As described in Section 2, the existing day tanks and metering pumps may require upsizing to allow for the anticipated average and maximum conditions, and the existing room is sufficiently sized to allow that.

- *Outdoor installation and operation of the new chemical system*: The potential alternative of locating and operating the new bulk storage tank and transfer pumps outside without a building enclosure to decrease the overall construction cost was investigated. This concept would require a double walled bulk tank for chemical containment as well as heat tracing of the tank, and insulation required to protect various components of the new chemical system if operated throughout the year.

  CDM Smith strongly recommends against this concept as it is inconsistent with the standard drinking water industry practice in northern New England. CDM Smith is unaware of any outdoor chemical bulk storage systems for drinking water treatment application in New England, due to the local climate and associated operation and maintenance challenges. The outdoor installation and operation approach leaves the chemical, storage tank, transfer pumps, and associated electrical controls vulnerable to natural and manmade threats, such as extreme weather events, vandalism, and malicious acts that may endanger both plant operation and water quality. Also, while the tanks can be double walled for chemical containment of bulk storage, containment wall will be required for transfer pumps and chemical piping regardless, which poses maintenance challenges in rain events. Finally, the new building is required for the new sodium hypochlorite chemical system nonetheless, and therefore, installing an indoor ferric chloride system represents adding one additional room to the new building.

  In addition, interviewing a major local chemical tank manufacturer, PolyProcessing, confirmed that outdoor chemical bulk storage is an uncommon practice for drinking water systems. The two outdoor chemical storage tank installations that they are aware of are both for wastewater treatment plants.

  After discussions of these considerations with PWW, the design approach will continue with the new ferric chloride chemical system housed indoor in the new building.

- *Potential Coagulant Dose Decrease from Polymer Usage*: PWW initiated an evaluation to identify a polymer product that may lead to reduction in ferric chloride usage. However, CDM Smith recommends continuing the design of the new ferric chloride system without the use of the polymer. This will ensure the plant will be equipped to treat water sufficiently regardless of the polymer performance and fluctuations on availability or cost since each polymer product is proprietary.

6.2 Finalized Basis of Design Criteria for the New Chemical Systems

Updated basis of design for the new chemical systems for ferric chloride and sodium hypochlorite that reflect the design decisions discussed in Section 6.1 are presented in this section.

6.2.1 Ferric Chloride

Updated preliminary design criteria for the ferric chloride system to be housed in the new chemical building are presented on **Table 6-1**. The design incorporates the 19,800 gallons of bulk chemical storage offered by the existing tanks and supplements it with a new 15,000 gallon tank to meet the 30-day requirement at the average condition and provide 14 days of storage at the maximum condition. As presented in Section 2.3.2, the anticipated doses were projected for 2042 following the linear trend observed over an approximate 10-year duration. If the dose in the future increases more substantially than assumed, and greater than 14 days of bulk storage is needed in the future, the new ferric chloride room is sized to house one more 15,000 gallon bulk tank. New transfer pumps will be sized to fill a day tank in three minutes.

Table 6-1 Finalized Preliminary Design Criteria for Ferric Chloride

Process Unit	Design Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8	15	32
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Ferric Chloride				
Bulk Storage Tanks	Dose Range, mg/L as $FeCl_3$	22	53	60
	Dose Range, mg/L as Product	39	94	106
	Usage, lb/day as Product	2,603	11,756	28,391
	Bulk Density, lb/gal	11.8	11.8	11.8
	Concentration as $FeCl_3$		40%	
	Usage, gph (as Product)	9.2	41.6	100.5
	Usage, gpd (as Product)	221	999	2,413
	Truck Delivery Volume, gal		4,000	
	(Existing) Storage Capacity per Tank, gal		6,600	
	(Existing) Number of Tanks		3	
	(Existing) Total Storage, gal		19,800	
	(New) Storage Capacity per Tank, gal		15,000	
	(New) Number of Tanks		1	
	(New) Total Storage, gal		15,000	
	(Existing + New) Total Storage, gal		34,800	
	Days of Storage, days	157	35	14

6.2.2 Sodium Hypochlorite

Updated preliminary design criteria for the sodium hypochlorite system for the bulk tank storage have remained the same from the revised Final Report issues in May 2023 and are re-presented in **Table 6-2**. The design includes three bulk storage tanks with a storage capacity of 6,000 gallons per tank, which exceeds the maximum chemical delivery truck volume. Both chemical rooms will have provisions for removal of the tanks and installation of new tanks in the future. New transfer pumps will be sized to fill a day tank in three minutes.

Table 6-2 Finalized Preliminary Design Criteria for Sodium Hypochlorite

Process Unit	Design Criteria	Minimum	Average	Maximum
	Nominal Plant Capacity, mgd	8.0	15.0	32.0
	Nominal Plant Capacity, gpm	5,556	10,417	22,222
	Nominal Plant Capacity, ft^3/sec	12.4	23.2	49.5
Sodium Hypochlorite				
Bulk Storage Tanks	Dose Range, mg/L as Cl_2	1.0	2.5	5.0
	Usage, lb/day as Cl_2	67	313	1,334
	Bulk Density, lb/gal		10	
	Concentration as Cl_2		10%	
	Chlorine equivalent, lb Cl_2 per gallon		0.8	
	Usage, gph (as Product)	2.7	12.5	53.3
	Usage, gpd (as Product)	64	300	1,280
	Truck Delivery Volume, gal		5,000	
	Storage Capacity per Tank, gal		6,000	
	Days of Storage per Tank, days	94	20	5
	Number of Tanks		3	
	Total Storage, gal		18,000	
	Days of Storage, days	281[1]	60[1]	14

[1] CDM Smith recommends PWW manage chemical inventory such that the potential for degradation is minimized.

6.3 New Chemical Storage Building

The new building will store the new equipment for the ferric chloride and sodium hypochlorite systems. Section 5 compared the two locations for a new building – 1) standalone building as presented in **Figure 4-3** and 2) building addition abutting the existing WTP as presented in **Figure 5-3**. Comparison of the opinion of probable project costs (**Table 5-3**) indicated a lower project cost for the standalone building option, mostly due to the relocations of the transmission piping, utilities, and roadway and the complexities of connecting to the existing plant. Therefore, the new chemical systems will be constructed in their own building detached from the existing WTP. However, the footprint of the new building has been reduced substantially due to the updates to the ferric chloride chemical system from continued use of the existing ferric chloride space and reduction of the new bulk tanks.

Figures 6-1, 6-2, and **6-3** depict plan view, isometric, and site location views for a new ferric chloride and sodium hypochlorite storage building. Key features of the design concept include:

- One 15,000 gallon ferric chloride storage tanks, supplementing substantial bulk storage capacity to the existing 19,800 gallons of storage in the existing building.

- Three 6,000 gallon sodium hypochlorite bulk storage tanks, or 18,000 gallons of total storage, representing a 2-fold increase from the existing 9,000 gallons of storage in the existing building.
- With an elevated finished floor mimicking the existing building's loading dock provisions, the building features a depressed secondary containment with concrete stairs provided to allow access into and egress out of the 42-inch depressed containment areas.
- Transfer pumps are located local to the new bulk storage tanks to allow day tank filling in the existing WTP.
- The new building will include spill sumps, and emergency shower / eye wash units, which are not shown in the conceptual drawings herein.
- The site plan shows that the proposed location where the new building will be placed, with utility pole and power line relocation required.
- The building will have provisions for removal of tanks and installation of new tanks in the future. These provisions should allow Pennichuck to perform such activities without destructive actions to open the building walls or roof to enable tank removal and installation. CDM Smith has provided translucent panels and "storefront glass" in recent chemical system designs. These approaches provide natural light, and functionality in the form of a removable wall system.
- As described in Section 4, CDM Smith and Pennichuck Water Works had discussed the concept of an elevated walkway connecting the second floor of the existing WTP with the new ferric chloride and sodium hypochlorite bulk storage building. The walkway was removed from the finalized conceptual design as a cost-saving measure, and a utility chase is included for piping for chemicals and plant water to cross over the existing driveway.

PLAN
3/16" = 1'-0"

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. LEDOUX
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PENNICHUCK WATER WORKS

NASHUA WATER TREATMENT PLANT
CHEMICAL SYSTEMS UPGRADE

NEW CHEMICAL BUILDING
PLAN

PROJECT NO. 0246-275436
FILE NAME: FIGURE 6-1.DWG
SHEET NO.
FIGURE 6-1

30% SUBMITTAL - NOT FOR CONSTRUCTION

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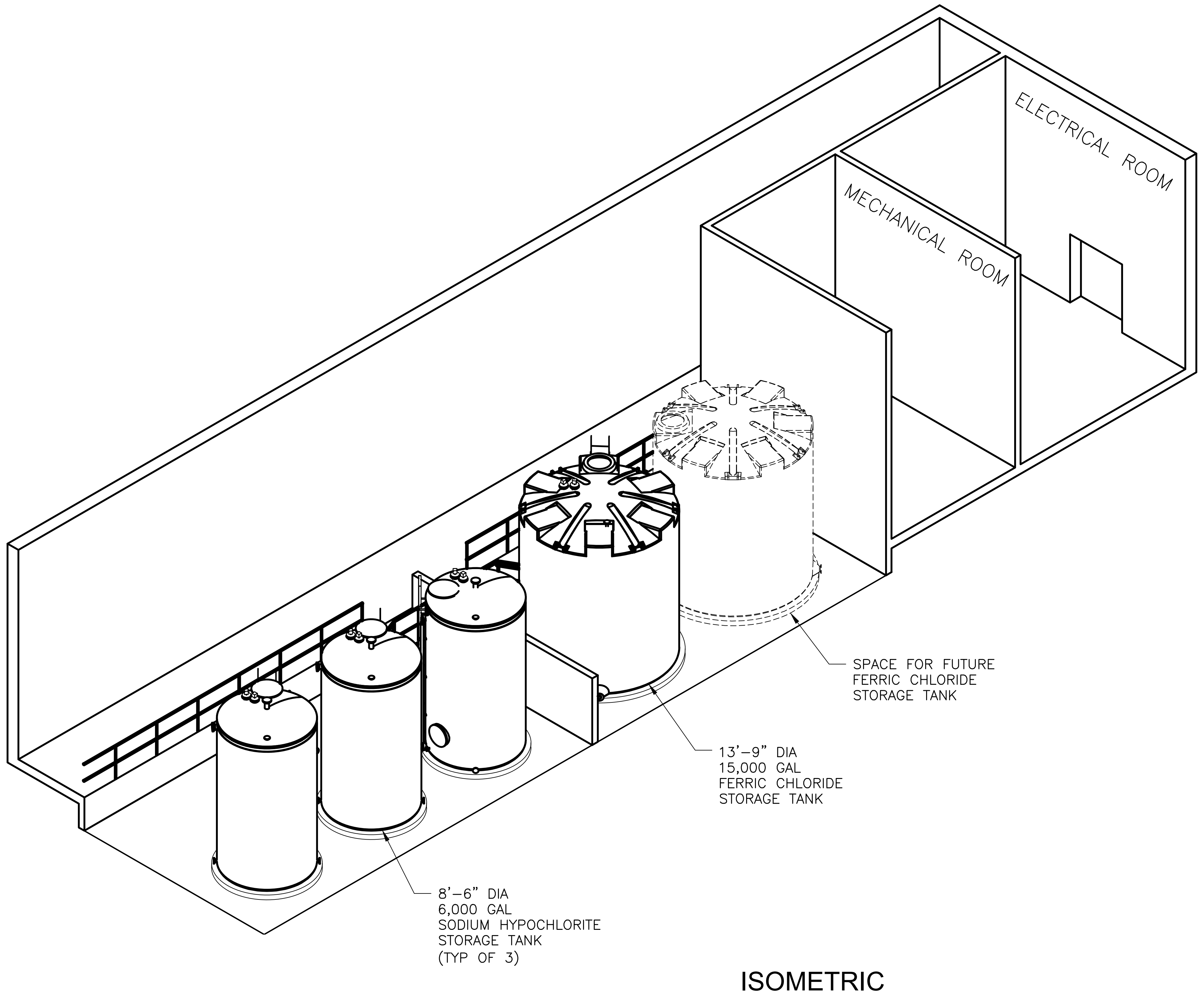
C:\Users\vigneshr\AppData\Local\Autodesk\AutoCAD Plant 3D\CollaborationCache\0246_275436\Orthos\DWGs\FIGURE 6-1.dwg



ISOMETRIC
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APPROVED BY: A. LEBLANC
DATE: SEPTEMBER 2023

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PENNICHUCK WATER WORKS

NASHUA WATER TREATMENT PLANT
CHEMICAL SYSTEMS UPGRADE

NEW CHEMICAL BUILDING
ISOMETRIC

PROJECT NO. 0246-275436
FILE NAME: FIGURE 6-2.DWG
SHEET NO.
FIGURE 6-2

30% SUBMITTAL - NOT FOR CONSTRUCTION

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FIGURE 6-3. PENNICHUCK WATER
CONCEPTUAL SITE PLAN
SEPTEMBER 9, 2023

6.4 Improvements in the Existing Building

Figure 6-4 and **Figure 6-5** show the proposed work associated with the existing chemical systems, including:

- Replacement and likely upsizing of the existing ferric chloride day tanks, transfer pumps, and metering pumps
- Replacement of the existing sodium hypochlorite day tanks and replacement and upsizing of the existing sodium hypochlorite metering pumps
- Replacement of the metering pumps and transfer pumps for pre- and post-caustic soda, sodium permanganate, zinc orthophosphate, and TKPP. Replacement of metering pumps for polymer.
- Replacement of bulk storage tanks and day tanks for pre- and post-caustic soda, sodium permanganate, zinc orthophosphate, and TKPP will occur in a future phase of this work. These longer-term improvements also consider the replacement of the ferric chloride bulk storage tanks.

The findings and recommendations identified for the existing ferric chloride and sodium hypochlorite rooms will be reviewed and incorporated in the design of the new replacement bulk storage and transfer pump systems. Therefore, many deficiencies identified in those two existing rooms will be addressed as part of that process. The remaining deficiencies in the other existing chemical rooms and areas should be reviewed and corrected as soon as possible.

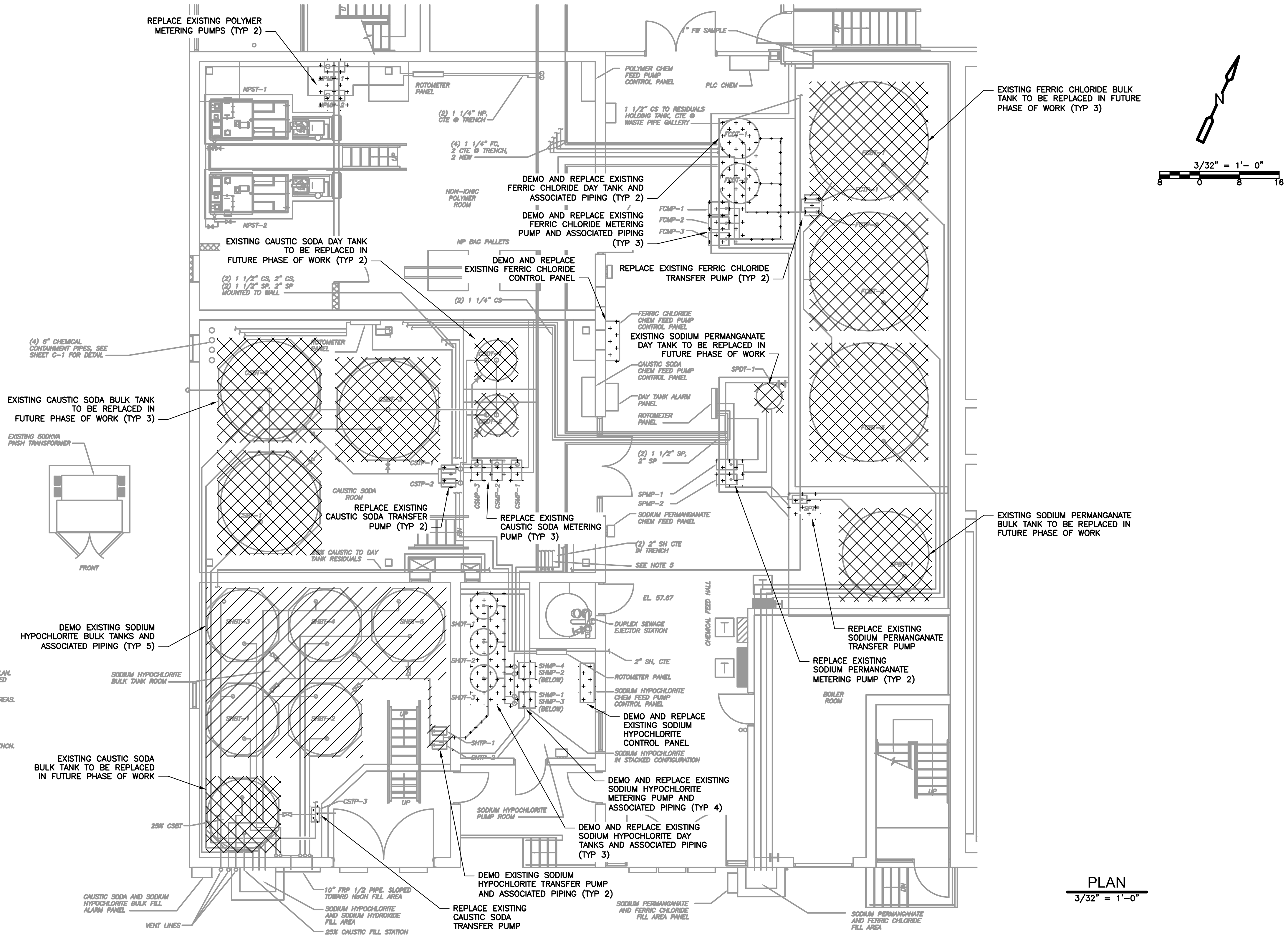
6.5 Implementation Schedule

The most pressing need identified in this study is to remedy the shortfall in ferric chloride coagulant bulk storage, followed by the need for additional sodium hypochlorite bulk storage on site.

Secondarily, within all chemical storage and feed systems, the electrical, instrumentation and control, HVAC, and mechanical components throughout are reaching the end of their useful service life. Other needs identified in the condition assessment require near-term action. Customarily the service life for these components is on the order of 20 years, though within the inherently corrosive environment typical of chemical storage areas, these 2007-vintage items (16 years old as of 2023) are recommended for replacement as soon as possible.

The above categories are recommended for implementation in the near-term, with ferric chloride bulk storage augmentation being necessary as soon as possible. **Figure 4-6** shows the design, permitting, bidding, construction, and startup of all of the above-noted work in the near-term assuming a design-phase start date of October 1, 2023.

Finally, beyond sodium hypochlorite bulk and storage tanks, the other chemical systems' tanks are not exhibiting visual signs of failure as of 2022. As a service life for tanks containing relatively non-aggressive chemicals of 25 years is possible, CDM Smith notes that replacement of these remaining bulk and day tanks should be planned for approximately 2033, unless condition assessments before that date warrant more rapid action.



NOTES:

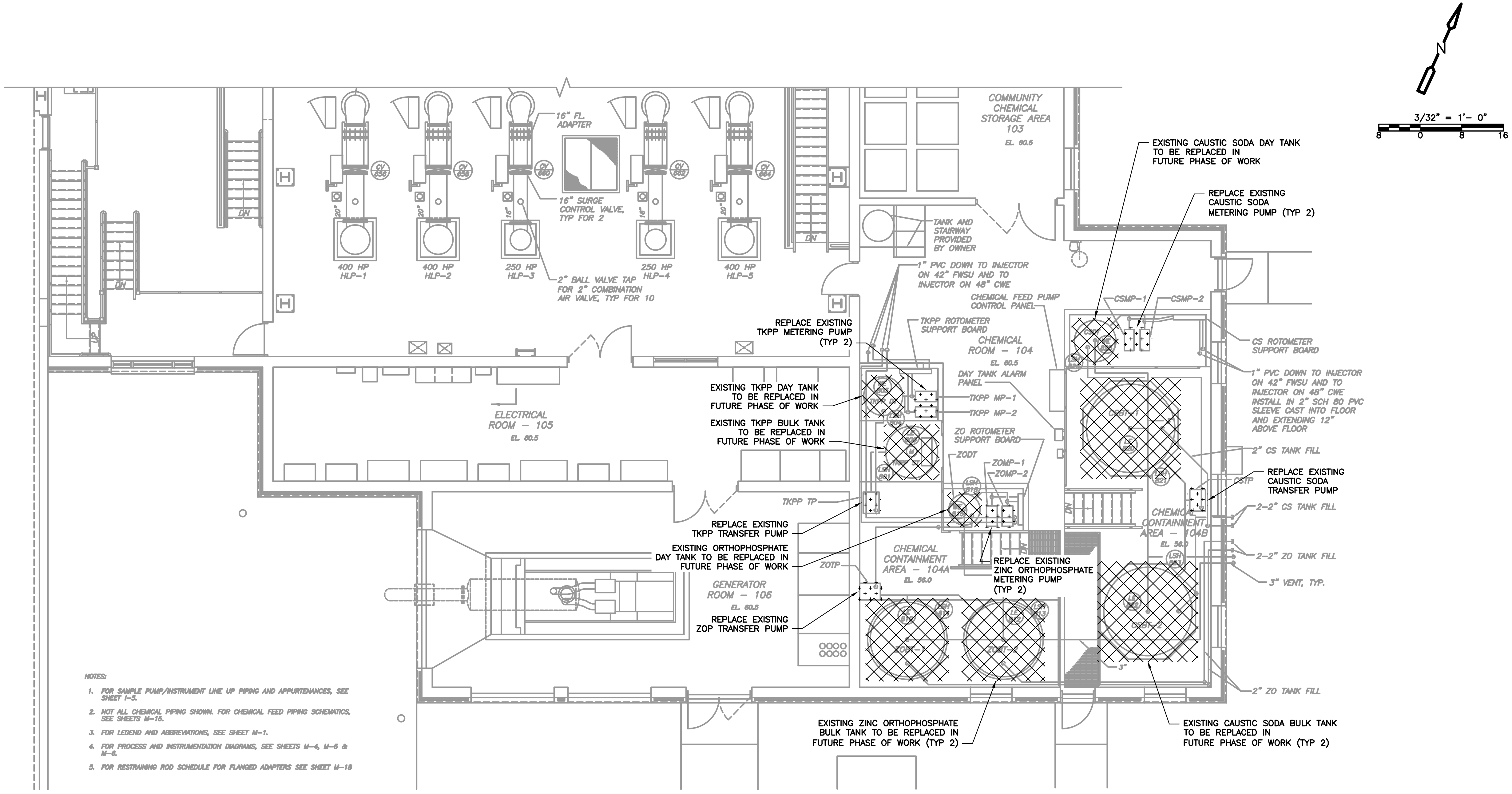
1. NOT ALL PIPING, FITTINGS, APPURTENANCES ARE SHOWN ON THIS PLAN. SEE CHEMICAL FEED SCHEMATIC FOR DETAILS ON THE CHEMICAL FEED SYSTEMS.
2. SEE STRUCTURAL DRAWINGS FOR MODIFICATIONS TO CONTAINMENT AREAS.
3. SEE ELECTRICAL DRAWINGS FOR NUMBER AND LOCATION OF INSTRUMENTS ON THE TANKS.
4. RESUME EXISTING VENT AND FILL PIPING WHERE POSSIBLE.
5. CONNECT SAMPLE LINES TO EXISTING LINES TO LAB AT END OF TRENCH.

LEGEND:

▨ TO BE DEMOLISHED
▩ TO BE REPLACED IN FUTURE PHASE OF WORK
⛶ TO BE DEMOLISHED AND REPLCED

CDM Smith

FIGURE 6-4
EXISTING CHEMICAL FEED AREA DEMOLITION PLAN PART 1
SEPTEMBER 2023



NOTES:

1. FOR SAMPLE PUMP/INSTRUMENT LINE UP PIPING AND APPURTENANCES, SEE SHEET I-5.
2. NOT ALL CHEMICAL PIPING SHOWN. FOR CHEMICAL FEED PIPING SCHEMATICS, SEE SHEETS M-15.
3. FOR LEGEND AND ABBREVIATIONS, SEE SHEET M-1.
4. FOR PROCESS AND INSTRUMENTATION DIAGRAMS, SEE SHEETS M-4, M-5 & M-6.
5. FOR RESTRAINING ROD SCHEDULE FOR FLANGED ADAPTERS SEE SHEET M-18

PLAN
3/32" = 1'-0"

LEGEND:

- ▨ TO BE DEMOLISHED
- ▦ TO BE REPLACED IN FUTURE PHASE OF WORK
- ⁘ TO BE DEMOLISHED AND REPLCED

CDM Smith

FIGURE 6-5
EXISTING CHEMICAL AREA DEMOLITION PLAN PART 2
SEPTEMBER 2023

6.6 Opinion of Probable Project Costs

Table 4-1 and **Table 4-2** present CDM Smith's Opinions of Probable Project Cost (OPCC) for near-term and longer-term improvements, on the implementation timeline described in Section 4.3 assuming the October 2022 design approach. **Table 5-1** and **Table 5-2** (identical to Table 4-2) presents CDM Smith's OPCCs assuming the revised March 2023 design approach for the chemical building described in Section 5. **Table 5-3** offers a comparison between the two OPCCs for near-term improvements between the October 2022 and March 2023 design approaches, which considered relocating the new building to abut the existing WTP. Based on discussions from the August 1, 2023 workshop, PWW advised CDM Smith to proceed with modifying the design approach to consider a standalone structure with a reduced footprint, as compared to the October 2022 approach which considered a standalone structure with a larger footprint. **Table 6-1** and **Table 6-2** present CDM Smith's OPCC for near-term and longer-term improvements, described in Section 6 assuming the September 2023 design approach. **Table 6-3** and **Table 6-4** offer a comparison between the two OPCCs (October 2022 and September 2023 approaches) for near-term and longer-term improvements, respectively. The intent of this comparison is to outline the potential cost savings associated with the reuse of the existing ferric chloride chemical area and subsequent reduction in the overall new building footprint. The construction contingency used in these tables is based on a Class 4 estimate per the recommendations of the American Association of Cost Estimators (AACE) for projects at this level of design. AACE recommends the construction contingency be lessened as the design is further developed.

Table 6-1 Opinion of Probable Project Cost for Near-Term Improvements

Cost Element	Cost
Furnish and Install All Work	$4,000,000
General Contractor Overhead & Profit, Taxes, Insurance and Permits	$1,700,000
Subtotal September 2023 Dollars, ENR 20-City Index = 13,486	$5,700,000
Construction Contingency (30%)	$1,700,000
Subtotal	$7,400,000
Escalation to September 2025 midpoint of construction at 7%/year	$1,100,000
Opinion of Probable Construction Cost	$8,500,000
Engineering and Implementation Allowance	$2,600,000
Opinion of Probable Project Cost (rounded)	$11,100,000

Table 6-2 Opinion of Probable Project Cost for Longer-Term Improvements

Cost Element	Cost
Furnish and Install All Work	$1,000,000
General Contractor Overhead & Profit, Taxes, Insurance and Permits	$450,000
Subtotal September 2023 Dollars, ENR 20-City Index = 13,486	$1,450,000
Construction Contingency (30%)	$430,000
Subtotal	$1,900,000
Escalation to September 2033 midpoint of construction at 5%/year	$1,200,000
Opinion of Probable Construction Cost	$3,100,000

Cost Element	Cost
Engineering and Implementation Allowance (25%)	$800,000
Opinion of Probable Project Cost (rounded)	$3,900,000

Table 6-3 Opinion of Probable Project Cost Comparison for Near-Term Improvements

Cost Element	Cost October 2022[1] *Detached Building*	Cost September 2023 *Detached Building with Reduced Footprint*
Furnish and Install All Work	$4,800,000	$4,000,000
General Contractor Overhead & Profit, Taxes, Insurance and Permits	$2,000,000	$1,700,000
Subtotal	$6,800,000	$5,700,000
Construction Contingency (30%)	$2,000,000	$1,700,000
Subtotal	$8,800,000	$7,400,000
Escalation to September 2025 midpoint of construction at 7%/year	$1,300,000	$1,100,000
Opinion of Probable Construction Cost	$10,000,000	$8,500,000
Engineering and Implementation Allowance	$2,600,000	$2,600,000
Opinion of Probable Project Cost (rounded)	$12,600,000	$11,100,000

Table 6-4 Opinion of Probable Project Cost Comparison for Longer-Term Improvements

Cost Element	Cost October 2022[1] *Detached Building*	Cost September 2023 *Detached Building with Reduced Footprint*
Furnish and Install All Work	$800,000	$1,000,000
General Contractor Overhead & Profit, Taxes, Insurance and Permits	$400,000	$500,000
Subtotal	$1,200,000	$1,500,000
Construction Contingency (30%)	$350,000	$450,000
Subtotal	$1,600,000	$1,900,000
Escalation to September 2033 midpoint of construction at 5%/year	$950,000	$1,200,000
Opinion of Probable Construction Cost	$2,400,000	$3,100,000
Engineering and Implementation Allowance (25%)	$600,000	$800,000
Opinion of Probable Project Cost (rounded)	$3,000,000	$3,900,000

[1]The costs displayed for the October 2022 design approach were brought into September 2023 dollars to offer a more representative comparison.

6.5 Considerations for Final Design

Several aspects of the work need to be investigated in the early portion of the final design phase. These topics have the potential to add cost or otherwise add complexity to the project.

- Updated surveys completed in spring 2023 are reflected in the updated site civil design during.
- The geotechnical memorandum is included in this report as **Appendix B** and was written with a focus on the finalized building location. Therefore, the current version of the geotechnical memorandum is sufficient for civil and structural final design purposes.

- Reusing the existing day tanks represents that the transfer pumps filling the day tanks will be not located next to the day tanks as the existing chemical systems are currently set up. CDM Smith will work with PWW to determine the optimal alternative to allow visual observations of the day tank filling while the transfer pumps are located in another building.

- The conceptual design does not include a bathroom or shower and assumes any floor drains of the new chemical building will be discharged in the same manner as the existing plant, and therefore, no provision of a holding tank or "Tight Tank" is necessary. These items can be investigated early in the final design phase.

- The early final design phase will investigate the impact of the added impervious area from the new chemical building and adequacy of the existing stormwater management systems. The conceptual design and OPCC did not include any new work associated with upgrading the existing stormwater system.

- Maintenance of plant operation during the construction and startup will be planned carefully in the final design. However, reusing the existing space for day tanks and metering pumps as well as ferric chloride bulk tanks will minimize the transition and startup of the new chemical systems.

Appendix A

Technical Memorandum - Task 2 Condition Assessments of the Existing Chemical System

Technical Memorandum

To: John Boisvert, P.E., Chris Countie, and Hannah Marshall - Pennichuck Water Works

From: Al LeBlanc, P.E., BCEE, Michaela Bogosh, P.E., PMP, Ji Im, P.E., and Maddie Ledoux, P.E.

Date: March 29, 2023

Subject: Nashua Water Treatment Plant Chemical Feed and Storage Facilities Upgrades
Task 2 Condition Assessments of the Existing Chemical Systems

As part of the chemical feed and storage facilities upgrade project at the Nashua Water Treatment Plant (WTP) owned and operated by Pennichuck Water Works (PWW), a condition assessment was performed by the CDM Smith team to assess the condition of the existing chemical systems and key ancillary systems. The summary of this field assessment is presented in this memorandum.

Pre-Site Visit Meeting Notes with PWW Staff:

Ferric Chloride

- Chemical delivered 3x/week in the summer (48,000 gallons/month)
- Chemical delivered 1-2x/week in the winter (16,000-32,000 gallons/month)
- 3 bulk tanks (6,600 gallons) and 2 day tanks (475 gallons) = 19,800 gallons of total storage

Caustic Soda

- Chemical delivered 1-2x/week (16,000-32,000 gallons/month)
- 3 bulk tanks (4,550 gallons) and 2 day tanks (475 gallons) = 13,650 gallons total storage

Chlorine

- Chemical delivered every 2 weeks (8,000 gallons/month)
- 5 bulk tanks (2,000 gallons) and 3 day tanks (230 gallons)
- Normal delivery volume is 4,000 gallons
- Don’t experience any degradation of the chlorine

General Comments

- All chemical equipment was replaced approximately 12-13 years ago
- All eye washes have tepid water and have alarms connected.

Sodium Hypo Bulk Tank Storage Room (and 25% Caustic) Storage

- Transfer pumps are located on the floor and therefore are susceptible to flooding
- Does PWW like the # of bulk tanks: Chris would like to have fewer larger tanks in new space
- During chemical deliveries, PWW struggles to equalize the tanks which causes a more operator-intensive operation
- The bulk hypo tanks overflow at 1,800 gallons, "full" capacity at 2,000 gallons. This is the same for the caustic bulk tank.
- PWW would benefit from having an improved process for filling the day tanks from the bulk storage tanks
- There are not any volume stamps on tanks
- There are not any mineral oil pales present on bulk tank overflows
- SS flanges on bulk tanks, susceptible to corrosion?
- There is concrete floor deterioration and corrosion present
- Inadequate sump pump size and sloping to the sump
- Fire sprinklers are present
- Pipeline labeling was good but need to be consistent for caustic labels. All pipelines in this area should be 25%
- Tank and pump tags are present
- There is no ventilation – not conducive for necessary air exchanges
- Generally, the instruments are inaccessible
- Heater is present
- The space is very tight, cannot access the back of tanks or the area around them. Access to the center flange connections on the top is also not easily available.
- Tanks all drain to one another

- Secondary containment not used when filling carboys for use at remote sites. This process could be improved.
- 8" tread on bulk tank storage cross over ladder, is this to code?
- There is corrosion on overhead drain pipelines in the front and back of room
- Storing different chemicals in the same containment area is not best practice
- Containment wall is 3'-4.5" high (I have 40.5" written)
- Eyewash station is not depicted in as-built but is present inside the bulk storage area
- There is not a way to drain the bulk tanks
- The access steps in and out of the containment area are steep. May be a hazard if carrying tools and equipment.

Sodium Hypo Day Tank Room

- Day tanks are not located in same room as bulk tanks, which is not ideal
- Metal tank stands are deteriorating – material compatibility issue with hypo.
- Inadequate sump size
- There is no indication of tank capacity
- Corrosion on pipelines
- Fire sprinklers are present
- Labels on tanks are present
- Overflow on day tanks is needed
- The concrete floors need to be recoated
- There is no ventilation
- Metering pumps should be facing into secondary containment in the event they break or leak
- Chlorine carboys were located inside secondary containment
- Containment wall is 1'-6" high
- The loading dock handrail outside the hypo day tank room is 3'

- There is corrosion on the drain plumbing

Caustic Storage Room

- Inadequate sump size
- Overflow buckets are present
- There is crystallization at a connection on bulk tank No. 2
- Transfer pump is located on the floor and therefore susceptible to flooding
- Is there adequate secondary containment for day tank and bulk tank volume? Day tanks appear to drain into bulk tank secondary storage sump
- There is no eye wash down in the pit
- Fire sprinklers are present
- There is no ventilation
- What is push water?
- There are not any overflows on day tanks
- Generally, there was more room to move around compared to the sodium hypo bulk tank room
- Containment wall in bulk area is 3’ high

Sodium Permanganate Area

- There is surface corrosion on electrical panels and PLC panels
- Tags on tanks and pumps are present
- Vents on bulk tank are present
- Should likely be in its own room, there is a lot of corrosion present
- The bulk tank has never been used
- Transfer pump has been taken from the area
- Inadequate space around bulk tank
- Overflow buckets are present on bulk tank
- There is no indication of bulk tank size on tank

- Tank and pump tags are present
- Is there adequate secondary containment for day tank and bulk tank volume? Day tanks appear to drain into bulk tank secondary storage sump.
- Guardrails are needed from day tank to bulk tank area
- Ventilation appears to not be working
- Does permanganate attack carbon steel columns?
- There is no eye wash in pit
- Capacity is indicated on day tanks
- Vents on bulk tanks are present
- Containment wall in bulk area is 3’-8”
- Containment curb for day tank area is 1’-2”

Ferric Chloride Area

- Vents on bulk tanks are present
- Is there adequate secondary containment for day tank and bulk tank volume? Day tanks appear to drain into bulk tank secondary storage sump.
- Guardrails are needed from day tank to bulk tank area
- Tags on pumps and tanks are present
- Overflow buckets on bulk tanks are present but there appears to have been a spill in the past as evident by staining on the floor
- There is a sodium hydroxide line going through the ferric chloride bulk tank area, potential acid mixing with a base
- There is no overflow on day tanks
- There is no eye wash in the put
- Containment wall in bulk area is 4’-9”
- Containment curb for day tank area is 1’-2”

Polymer Room

- Good labeling on chemical lines
- Fire sprinklers are present
- Ventilation does not appear to be working
- Overflow buckets on tanks are present
- No eyewash/shower are present
- Containment curb for feed area is 1’-3.5”

Caustic Storage for Residuals

- There is a day tank for 25% caustic
- The capacity is indicated on tank
- There is not any secondary containment present
- There is a large hole in the floor below waste line which is a safety concern
- There is no eye wash/shower present
- Pipeline labeling is good
- No ventilation

Finished Chemical Room

- Eye wash/shower present but not in pits
- Pipeline labeling is good
- Capacity on Caustic, TKPP and Zinc Ortho bulk tangs are shown
- Disconnect for the transfer pump is below the height of the secondary containment wall and therefore susceptible to impacts from flooding
- Fire sprinklers are present
- Overflow buckets on bulk tanks are present
- There is no ventilation
- Vents on bulk tanks are present

- Tags on tanks and pump are present
- Expansion joint on bulk tanks is not in the correct location, tank warranty issue?
- Is there adequate secondary containment for day tank and bulk tank volume? Day tanks appear to drain into bulk tank secondary storage sump.
- Is TKPP compatible with zinc ortho?
- There is no indication of tank capacity on any day tanks
- There is not any secondary containment on blended ortho tank
- Overflow bucket on zinc ortho is present
- Caustic day tank handrail/toe board blocks overflow into bulk tank secondary containment
- Washdown station present, this should be added to other chemical storage areas
- TKPP is labeled incorrectly in as-builts as HXDT
- ZOP and caustic bulk containment walls are 4’-2” high

Follow-up meeting with PWW

- PWW likes Pulsafeeder pumps for larger chemical application, LMI is also good
- PWW has had issue with Poly Processing hypo storage tanks after 10-15 years of use. The flange is leaking. They’re interested in seeing what other storage options there are.
    - They previously had FRP tanks that lasted ~30 years

Appendix B

Technical Memorandum – Geotechnical Recommendations

CDM Smith

Memorandum

To: *Hannah Marshall, Pennichuck Water Works*

From: *Gavin Power, P.E.*
Ceira Dawson

Reviewed: *Douglas J. Aghjayan, P.E.*

Date: *January 27, 2023*

Subject: *Geotechnical Subsurface Explorations and Engineering Recommendations*
Pennichuck Water Works – Chemical Storage Building
Nashua, New Hampshire

Introduction

This memorandum presents the results of our subsurface explorations program and provides geotechnical engineering recommendations for the design and construction of the proposed Chemical Storage Building at the Pennichuck Water Works facility in Nashua, New Hampshire.

Elevations herein are in feet and referenced to the Nashua City Datum.

Purpose and Scope

The purpose of this study was to investigate the subsurface conditions at the location of the proposed structures and to provide geotechnical engineering recommendations for design and construction of the project.

We performed the following scope of work for this project:

- Conducted a subsurface exploration program consisting of three borings to evaluate subsurface conditions and obtain soil samples for laboratory testing.
- Conducted laboratory tests on select soil samples to assist with classifying and determining engineering properties.
- Developed geotechnical engineering recommendations for design and construction of the project.
- Prepared this memorandum.

Site and Project Descriptions

Site Description

The Pennichuck Water Works Water Treatment Plant (PWW WTP) is located at 200 Concord Street in Nashua, New Hampshire (**Figure 1**). The site is bounded to the west by Supply Pond, to the north by a wooded area and Pennichuck Brook, to the south residential homes, and to the east by Concord Street.

There is a gated entrance on Concord Street that provides access to the site. Major WTP structures at the site include the main WTP plant building and the snow station building. Numerous below-grade pipes that support WTP operations are located throughout much of the site.

The overall site topography generally slopes downward towards Supply Pond to the west side of the property. There is a steep slope leading up to tree line along the south side of the existing WTP building that ranges from about El. 87 at the top of the slope down to about El. 56 along the southern edge of the WTP building. Existing WTP site conditions are shown on **Figure 2**.

Project Description

The proposed Chemical Storage building will be a single level approximately 165-foot by 32-foot structure without basement. The building will be located along the south side of the existing main WTP and the footprint of the building will extend into existing steep slope. Due to the existing steep slope, the southern wall of the proposed building will be designed as a retaining wall. We have assumed that the ground floor of the proposed building will be at about existing exterior grade.

Subsurface Exploration Program

Borings

CDM Smith engaged New England Boring Contractors (NEBC) of Derry, New Hampshire to advance four borings (CDM-PWW-1, CDM-PWW-2, CDM-PWW-3, and CDM-PWW-4) at the site on December 14 and 15, 2022 (**Figure 1**). Borings CDM-PWW-2, CDM-PWW-3, and CDM-PWW-4 were offset from their original locations due to buried utilities . CDM-PWW-3 was ultimately removed from the program. A CDM Smith engineer was on site full time to coordinate the work, log the borings, and collect soil samples.

Prior to drilling, NEBC advanced each boring to a depth of approximately 6 feet below ground surface (ft bgs) by vacuum excavation to check for buried utilities. Following vacuum excavation, NEBC advanced the borings through soil using four-inch inside diameter flush-joint casing with drive-and-wash drilling techniques and through rock through rock using an NX-diameter core sampler.

Standard Penetration Tests (SPTs) with split-spoon sampling were conducted in accordance with ASTM D1586 on a continuous basis beginning at the bottom of the vacuum excavated borehole to a depth of 11 ft bgs (except for CDM-PWW-1 where bedrock was encountered at 7 ft bgs) and then at about 5-foot intervals thereafter to the top of rock. SPTs were conducted using a 2-inch outside-diameter sampler driven 24 inches by blows from a 140- pound safety hammer falling freely for 30-inches. The number of blows required to drive the sampler each 6-inch increment was recorded and the SPT N-value was determined as the sum of the blows required to drive the sampler from 6 to 18 inches of penetration, measured in blows per foot (bl/ft).

Rock coring was conducted in accordance with ASTM D2113 in borings CDM-PWW-2, and CDM-PWW-4. The core descriptions include rock type, penetration, percent recovery, Rock Quality Designation (RQD), orientation and frequency of the fractures, observed fracture in-filling or coatings, the weathering state of the core, and other characteristics of note. The RQD is expressed as a percentage and defined as the sum of the lengths of rock core pieces longer than four inches divided by the total length of the core run. The time to advance each foot of rock core was also recorded during the rock coring process.

A CDM Smith engineer visually classified the recovered soil samples using the modified Burmister classification system and collected soil samples and rock core for subsequent review and laboratory testing.

When possible, groundwater levels at the boring locations were estimated from the moisture condition of the samples obtained and by the observed water levels within the boreholes at the time of drilling. However, groundwater levels observed at the time of drilling may not represent stabilized levels because water is introduced into the boreholes during drilling.

The boreholes were backfilled with the soil cuttings upon completion. The as-drilled boring locations were located in the field by tape measurement to fixed landmarks. The approximate ground surface elevations at each boring location were estimated from existing plans.

The approximate boring locations are shown on **Figure 2**. The boring logs are contained in **Attachment A**.

Geotechnical Laboratory Tests

Geotechnical laboratory tests were performed on select soil samples obtained collected from the borings. Particle size analyses by mechanical sieving were performed on five samples in accordance with ASTM D6913. All tested samples were classified in accordance with the Unified Soil Classification System (USCS). The purpose of these tests was to assist with soil classification, assign soil parameters for engineering analyses, and to assess the reuse potential of the soils during construction.

Geotechnical laboratory test results are summarized in **Table 1**. The geotechnical laboratory test reports are contained in **Attachment B**.

Subsurface Conditions

The generalized descriptions of the major soil and rock layers encountered in the borings are described below, beginning at the ground surface and proceeding downward. The subsurface conditions are known only at the sampling locations and may vary significantly from the descriptions given below at other locations. These variations may not become evident until construction. A summary of the subsurface conditions encountered in the borings are included in **Table 2**.

Fill

Fill was encountered at the ground surface in each boring. The layer extended to depths ranging from about 5 to 6 ft bgs.

The Fill generally consisted of brown fine to coarse SAND and fine to coarse GRAVEL, with varying amounts of silt. Cobbles and boulders up to 12 inches in diameter were encountered in the Fill. SPT N-values were not recorded as the Fill was vacuum excavated.

Silty Sand

Silty Sand was encountered beneath the Fill in each boring. The layer extended to depths ranging from about 7 to 15.5 ft bgs.

The Silty Sand generally consisted of brown, fine to coarse SAND, varying amounts of fine to coarse gravel and silt. SPT N-values in the Silty Sand ranged from 37 bl/ft to greater than 81 bl/ft indicating a dense to very dense material.

Bedrock (Granite)

Bedrock was encountered beneath the Silty Sand in each boring at depths ranging from about 7 to 15.5 ft bgs. The Bedrock was generally hard, slightly weathered, moderately fractured, dark gray, fine grained GRANITE. Recovery values in the core samples ranged from 77 to 93 percent. RQD values ranged from 57 to 83 percent.

Groundwater Conditions

Groundwater was measured at depths ranging from about 5 to 11 ft bgs in the borings approximately 20 minutes after drilling concluded with the 4-inch casing in the ground.

Water levels measured at the conclusion of drilling may not represent stabilized groundwater levels because water is introduced into the boreholes during drilling.

Expected Variation in Subsurface Conditions

Our interpretation of the subsurface conditions presented herein is based on soil and groundwater conditions observed at discreet locations in the borings at the time of drilling. The subsurface conditions may vary from those described herein at other locations and times. These variations may not become evident until construction. If subsurface conditions are found to be different than described herein, the recommendations contained in this memorandum should be re-evaluated by CDM Smith and confirmed in writing.

Water levels measured in the borings may not represent stabilized levels. Groundwater levels can fluctuate with rainfall, time, season, temperature, climate, construction activities in the area, and other factors. Furthermore, the introduction of drilling fluids into the borehole during drilling may affect water level measurements conducted at the conclusion of drilling. Therefore, groundwater levels at the time of construction may be different from those observed at the time of the explorations.

Geotechnical Design Recommendations

General

Geotechnical engineering evaluations have been made as they relate to the proposed new structures for the Pennichuck Water Works Chemical Storage Building project. These evaluations have been based on the results of our recent subsurface explorations, laboratory test results, published correlations with soil properties, and the minimum requirements of the 2018 International Building Code (Code). In addition, recommended design criteria are based on performance tolerances, such as allowable settlement, as understood to relate to similar structures.

Foundation Design

Based on the proposed structure size and subsurface conditions, the proposed Chemical Storage Building may be supported on spread or strip footings that bear directly in the natural Silty Sand, or on compacted Structural Fill that extends down to the natural Silty Sand. We recommend that the footings be at least 3 feet wide and designed for a net allowable bearing pressure of 2,000 pounds per square foot (psf). A friction coefficient of 0.25 may be used to compute resistance to sliding, which assumes that the concrete for the footings is placed directly on a granular soil subgrade.

Ground Floor Slab

The ground floor slab of the proposed Chemical Storage Building may be designed as a slab-on-grade. The top 9 inches of soil immediately beneath the slab should consist of compacted Structural Fill.

The slab-on-grade should not rest directly on bedrock, boulders, or cobbles. Protruding bedrock, boulders, and cobbles should be excavated as needed to allow a minimum 9-inch-thick compacted Structural Fill “cushion” to be placed below the slab. Eliminating the hard spots caused by protruding, bedrock, boulders, and cobbles will reduce the risk of cracking of the slab caused by stress concentrations.

Construction joints should be incorporated between the slab-on-grade and the columns and perimeter walls of the proposed building.

Southern Building Wall

The southern wall of the Chemical Storage Building will be built into the existing slope along the south side of the site. Therefore, this wall will act as a retaining wall against the slope. The wall should be designed in accordance with Section 1807.2 of the Code and its design should consider the lateral earth pressure from the slope, surcharge loads at the top of the wall as well as impacts from the proposed landscaping. A maximum allowable bearing pressure of 2,000 psf is recommend for the wall foundation design. Recommended lateral earth pressures are discussed below.

Foundation Depth

In accordance with the Code, all foundations supported on soil should bear at least 5 feet below any adjacent ground surface exposed to freezing. Interior footings within heated portions of the structures should bear at least 18 inches below the respective top of slab elevations.

Hydrostatic Pressure

We recommend a design groundwater level of El. 50 for calculating hydrostatic pressures.

Damp-proofing, Foundation Drainage, and Waterproofing

We recommend that the slab-on-grade for the proposed Chemical Storage Building be damp-proofed in accordance with Section 1805.2 of the Code. In our opinion, a subfloor drainage layer is not required. This assumes that the site grades will remain relatively unchanged and that the floor slab will be at the current site grades or higher.

To prevent the buildup of hydrostatic pressure against the southern wall of the proposed building, we recommend that the wall be waterproofed and a geocomposite drainage board be installed against the full outside face of the wall from its base up to El. 50. A foundation drain should be installed along entire length of the wall. Any backfill placed within three feet of the wall should consist of Structural Fill or Screened Gravel. A geotextile filter fabric should be placed between the backfill and natural soil of the slope.

For any ancillary equipment (e.g., mechanical pits or sumps) that may extend below El. 50 should be membrane waterproofed and include structural design for hydrostatic uplift.

Resistance to Buoyancy

Any portion of a structure that extends below the design groundwater elevation should be appropriately waterproofed and designed to resist buoyancy from hydrostatic pressure based on the design groundwater level. The dead weight of the structure and the weight of any backfill directly above the foundation may be used to resist buoyancy. Soil used as backfill may be assumed to have a total unit weight of 125 pounds per cubic foot (pcf) if above the design groundwater level, and an effective unit weight of 65 pcf if below the design groundwater level.

Lateral Pressures on Below-Grade Structures

Below-grade walls that are restrained from movement should be designed for lateral pressures from soil and groundwater. For below-grade walls above the design groundwater elevation we recommend using an equivalent fluid unit weight of 65 pounds per cubic foot (pcf) for computing the lateral soil pressure. For below-grade walls below the design groundwater elevation we recommend using an equivalent fluid unit weight of 95 pcf for computing the combined lateral soil and hydrostatic pressure against foundation walls.

For surcharge loads adjacent to the walls, a uniform lateral pressure equal to 0.5 times surcharge pressure should be applied over the full height of the walls. To eliminate the surcharge loading from adjacent structure foundations on walls, the structures should be separated such that a line extending 2 feet beyond the edge of the foundation, then outward and downward at a slope of 1 horizontal to 1 vertical (1H:1V) does not intersect the adjacent structure.

Seismic forces against buried structures should be determined in accordance with Section 1613 of the Code. For computing seismic forces, we recommend a seismic pressure distribution equal to 17.4H for computing the seismic forces, where the seismic pressure is in psf, H is the height of the buried structure in feet, and the pressure distribution is an inverted triangle over the height of the structure.

Resistance to Unbalanced Lateral Forces

Unbalanced loads should be designed to be resisted by friction on the bottom of the foundation. For purposes of design, a coefficient of friction of 0.25 should be used. A passive lateral earth pressure resistance of up to a maximum equivalent fluid pressure of 150 pcf may be used, provided the foundations are backfilled with structural fill that is compacted to a density of at least 95 percent of the maximum dry density as determined by laboratory test ASTM D1557. The top 2 feet of passive resistance should be neglected due to surface effects and potential for disturbance from frost action and other factors. Frictional resistance should be assumed to be mobilized first to its full capacity before any passive pressure is developed.

Settlement

We estimate the new foundations designed and constructed in accordance with our recommendations will have a total settlement of about 1 inch and differential settlements between adjacent columns of up to about 0.5 inch. These settlements exclude the additional settlement that will occur from any site grade raise.

Seismic Design and Liquefaction

It is our opinion that the site should be classified as Site Class D for seismic design purposes. Spectral accelerations should be modified for Site Class D when determining the design earthquake response accelerations and seismic design category for the seismic analysis at the site.

The underlying soils at the site are not considered susceptible to liquefaction.

Construction Considerations

Excavations and Excavation Support

All excavations should be made in accordance with Occupational Safety and Health Administration (OSHA) regulations.

We estimate that excavations ranging from about 5 to 15 feet deep will be required for construction of the proposed Chemical Storage Building. We anticipate that excavations can be made using conventional earthmoving equipment and that the excavated materials will consist mostly of fill and sand and gravel.

Depending on the available space, it may be possible to perform the portions of the excavation as an open cut with temporary sides slopes no steeper than 1 horizontal to 1 vertical. However, temporary excavation support may be required to maintain roadways and protect surrounding infrastructure on the north, east and west sides. Temporary excavation support may also be required on the south side of the proposed building to support and protect the existing slope and the structures atop the hill to the south. We anticipate that soldier piles and lagging and trench boxes will be suitable for bracing excavations.

Care should be taken during excavations to avoid undermining adjacent structures, pipelines, and utilities. Excavations that extend into the zone of influence of these structures should be braced. The zone of influence is defined as extending 2 feet beyond the bottom exterior edge of the foundation or springline of pipe then out and away at an angle of 45 degrees.

The excavation support system should be designed by a Professional Engineer registered in New Hampshire who is engaged by the Contractor. CDM Smith should review the design of the excavation support system.

Dewatering

The depth to groundwater encountered in the borings during drilling ranged from about 5 to 11 ft bgs. Therefore, excavations may encounter groundwater.

The Contractor should be prepared to manage groundwater, perched water, or surface runoff that enters excavations. We expect that dewatering can be accomplished with sumps and conventional submersible pumps that discharge into on-site recharge pits. Sumps must be adequately filtered to avoid loss of fines and clogging of pumps. The site should be graded to direct surface water runoff away from the excavations.

All dewatering, handling and disposal of effluent, and any special testing should be conducted in accordance with local regulations, permits and specified requirements. If wet weather is encountered during construction, the Contractor should consider scheduling excavations to limit the duration of open cuts, slope the bottoms of excavations to facilitate drainage, and provide berms to limit runoff into the excavations. Additionally, any excavated material that is to be reused as fill should be stockpiled in such a manner that promotes runoff and limits saturation of the material.

Preparation and Protection of Subgrades

The groundwater level should be lowered at least two feet below the bottom of the excavation before final excavations for foundations are made. The final excavation to subgrade should be made using a smooth-edged bucket where possible. Granular soil foundation subgrades should be proof-compacted with a minimum of 4 passes using a vibratory plate compactor. Care should be taken to avoid excess traffic on the prepared subgrades prior to backfilling and foundation construction.

Boulders, cobbles, debris, and any other obstructions should be removed, and the resulting area replaced with compacted Structural Fill. Any unsuitable material present at the subgrade level including silty or clayey fill, organic soils, or any other soft, loose, or disturbed soil present at subgrade level should be removed and replaced with compacted Structural Fill.

Concrete for foundations may be placed directly on the soil subgrade. The final foundation subgrade should be free of standing water, frost, and frozen or loose soil. Areas of the subgrade disturbed by traffic or surface water should be repaired. We recommend that a CDM Smith engineer observe the final preparation of foundation subgrades.

Backfilling and Reuse of On-Site Materials

Backfill placed for the support of footings and slabs-on grade, and within three feet of buried walls and structures should meet the gradation and compaction requirements for Structural Fill. Section 1704 of the Code requires the continuous observation of the placement and compaction of Structural Fill below foundations. We recommend that CDM Smith observe and document placement and compaction of fill beneath foundations.

Backfill placed outside the building limits should meet the requirements for Common Fill or Select Common Fill. Common Fill and Select Common Fill may be susceptible to frost heave. The potential for frost heave can be reduced by grading outside areas for proper drainage, installing sub-drains, and by using Structural Fill or Crushed Stone rather than Common Fill within 1 to 2 feet of the ground surface.

Any material containing organic matter or debris is unsuitable for reuse beneath paved surfaces but may be reused in landscaped areas.

On-site excavated material that is intended for re-use should be segregated, graded, and protected to prevent the stockpiled material from becoming saturated. Depending on the moisture condition of the materials, stockpiled soils may have to be dried and further segregated prior to use as backfill.

The moisture content of any material proposed as backfill generally should be within 3 percent of its optimum moisture content at the time of placement and compaction.

Based on our review of soil samples collected from the borings and the results of laboratory gradation tests on selected samples, the Fill and Silty Sand are considered unsuitable for reuse as Structural Fill, but may be suitable for reuse as Common Fill, provided particles larger than 6 inches are removed prior to placement and compaction. Prior to reusing on-site soils as fill, we recommend that sieve analyses and laboratory compaction tests be performed on representative samples of the on-site soils.

Structural Fill

Structural Fill placed below foundations and against foundation walls should consist of a mineral soil free of organic material, loam, debris, frozen soil, clay lumps, or other deleterious material which may be compressible, or which cannot be properly compacted. Structural Fill should conform to the following gradation requirements:

U.S. Standard Sieve Size	Percent Passing by Weight
3 inches	100
No. 4	20 - 70
No. 40	5 – 35
No. 200	0 – 10

Structural Fill should be placed in loose layers no thicker than 8 inches and compacted with suitable compaction equipment to at least 95 percent of maximum dry density as determined by ASTM D1557. Lift thickness should be reduced to 4 inches in confined areas accessible only to hand guided compaction equipment.

Common Fill

Common Fill used as backfill to restore the site grades, around structures where passive pressure is not relied on, and in landscaped areas should consist of granular soil free from organic material, loam, debris, frozen soil, or other deleterious material that may be compressible or which cannot be compacted properly. It should contain stones no larger than 6 inches and have no more than 20 percent of material passing the No. 200 sieve. The material passing the No. 200 sieve shall be non-plastic. Common Fill should conform to the following gradation:

U.S. Standard Sieve Size	Percent Passing by Weight
6 inches	100
3 inches	80 - 100
No. 4	20 - 100
No. 200	0 - 20

Common Fill should be placed in loose lifts not to exceed 12 inches and compacted with suitable compaction equipment to at least 92 percent of maximum dry density as determined by ASTM D1557. Lift thickness should be reduced to 6 inches in confined areas accessible only to hand-guided compaction equipment.

Select Common Fill

Select Common Fill used for trench backfilling or grading below pavement subbase should be the same as Common Fill except that it should not contain stone larger than 2 inches.

Select Common Fill should be placed in loose lifts no thicker than 12 inches and compacted with suitable compaction equipment to at least 95 percent of maximum dry density as determined by ASTM D1557. Lift thicknesses should be reduced to 6 inches in confined areas accessible only to hand guided compaction equipment.

Filter Fabric

Filter fabric, when used as a separation barrier between soil and crushed stone, should be non-woven geotextile such as Mirafi 140N or an approved equivalent.

Freezing Conditions

Freezing of the soil beneath the foundations during construction may result in subsequent settlement of the structure. Therefore, special precautions should be taken to prevent the subgrade soils from freezing if construction is performed during freezing weather.

All subgrades should be free of frost before placement of concrete. Frost-susceptible soils that have frozen should be removed and replaced with compacted Structural Fill. The footings and the soil adjacent to the footings should be insulated until they are backfilled. Soil placed as fill should be free of frost, as should the ground on which it is placed.

If slabs-on-grade or footings are built and left exposed during the winter, precautions should be taken to prevent freezing of the underlying soil.

Monitoring and Protection of Existing Structures

Pre- and Post-Construction Surveys

Prior to the start of construction, a pre-construction survey that includes descriptions of interior and exterior conditions of existing structures and site conditions within 100 feet of the work should be performed. Descriptions shall include cracks, damage, or other existing defects and should include information to make it possible to determine the effect, if any, of the construction operations on the defect. Where significant cracks or damage exists, or for defects too complicated to describe in words, photographs should be taken and made part of the record. The Contractor's record of the pre- construction survey should consist of written documentation, video, and photographs of the conditions identified.

Vibration Monitoring

Construction vibrations from excavation activities such as installing excavation support systems, demolition of existing infrastructure, or other activities can cause damage to adjacent structures, utilities, and other facilities. To avoid or mitigate this potential damage, limits on ground vibrations in the form of ground displacement, velocity, or acceleration at given frequencies are typically established. The U.S. Bureau of Mines has established criteria to limit ground vibrations using the peak particle velocity (PPV) and frequency parameters. These limits have been established using the cracking of plaster walls in a residential house as a model.

The maximum peak particle velocities associated with impact or vibratory methods at the ground surface at existing adjacent structures and utilities should be as follows:

Maximum Frequency (Hz)	Peak Particle Velocity (inch per. Sec.)
Over 40	2.0
30 to 40	1.5
20 to 30	1.0
Less than 20	0.5

In no case should the maximum peak particle velocities caused by construction activities exceed 2.0 inches per second at the closest facility (structure or utility) to the work.

Settlement/Deformation Monitoring

Settlement/deformation monitoring points should be established on adjacent existing structures, roadways, and utilities located within 50 feet from an excavation. The monitoring points should be established on the exterior corners and along the perimeter existing structures at a spacing of not more than 25 feet. Where excavation support is used, the lateral movement of the system should be monitored at the top of the support system at points not more than 25 feet on center along the length of the system. In addition, we recommend surface monitoring of existing manhole rims and the pavement or ground surface overlying sensitive utilities located within 50 feet from an excavation.

Monitoring should be performed during the installation of any excavation support system, dewatering, excavations, and backfilling associated with the work. The monitoring points should be installed and baseline locations taken prior to the start of construction. The survey of the monitoring points should be performed daily during the installation of any excavation support system, excavation, and dewatering, and then twice weekly thereafter until all backfilling is complete.

The Contractor should be prepared to alter the excavation methods if settlements/deformations measured exceed any of the below threshold values. If settlement/deformation exceeds any of the limiting values, the Contractor should stop all construction activities, stabilize the excavation, and revise excavation methods to prevent additional settlement/deformation. These criteria may need to be altered by the Engineer as necessary on a case-by-case basis.

The Contractor should be prepared to alter the excavation methods if settlement exceeding 1/4 inch is measured at the existing structures. If settlement exceeding 1/2 inch is measured at the existing structures, the Contractor should stop all construction activities, stabilize the excavation, and revise excavation methods to prevent additional settlement.

Future Work

We recommend that CDM Smith be engaged during construction to:

- Review contract drawings and specifications related to the geotechnical aspects of the project to confirm that our recommendations have been properly interpreted and incorporated into the documents.
- Review contractor submittals and respond to Request for Information (RFIs) related to the geotechnical aspects of the project.
- Review installation and monitoring of geotechnical instrumentation.
- Confirm that the foundation subgrades are prepared and conditions encountered are suitable for support of the proposed structures.
- Observe, test and document placement and compaction of backfill material where appropriate.

In addition, CDM Smith would be present to identify and provide response should conditions encountered differ from those assumed during preparation of this report.

Closing

This memorandum was prepared exclusively for Pennichuck Water Works Water Treatment Plant – Chemical Storage Building project. Our recommendations are based on the project information provided to us at the time of this report and may require modification if there are any changes in the nature, design, or location of the proposed work. We cannot accept responsibility for designs based on our recommendations unless we are engaged to review the final plans and specifications to determine whether any changes in the project affect the validity of our recommendations and whether our recommendations have been properly implemented in the design.

The recommendations in this report are based in part on the data obtained from the subsurface explorations. The nature and extent of variations between explorations may not become evident until construction. If variations from the anticipated conditions are encountered, it may be necessary to revise the recommendations in this report.

If changes in the design or location of the proposed development occur, the interpretation of data and considerations contained herein should not be considered valid unless verified by CDM Smith in writing.

Our professional services for this project have been performed in accordance with generally accepted engineering practices; no warranty, express or implied, is made.

Figures

Tables

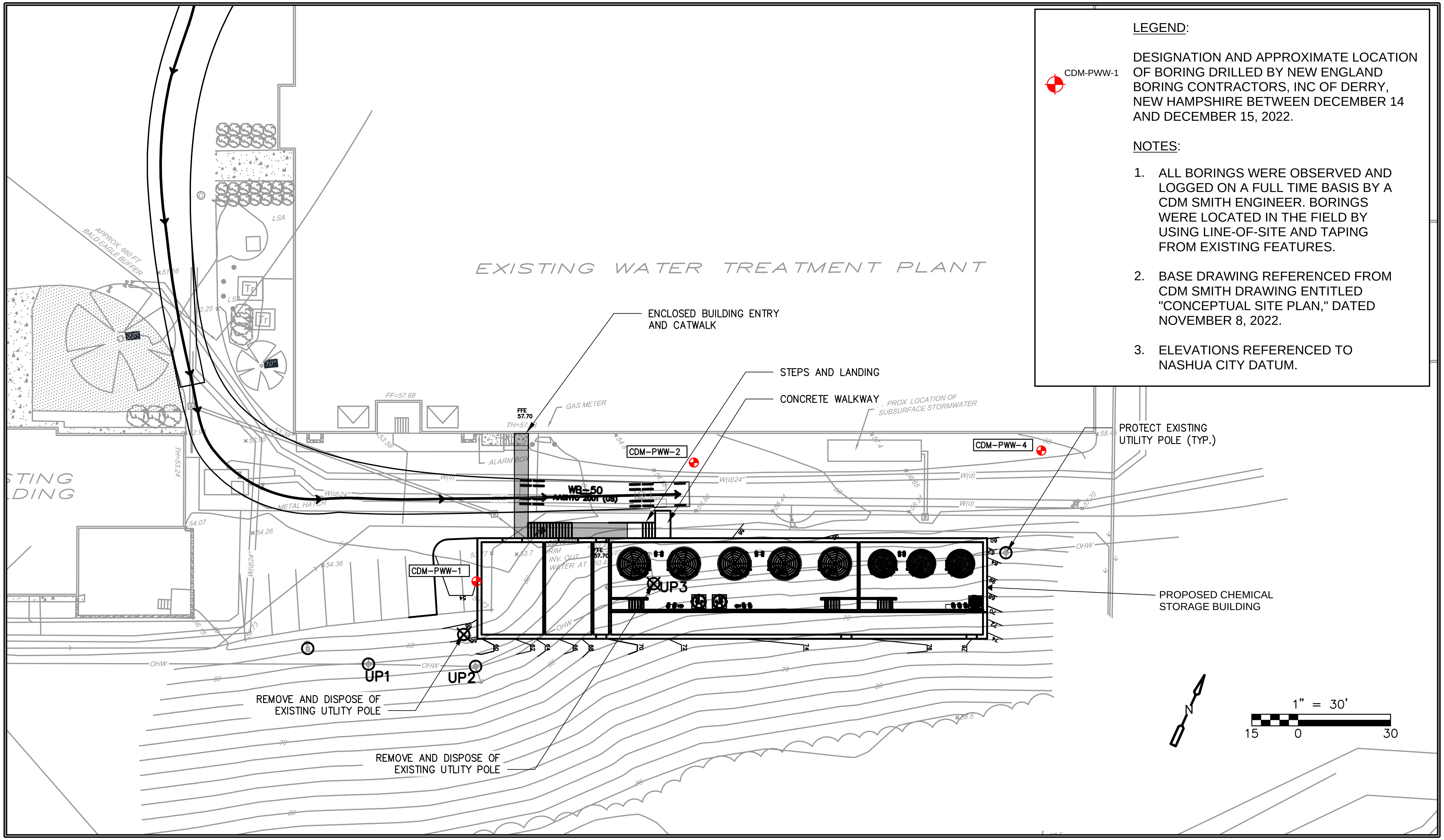
Attachments

Figures

CDM Smith

PENNICHUCK WATER WORKS
CHEMICAL STORAGE BUILDING
NASHUA, NEW HAMPSHIRE

SITE LOCATION MAP
FIGURE 1



LEGEND:

CDM-PWW-1 DESIGNATION AND APPROXIMATE LOCATION OF BORING DRILLED BY NEW ENGLAND BORING CONTRACTORS, INC OF DERRY, NEW HAMPSHIRE BETWEEN DECEMBER 14 AND DECEMBER 15, 2022.

NOTES:

1. ALL BORINGS WERE OBSERVED AND LOGGED ON A FULL TIME BASIS BY A CDM SMITH ENGINEER. BORINGS WERE LOCATED IN THE FIELD BY USING LINE-OF-SITE AND TAPING FROM EXISTING FEATURES.
2. BASE DRAWING REFERENCED FROM CDM SMITH DRAWING ENTITLED "CONCEPTUAL SITE PLAN," DATED NOVEMBER 8, 2022.
3. ELEVATIONS REFERENCED TO NASHUA CITY DATUM.

CDM Smith

PENNICHUCK WATER WORKS
CHEMICAL STORAGE BUILDING
NASHUA, NEW HAMPSHIRE

SUBSURFACE EXPLORATION PLAN
FIGURE 2

Tables

Pennichuck Water Works
Pennichuck Water Works Chemical System Evaluation
Nashua, New Hampshire

Table 1 Summary of Geotechnical Laboratory Soil Test Results

Exploration Number	Sample Number	Sample Depth (ft)	Stratum	USCS Classification (1)	Grain Size Analysis (2)							Moisture Content (%) (3)
					Gravel (%)		Sand (%)			Fines (%)		
					Coarse	Fine	Coarse	Medium	Fine	Silt	Clay	
CDM-PWW-1	VE-1	0-5	Fill	SM	4.3	25.9	10.5	16.5	19.5	23.3		8.1
CDM-PWW-1	S-2	5-7	Silty Sand	SM	0.0	10.8	5.8	10.4	12.7	60.3		11.8
CDM-PWW-2	S-2	6-8	Silty Sand	SM	0.0	16.4	14.4	28.5	18.9	21.8		8.3
CDM-PWW-4	VE-1	0-6	Fill	SM	6.7	30.5	5.8	18.2	26	12.8		6.2
CDM-PWW-4	S-2	6-8	Silty Sand	SM	7.3	34	13.3	15.8	15.8	13.8		7.8

Notes:

1. USCS classifications were performed in accordance with ASTM D2487.
2. Grain size analysis tests performed in accordance with ASTM D6913.
3. Moisture content analysis performed in accordance with ASTM D2216.

Abbreviations:

SM: Silty Sand
ML: Silt
ft: Feet
%: Percentage
psf: Pounds per square foot

Pennichuck Water Works

Pennichuck Water Works Chemical System Evaluation

Nashua, New Hampshire

Table 2 Summary of Subsurface Exploration Program

Exploration Number	Approximate Coordinates [1]		Approximate Ground Surface Elevation[2] (ft)	Approximate Exploration Depth[3] (ft)	Depth to Top of Stratum (ft)			Approximate Top of Bedrock Elevation[2] (ft)	Approximate Depth to Groundwater[4] (ft)	Approximate Groundwater Elevation (ft)
	Northing	Easting			Fill	Silty Sand	Bedrock			
CDM-PWW-1	106095.09	551944.88	54.3	16.0	0.0	5.0	7.0	47.3	5.0	49.3
CDM-PWW-2	106159.11	551993.42	55.1	17.0	0.0	6.0	11.0	44.1	8.3	46.8
CDM-PWW-4	106208.81	552094.65	57.8	21.0	0.0	6.0	15.4	42.4	10.9	46.9

Notes:

1. Northings and Eastings are in feet and reference the New Hampshire Plane Coordinate System, North American Datum of 1983 (NAD 83).
2. Elevations are in feet and are referenced to the Nashua City Datum.
3. Indicated depths are referenced to ground surface at the time of drilling.
4. Groundwater depth recorded after drilling.

Abbreviations:

--: Not encountered
ft: Feet

Appendix A

Test Boring Logs

Sheet 1 of 2

Boring Number: CDM-PWW-1

Client: Pennichuck Water Works
Project Name: Pennichuck WW Chemical Storage Building
Project Location: Nashua, NH
Project Number: 275436

Drilling Contractor/Driller: New England Boring Contractors/Patrick Schofield
Drilling Method/Bore Hole Diameter: Drive and Wash/4 in.
Hammer Style/Weight/Drop Height/Spoon Size: Automatic/140 lb/30 in./2 in.
Bore Hole Location:
N: 106095.09 **E:** 551944.88
Drilling Date: Start: 12/14/2022 **End:** 12/14/2022

Surface Elevation (ft): 54.2
Total Depth (ft): 16.0
Depth to Initial Water Level (ft):

Depth	Date	Time
5.0	12/14/2022	13:40

Abandonment Method: Backfilled with soil cuttings.
Logged By: C. Dawson

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	0	VE	S-1	60	--	60			FILL	Moist, brown, fine to coarse SAND, some fine to coarse gravel, some silt, (SM).	Possible cobbles between 0' and 5' BGS.
50.0	▼ 5	SS	S-2	24	5 20 38 52	14	58		SILTY SAND	Moist, very dense, brown, SILT, some fine to coarse sand, little fine gravel, (ML).	
45.0 40.0	10								BEDROCK	*See next page for rock material descriptions.*	

Sample Types

AS - Auger/Grab Sample	HP - Hydro Punch
CS - California Sampler	SS - Split Spoon
NQ - 1.9" Rock Core	ST - Shelby Tube
NX - 2.2" Rock Core	WS - Wash Sample
	GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

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

Fine Grained (Clay):

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

Burmister Classification

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

moisture, density, color

Reviewed by: HAA **Date:** 12/29/2022 **Boring Number:** CDM-PWW-1

Sheet 2 of 2

Boring Number: CDM-PWW-1

Client: Pennichuck Water Works
Project Name: Pennichuck WW Chemical Storage Building
Project Location: Nashua, NH
Project Number: 275436

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Recovery (%)	RQD (%)	Drill Rate (min/ft)	Down Press. (psi)	Graphic Log	Strata	Material Description	Remarks
	0										*See previous page for soil material descriptions.*	
50.0	5											
45.0	10											
		NX	C-1	60	93	83	6.0 5.0 6.0 4.0 5.0	600 600 600 600 600		BEDROCK	Hard, slightly weathered, moderately fractured, dark gray, fine grained GRANITE; Bedding: thin; Primary joint set: high angle, close to very close, smooth slickensided. Secondary joint set: low angle, close, smooth slickensided.	
40.0	15											
											Test boring terminated at 16.0 feet bgs.	
35.0	20											

Boring Number: CDM-PWW-1

Sheet 1 of 2

Boring Number: CDM-PWW-2

Client: Pennichuck Water Works
Project Name: Pennichuck WW Chemical Storage Building
Project Location: Nashua, NH
Project Number: 275436

Drilling Contractor/Driller: New England Boring Contractors/Patrick Schofield
Drilling Method/Bore Hole Diameter: Drive and Wash/4 in.
Hammer Style/Weight/Drop Height/Spoon Size: Automatic/140 lb/30 in./2 in.
Bore Hole Location:
N: 106159.11 **E:** 551993.42
Drilling Date: Start: 12/14/2022 **End:** 12/15/2022

Surface Elevation (ft): 55.1
Total Depth (ft): 17.0
Depth to Initial Water Level (ft):

Depth	**Date**	**Time**
8.3	12/15/2022	7:30

Abandonment Method: Backfilled with soil cuttings.
Logged By: C. Dawson

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
51.0	0 5	VE	S-1	72	--	72		▨	FILL	Moist, brown, fine to coarse SAND and fine to coarse GRAVEL, little silt (SM).	Possible cobbles between 0' and 6' BGS.
		SS	S-2	24	15 18 19 36	20	37	⁙	SILTY SAND	Moist, dense, brown, fine to coarse SAND, some silt, little fine gravel, (SM).	
	▼							⁙			
46.0	10	SS	S-3	24	19 29 45 70	16	74	⁙		Wet, very dense, brown, fine to coarse SAND, some fine to coarse gravel, trace silt, (SM, weathered rock fragments).	
41.0								⁄		*See next page for rock material descriptions.*	

Sample Types

AS - Auger/Grab Sample	HP - Hydro Punch
CS - California Sampler	SS - Split Spoon
NQ - 1.9" Rock Core	ST - Shelby Tube
NX - 2.2" Rock Core	WS - Wash Sample
	GP - Geoprobe

Consistency vs Blowcount/Foot

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

Burmister Classification

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

moisture, density, color

Reviewed by: HAA **Date:** 12/29/2022 **Boring Number:** CDM-PWW-2

Sheet 2 of 2

Boring Number: CDM-PWW-2

Client: Pennichuck Water Works
Project Name: Pennichuck WW Chemical Storage Building
Project Location: Nashua, NH
Project Number: 275436

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Recovery (%)	RQD (%)	Drill Rate (min/ft)	Down Press. (psi)	Graphic Log	Strata	Material Description	Remarks
	0										*See previous page for soil material descriptions.*	
51.0												
	5											
46.0												
	10											
										BEDROCK	Hard, slightly weathered, moderately fractured, dark gray, fine grained GRANITE; bedding: thin; primary joint set, low angle to horizontal, close to very close, rough.	
							8.0	600				
							6.5	600				
41.0		NX	C-1	60	77	57	6.0	600				
	15						6.5	600				
							7.5	600				
											Test boring terminated at 17.0 feet bgs.	
36.0												
	20											

Boring Number: CDM-PWW-2

Sheet 1 of 3

Boring Number: CDM-PWW-4

Client: Pennichuck Water Works
Project Name: Pennichuck WW Chemical Storage Building
Project Location: Nashua, NH
Project Number: 275436

Drilling Contractor/Driller: New England Boring Contractors/Patrick Schofield
Drilling Method/Bore Hole Diameter: Drive and Wash/4 in.
Hammer Style/Weight/Drop Height/Spoon Size: Automatic/140 lb/30 in./2 in.
Bore Hole Location:
N: 106208.81 **E:** 552094.65
Drilling Date: Start: 12/14/2022 **End:** 12/15/2022

Surface Elevation (ft): 57.8
Total Depth (ft): 21.0
Depth to Initial Water Level (ft):

Depth	**Date**	**Time**
10.9	12/15/2022	12:45

Abandonment Method: Backfilled with soil cuttings.
Logged By: C. Dawson

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	0	VE	S-1	72	--	72			FILL	Moist, brown, fine to coarse SAND and fine to coarse GRAVEL, little silt, (SM).	Possible cobbles between 0' and 6' BGS.
53.0	5										
		SS	S-2	24	20 20 20 20	18	40		SILTY SAND	Moist, dense, brown, fine to coarse SAND and fine to coarse GRAVEL, little silt, (SM, weathered rock fragments).	
48.0	10	SS	S-3	24	16 25 40 68	14	65			Wet, very dense, brown, fine to coarse SAND and fine to coarse GRAVEL, little silt, (SM, weathered rock fragments).	
▼											
		SS	S-4	17	15 26 55/5"	8	>81			Wet, very dense, brown, fine to coarse SAND, some fine to coarse gravel, little silt, (SM, weathered rock fragments).	

Sample Types

AS - Auger/Grab Sample	HP - Hydro Punch
CS - California Sampler	SS - Split Spoon
NQ - 1.9" Rock Core	ST - Shelby Tube
NX - 2.2" Rock Core	WS - Wash Sample
	GP - Geoprobe

Consistency vs Blowcount/Foot

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

Burmister Classification

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

moisture, density, color

Reviewed by: HAA **Date:** 12/29/2022 **Boring Number:** CDM-PWW-4

Smith CDM

Sheet 2 of 3

Boring Number: CDM-PWW-4

Client: Pennichuck Water Works
Project Name: Pennichuck WW Chemical Storage Building
Project Location: Nashua, NH
Project Number: 275436

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	15								SILTY SAND	Wet, very dense, brown, fine to coarse SAND, some fine to coarse gravel, little silt, (SM, weathered rock fragments).	
									BEDROCK	*See next page for rock material descriptions.*	
38.0	20										
33.0	25										
28.0	30										
23.0											

Boring Number: CDM-PWW-4

Sheet 3 of 3

Boring Number: CDM-PWW-4

Client: Pennichuck Water Works

Project Location: Nashua, NH

Project Name: Pennichuck WW Chemical Storage Building

Project Number: 275436

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Recovery (%)	RQD (%)	Drill Rate (min/ft)	Down Press. (psi)	Graphic Log	Strata	Material Description	Remarks
	15										*See previous page for soil material descriptions.*	
38.0	20	NX	C-1	60	85	72	6.0 5.0 5.0 5.5 3.0	600 600 600 600 600		BEDROCK	Hard, slightly weathered, moderately fractured, dark gray, fine grained GRANITE; bedding: thin; Primary joint set: high angle, close, smooth slickensided. Secondary joint set: low angle to horizontal, close, smooth slickensided.	
											Test boring terminated at 21.0 feet bgs.	
33.0	25											
28.0	30											
23.0												

Boring Number: CDM-PWW-4

Appendix B

Geotechnical Laboratory Test Reports

CDM Smith Geotechnical Laboratory Testing Summary Sheet

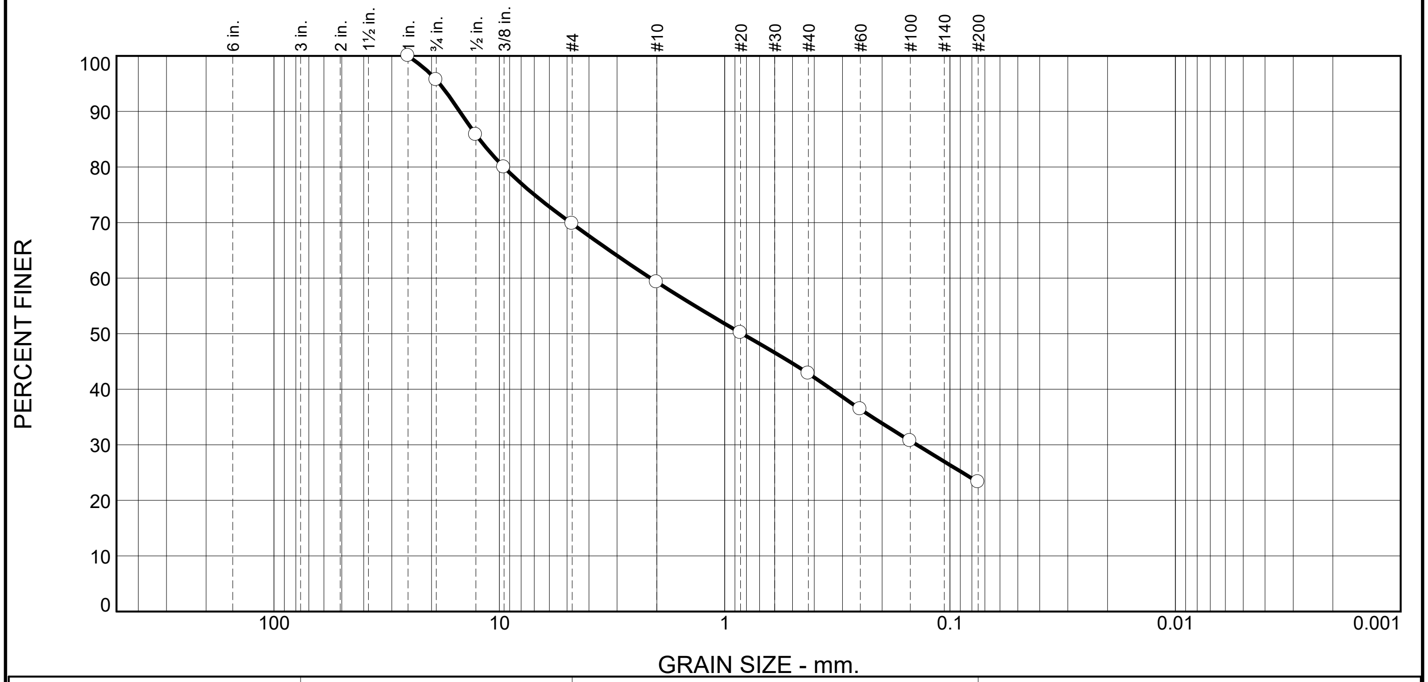
Client: Pennichuck Water Works
Project Name: Pennichuck WW Chemical System Evaluation
Project Location: Nashua, NH

Project Number: 0246-257436
Task: INV
Assigned By: G. Power

Reviewed By: M. Polsky - Lab Manager
Date Reviewed: 12/22/2022

				Identification Tests								Strength Tests					
Sample Date	Boring Number	Sample	Depth (ft)	Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	Sp. Gr.	Dry unit wt. pcf	$\bar{\sigma}_c$ psi	Failure Criteria (CIU)	$\sigma_1 - \sigma_3$ or τ psi	Strain %	Soil Description
12/14/22	CDM-PWW-1	S-1	Vac-ex	8.1			30.2	46.5	23.3								Brown silty sand with gravel
12/14/22	CDM-PWW-1	S-2	5-7'	11.8			10.8	28.9	60.3								Gray sandy silt
12/15/22	CDM-PWW-2	S-2	6-8'	8.3			16.4	61.8	21.8								Gray-brown silty sand with gravel
12/15/22	CDM-PWW-4	S-1	Vac-ex	6.2			37.2	50.0	12.8								Dark brown silty sand with gravel
12/15/22	CDM-PWW-4	S-2	6-8'	7.8			41.3	44.9	13.8								Dark brown silty sand with gravel

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.3	25.9	10.5	16.5	19.5	23.3	

Test Results (ASTM D6913 & ASTM D1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
0.75"	95.7		
0.5"	85.8		
0.375"	80.0		
#4	69.8		
#10	59.3		
#20	50.1		
#40	42.8		
#60	36.4		
#100	30.7		
#200	23.3		

* (no specification provided)

Material Description

Brown silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= **LL=** NP **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 14.9886 **D_{85}=** 12.2661 **D_{60}=** 2.1295
D_{50}= 0.8377 **D_{30}=** 0.1403 **D_{15}=**
D_{10}= **C_u=** **C_c=**

Remarks

As Received Moisture Content = 8.1%

Date Received: 12/16/22 **Date Tested:** 12/22/22
Tested By: KS/ZM
Checked By: MP
Title: Laboratory Manager

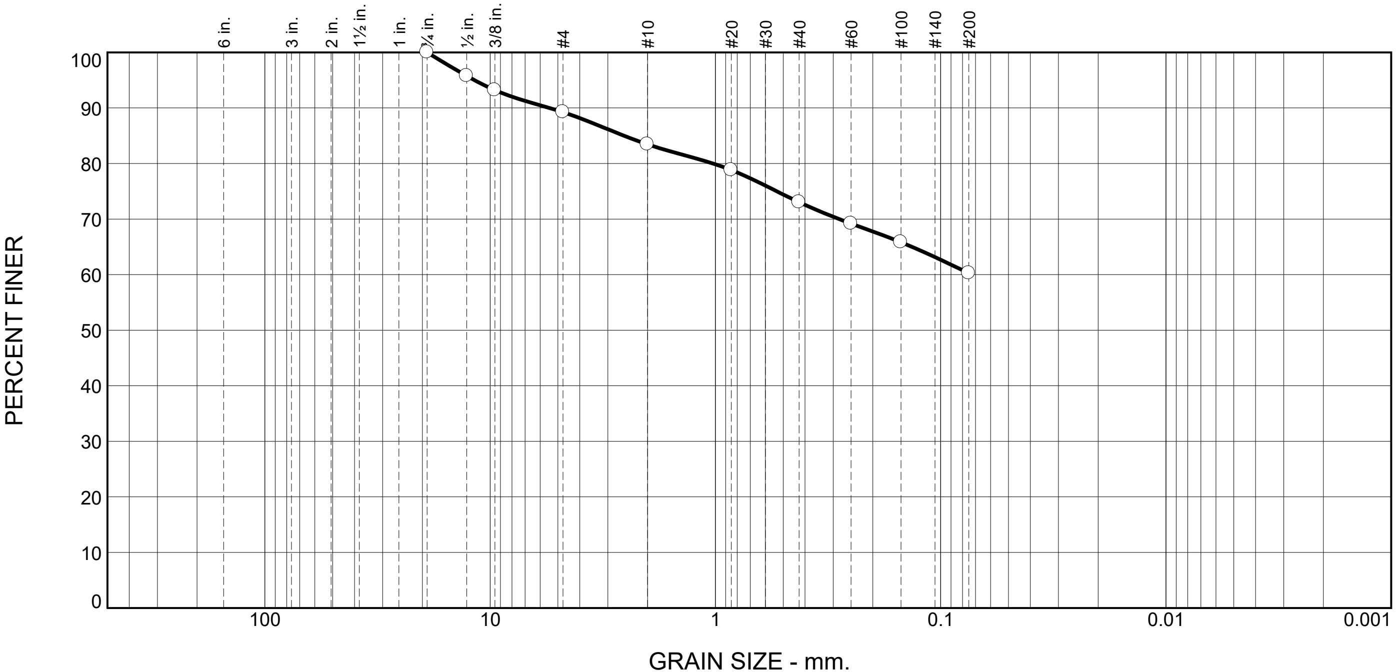
Source of Sample: CDM-PWW-1 **Depth:** Vac-Ex **Date Sampled:** 12/14/22
Sample Number: S-1

CDM Smith

Boston, Massachusetts

Client: Pennichuck Water Works
Project: Pennichuck WW Chemical System Evaluation
Nashua, NH
Project No: 0246-257436

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	10.8	5.8	10.4	12.7	60.3	

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	95.8		
0.375"	93.2		
#4	89.2		
#10	83.4		
#20	78.8		
#40	73.0		
#60	69.2		
#100	65.8		
#200	60.3		

* (no specification provided)

Material Description

Gray sandy silt

Atterberg Limits (ASTM D 4318)

PL= **LL=** NP **PI=**

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 5.4589 D_{85}= 2.5436 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

As Received Moisture Content = 11.8%

Date Received: 12/16/22 **Date Tested:** 12/22/22
Tested By: KS/ZM
Checked By: MP
Title: Laboratory Manager

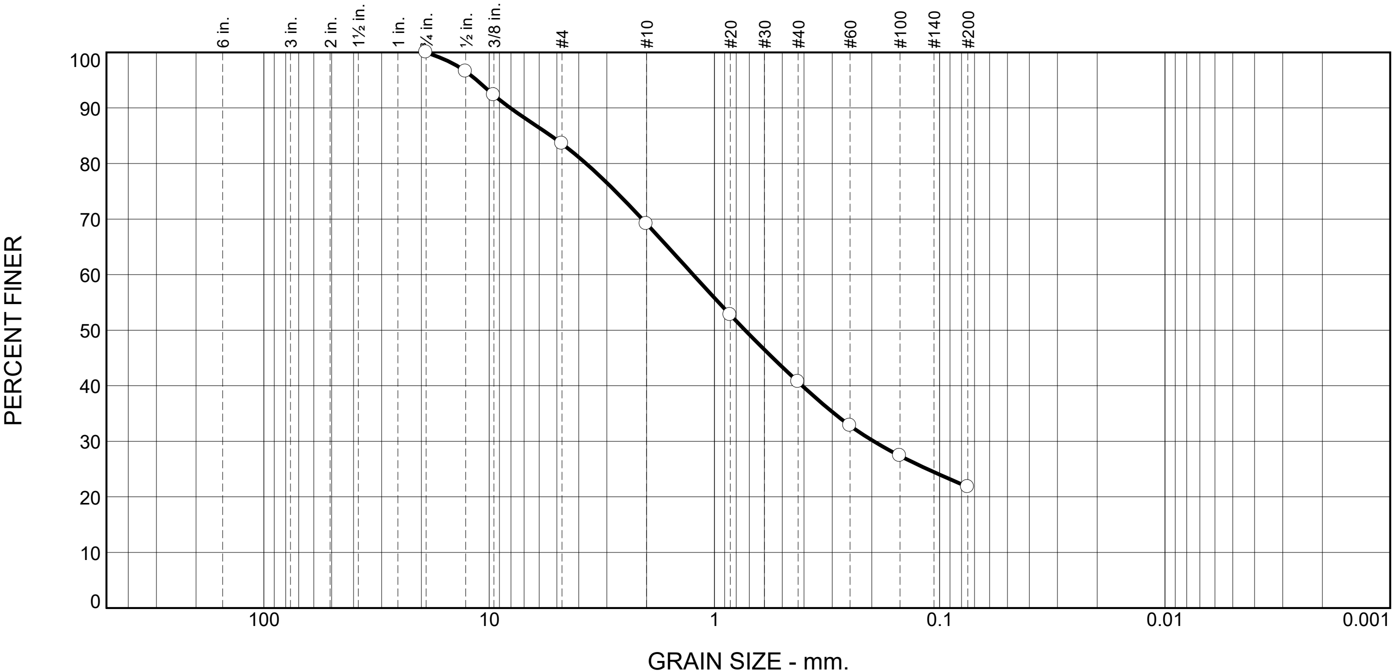
Source of Sample: CDM-PWW-1 **Depth:** 5-7' **Date Sampled:** 12/14/22
Sample Number: S-2

CDM Smith

Boston, Massachusetts

Client: Pennichuck Water Works
Project: Pennichuck WW Chemical System Evaluation
Nashua, NH
Project No: 0246-257436

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	16.4	14.4	28.5	18.9	21.8	

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	96.6		
0.375"	92.3		
#4	83.6		
#10	69.2		
#20	52.8		
#40	40.7		
#60	32.8		
#100	27.4		
#200	21.8		

* (no specification provided)

Material Description

Gray-brown silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= **LL=** NP **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 8.0588 D_{85}= 5.3158 D_{60}= 1.2432
D_{50}= 0.7308 D_{30}= 0.1961 D_{15}=
D_{10}= C_u= C_c=

Remarks

As Received Moisture Content = 8.3%

Date Received: 12/16/22 **Date Tested:** 12/22/22
Tested By: KS/ZM
Checked By: MP
Title: Laboratory Manager

Source of Sample: CDM-PWW-2 **Depth:** 6-8' **Date Sampled:** 12/15/22
Sample Number: S-2

CDM Smith

Boston, Massachusetts

Client: Pennichuck Water Works
Project: Pennichuck WW Chemical System Evaluation
Nashua, NH
Project No: 0246-257436

Particle Size Distribution Report

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.7	30.5	5.8	18.2	26.0	12.8	

Test Results (ASTM D6913 & ASTM D1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
0.75"	93.3		
0.5"	77.2		
0.375"	69.2		
#4	62.8		
#10	57.0		
#20	49.7		
#40	38.8		
#60	29.5		
#100	20.6		
#200	12.8		

* (no specification provided)

Material Description

Dark brown silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= **LL=** NP **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}=	17.3389	D_{85}=	15.3521	D_{60}=	3.0327
D_{50}=	0.8705	D_{30}=	0.2565	D_{15}=	0.0943
D_{10}=		C_u=		C_c=	

Remarks

As Received Moisture Content = 6.2%

Date Received: 12/16/22 **Date Tested:** 12/22/22

Tested By: KS/ZM

Checked By: MP

Title: Laboratory Manager

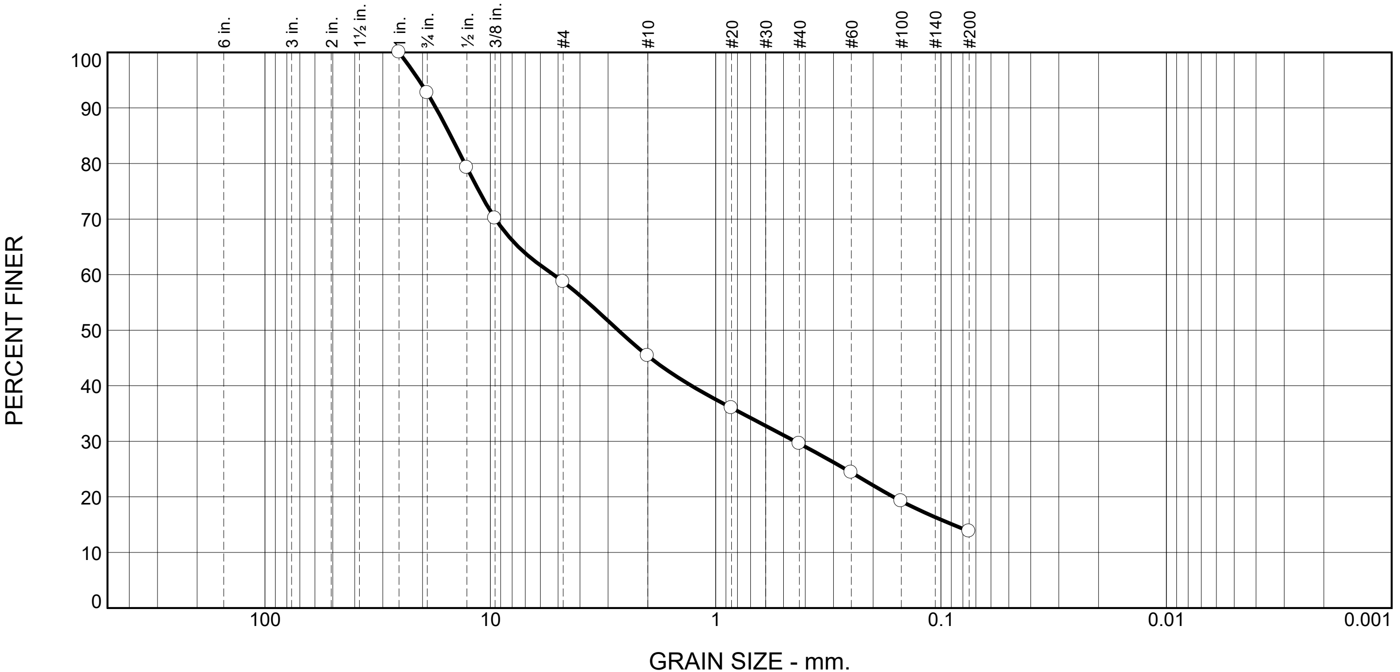
Source of Sample: CDM-PWW-4 **Depth:** Vac-Ex **Date Sampled:** 12/15/22
Sample Number: S-1

CDM Smith

Boston, Massachusetts

Client: Pennichuck Water Works
Project: Pennichuck WW Chemical System Evaluation
Nashua, NH
Project No: 0246-257436

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.3	34.0	13.3	15.8	15.8	13.8	

Test Results (ASTM D6913 & ASTM D1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
0.75"	92.7		
0.5"	79.2		
0.375"	70.1		
#4	58.7		
#10	45.4		
#20	36.0		
#40	29.6		
#60	24.4		
#100	19.2		
#200	13.8		

* (no specification provided)

Material Description

Dark brown silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= **LL=** NP **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}=	17.4295	D_{85}=	14.9886	D_{60}=	5.2491
D_{50}=	2.7060	D_{30}=	0.4443	D_{15}=	0.0886
D_{10}=		C_u=		C_c=	

Remarks

As Received Moisture Content = 7.8%

Date Received: 12/16/22 **Date Tested:** 12/22/22

Tested By: KS/ZM

Checked By: MP

Title: Laboratory Manager

Source of Sample: CDM-PWW-4 **Depth:** 6-8' **Date Sampled:** 12/15/22
Sample Number: S-2

CDM Smith

Boston, Massachusetts

Client: Pennichuck Water Works
Project: Pennichuck WW Chemical System Evaluation
Nashua, NH
Project No: 0246-257436

PENNICHUCK WATER WORKS, INC.

PROPOSAL

Professional Engineering Services for the Nashua Treatment Plant Chemical Feed System Upgrades

June 2022

CDM Smith

CDM Smith

670 N. Commercial Street, Suite 208
Manchester, New Hampshire 03101
tel: +1 603 222 8300
fax: +1 603 628 7675
cdmsmith.com

June 10, 2022

Mr. John Boisvert, PE
Chief Engineer
Pennichuck Water Works
25 Walnut Street
Nashua, NH 03060

Subject: **RFP for the Nashua Treatment Plant Chemical Feed System Upgrades**

Dear Mr. Boisvert:

Pennichuck Water Works, Inc. (PWW) is seeking a consultant partner as it embarks on an important project to evaluate the upgrades required for the chemical feed system and chemical storage facilities for the Nashua Water Treatment Plant (WTP). The plant serves as the main supply for the Nashua Core Water System (NCWS) and has a capacity of approximately 32 million gallons per day (mgd). At CDM Smith, we are excited for the opportunity to continue to work with PWW. Through this evaluation, CDM Smith will work collaboratively with PWW to optimize its chemical systems to meet varying water quality standards now and in the future.

CDM Smith is the right partner for PWW and we provide the following benefits:

History of Successful Collaboration. We collaborated with PWW on several important efforts including the Asset Management Services, AWIA Risk and Resiliency Assessment, Emergency Response Plan Update, and NCWS Hydraulic Model Development to name a few. We have touched on all aspects of the PWW system from asset management and risk assessment to emergency preparedness, and are well versed with your systems and staff. Our proposed team includes several key staff from prior projects that are knowledgeable about Pennichuck's facilities, the operating procedures for the chemical systems, facility features and challenges, and plant constraints. As a result, we are well informed to deliver this project efficiently.

Strong Chemical Systems Expertise. Our team brings one of the strongest portfolios of experience with chemical systems in the nation, having completed hundreds of projects nationwide. From some of the largest and most complex national projects including the San Francisco Public Utilities Commission's 180 mgd Harry Tracy WTP, which included 14 chemical systems; and the Santa Clara Valley Water District's 100 mgd Rinconada WTP, which included 11 chemical systems; to more local facilities including Manchester Water Works, NH; Brunswick & Topsham Water District, ME; Woburn and Franklin, MA; Providence, RI; and Concord, NH; CDM Smith has the expertise to evaluate, design and optimize chemical systems of any scale or level of complexity.

Active Engagement through Workshop-Based Approach. PWW and CDM Smith have been collaborating for nearly a decade with a strong history in delivering successful projects. While that success can be attributed to many key factors, it can be best described with a two simple words – collaboration and commitment. We've developed an approach that emphasizes direct engagement through regular workshops and will collaborate with PWW staff on every step of the work to make this important project a success and further advance the PWW/CDM Smith long-term partnership.

Specialized Team and In-House Construction and Operations Expertise. In addition to the chemical system experts, our team also includes a deep bench of staff including operations specialists, senior managers, and certified cost estimators from our construction group. This allows us to provide the full range of services required, including timely feedback on constructability, construction sequence and planned downtime, and cost estimates to help PWW successfully implement this project within its budget.

Readily Available Local Team with Extensive Knowledge. We have assembled an experienced, local project team that has completed dozens of complex plant retrofit and chemical system improvement projects with water suppliers throughout the New England region. Led by proposed Project Manager, **Alan G. LeBlanc, PE,** and supported by design engineers, permitting specialists, estimators, programmers and operations and construction professionals, our team will help meet PWW's safety, water quality, operational, and financial goals for the project. The bulk of our key team members (10 of 12) are located in our Manchester, NH and Boston, MA offices, both being less than an hour's drive from PWW. This allows us to be responsive and cost-effective in completing tasks that require significant on-site presence.

In preparation for this proposal, we have met with Pennichuck's staff to better understand the specific challenges with upgrading the chemical feed system at the plant while maintaining operations. We also understand your expectations for enhancing the safety for staff, neighbors, and the environment, and your commitment to cost-effectively produce high quality drinking water. The CDM Smith team is excited about the opportunity to help PWW map your water future. Working as an extension of your staff, we will help you gather critical input and ideas to deliver a path forward.

Thank you for inviting CDM Smith to submit a proposal for this important project. We encourage you to contact us to discuss our approach, team, and ideas, and look forward to the opportunity to work with you.

Very truly yours,

David G. Polcari, PE, PMP
Principal in Charge
CDM Smith Inc.

Alan G. LeBlanc, PE
Project Manager
CDM Smith Inc.

60+
CHEMICAL SYSTEM PROJECTS

30+
CHEMICAL RETROFIT PROJECTS

DESIGNED SYSTEMS FOR
27
DIFFERENT CHEMICALS

180 MGD
LARGEST CHEMICAL RETROFIT PROJECT

Contents

SECTION 1:

Statement of Interest

For 75 years, CDM Smith has been serving New England utilities like Pennichuck, entrusted to plan, design, and implement long-term solutions to their most critical water challenges. CDM Smith's skilled New Hampshire-based team will leverage our experience with chemical feed optimization, physical layout, mastery of building and fire code requirements, varying water quality conditions, and our track record of collaboration with operations and maintenance (O&M) staff, to deliver Pennichuck Water Works (PWW) a holistic, cost-effective path forward.

PWW and CDM Smith – A Collaborative Partnership

PWW and CDM Smith have been collaborating for more than a decade, advancing an asset management program and integrated GIS technology platform that has changed how PWW manages, operates, and improves its system assets. When PWW desired a comprehensive hydraulic model of the Nashua Core Water System (NCWS) to aid in identifying and prioritizing future capital improvements, you called upon CDM Smith to not only develop a planning tool but to train your staff on how to perform simulations in house. This computer model has allowed PWW to evaluate system conditions during various operating conditions and determine system efficiency. Since its development in 2017, PWW and CDM Smith have worked together utilizing the model to identify system deficiencies such as low system pressures created by unknown valve closures, evaluations of capital improvements to improve system redundancy and water quality. CDM Smith has also assisted also PWW with its Risk and Resilience Assessment (RRA) and Emergency Response Plan (ERP) for the NCWS, in accordance with America's Water Infrastructure Act (AWIA). Through the success of these projects, CDM Smith is proud to have developed a long-term trusted partnership with PWW based on strong collaboration with the Staff across all departments, stakeholder engagement, strategic long-term planning and successful implementation of solutions for prior projects. We have worked together with your Staff to provide strong technical solutions that have now become fully integrated into your day-to-day operations (e.g., asset management program, GIS tools, hydraulic model, etc.). In the same spirit, based on our strong track record of commitment to PWW, we are eager to continue to partner with PWW and its staff and leverage our technical capabilities for this Nashua Water Treatment Plant Chemical Feed System Upgrades projects.

Factors Critical to the Success of this Project

CDM Smith understands the goals of this project; we know that PWW needs adaptable chemical feed systems that can accommodate the current water quality and flow rates and allow for utilization of the plant at the full 32 mgd capacity in the future. Based on our ongoing conversations with PWW staff and operations personnel, CDM Smith understands that our evaluation must address a broad range of project drivers, such as the coagulant and chlorine systems and source water quality on the Merrimack River. We have assembled an experienced, local project team that has completed dozens of complex plant upgrade and chemical system improvement projects with water suppliers throughout New England and across the United States. These technical experts know PWW's system and facilities, and will work collaboratively with PWW plant operators to conduct a thorough and cost-effective evaluation of the chemical systems. This close collaboration will result in a prioritized list of improvements with accurate cost estimates, delivering PWW with an actionable plan for system reliability/redundancy, improved safety, and reduced chemical costs.

CDM Smith's Tag Line –
Listen. Think. Deliver.
Put into Action

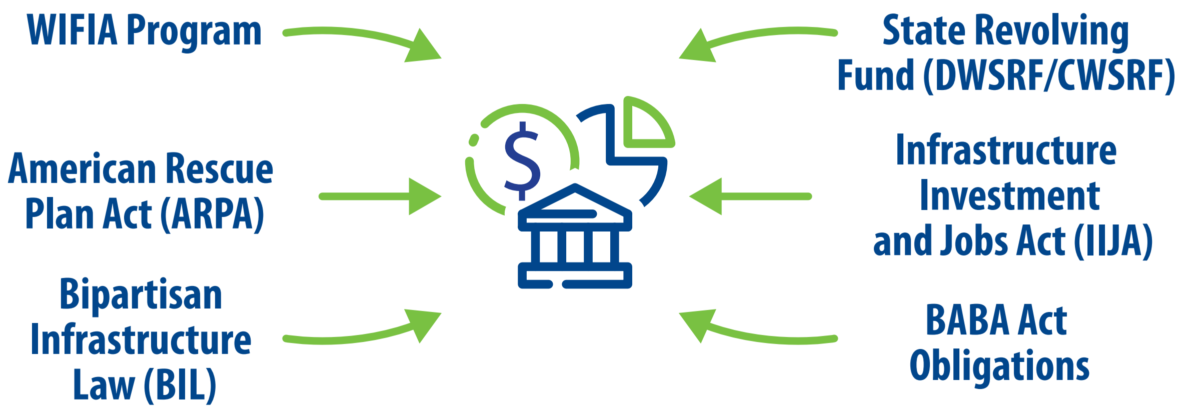
Operators and water system managers retain consulting firms for their expertise, but do not want to be "talked at" or have recommendations pushed upon them. CDM Smith will work collaboratively with PWW to develop a solid basis for all aspects of the design, to the point where all involved feel good about the decisions that have been made.

Consider this example from our work with Manchester Water Works (MWW) in 2003: The operators at the Manchester Water Works plant had struggled for years with chain and flight sedimentation basin sludge collection equipment. Their solution was to install self-designed, rotating wash down assemblies informally referred to as "whirly gigs". While CDM Smith's initial inclination was to recommend more traditional sludge removal technologies, we listened to the operators' success story, and studied their design. With a few improvements in materials, the staff's design appeared nearly intact on CDM Smith's contract drawings. All four sedimentation basins were retrofitted with these assemblies, and they are performing very well. We commend MWW's staff for their innovation, and we were proud to be part of this success.

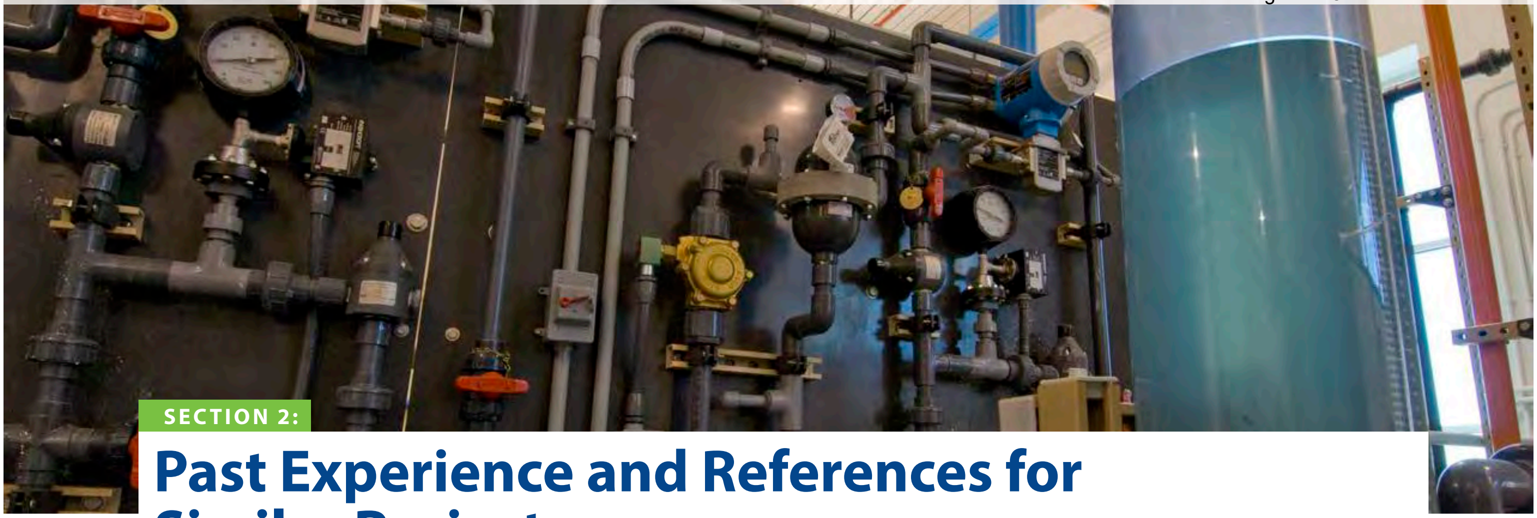
CDM Smith listened to MWW's operators, studied the self-designed rotating wash down "whirly-gig" assemblies, and after minor materials improvements included the staff designs in contract drawings.

Dedicated to Securing Funding for PWW

The Infrastructure Investment and Jobs Act provides historic levels of funding to water utilities. Funding is critical to ensuring our clients' projects can be built and CDM Smith can assist with all phases of the funding progression for a project or program. From determining the best loan or grant available for projects, to the application for the funds, as well as managing the funding and corresponding requirements through project completion. Our experts work with federal and state water and transportation funding programs to help our clients secure and manage needed funds. Often, time is of the essence to receive funding and move projects forward. PWW will benefit from a team who can leverage its familiarity with funding timeframes and requirements to secure the best funding package and stay on schedule.



CDM Smith is well-versed in the nuances of the various funding mechanisms and our experts will help guide PWW through appropriate funding requirements and timeframes.



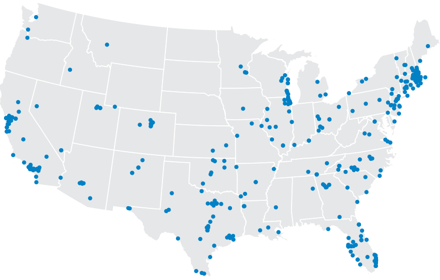
SECTION 2:

Past Experience and References for Similar Projects

Water treatment plant design and water quality improvements are in our DNA. They have been the cornerstone of CDM Smith's practice since the firm's founding in 1947. For seven and a half decades, CDM Smith has successfully designed new WTPs and facility improvements recognized for design excellence by national professional organizations. Over the years, we have worked on virtually every aspect of water quality investigations, treatment technologies, and approaches to treatment plant evaluation and design. We have completed more than 2,500 WTP projects; designing more than 1,500 new or expanded WTPs ranging from 1-mgd to 2,060-mgd across the globe—more than 50 of them here in New England—helping our clients provide cleaner, better tasting water to their communities.

Water Treatment

Our extensive understanding of chemical processes has enabled us to provide best-in-class plant design, pioneering many of the industry's standard water treatment technologies such as ozone, granular activated carbon (GAC), membrane filtration, peracetic acid (PAA), biologically active filtration (BAF), ultraviolet disinfection (UV), and UV Advanced Oxidation Processes (AOP) to resolve challenging water conditions. Continually innovating, several members of this team are currently participating in related research and development of guidance documentation regarding ozone, biofiltration, appropriate indicator and surrogate compounds for chemicals and pathogens for various treatment trains and leveraging computational fluid dynamics (CFD) modeling to optimize plant operations. CDM Smith engineers and scientists use state-of-the-art techniques and innovative source management strategies to provide the tools that water utilities need to help them reach their supply objectives.



> “We have completed more than 2,500 WTP projects; designing more than 1,500 new or expanded WTPs ranging from 1-mgd to 2,060-mgd across the globe—more than 50 of them here in New England—helping our clients provide safer, higher quality, better tasting water to their communities.

Planning, Climate Change, and Resiliency

In addition to our experience serving as a proven PWW partner, CDM Smith is an industry leader in resiliency planning and has successfully delivered more than 200 federal/municipal vulnerability and emergency response plans during the last 20 years, many of which were related to the original Bioterrorism Preparedness and Response Act of 2002. We have assisted water providers with identifying and prioritizing threats to drinking water and wastewater infrastructure; evaluating vulnerabilities and estimating consequences; creating modeling tools for vulnerability and consequence assessment; improving risk management; and planning for countermeasures to reduce risk. Additionally, we've helped communities vulnerable to climate change due to the risk of fluctuating sea levels, increasing water demands and changes in precipitation plan for their future. In California, CDM Smith helped the state and US EPA Regional office develop the Climate Change Handbook for Regional Water Planning, which integrates climate change and water planning.

Emerging Contaminants

While PWW currently uses the Merrimack River as its primary water supply due to its significantly lower levels of per- and polyfluoroalkyl substances (PFAS), PFAS contamination continues to spread throughout Southern New Hampshire. CDM Smith is committed to staying in front of PFAS regulations and can proactively work with Pennichuck to integrate mitigation measures into its recommended plan. We've assisted many utilities in New England and across the nation to develop effective and efficient ways to make their sites and water sources safe. Our PFAS experience is unmatched and CDM Smith is more knowledgeable with these emerging contaminants than any other firm in the region.

CDM Smith's high value solutions for PFAS are built upon:

- Our PFAS experts who are qualified to tackle the most challenging PFAS issues
- Science-based PFAS fate and transport information
- PFAS treatability testing in our state-of-the-art research and testing laboratory
- Our full-scale drinking water treatment design/bid/construction PFAS project experience
- Life cycle cost assessments
- Our R&D department, which advances innovative PFAS destruction technologies
- Our ability to clearly communicate PFAS risks with stakeholders and the general public

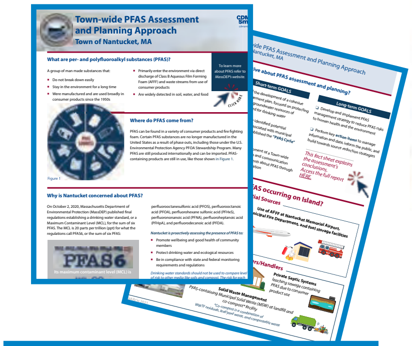
As a leader in PFAS solutions, CDM Smith investigates electrochemical and reductive approaches for treatment of PFAS in groundwater.

CDM Smith can assist PWW with meeting drinking water quality standards regardless of which source of supply (Pennichuck Brook or Merrimack River or some combination) is used to meet the demand. We can help PWW earn the trust of its customers to rely on safe, contaminant free drinking water.

Public Relations

Public concerns often play a key role in the decision-making process of public agencies and will potentially be a factor critical to the success of the design and construction of upgrades, should PWW choose that path forward. In an effort to address this directly, CDM Smith provides the benefit of a dedicated public relations role. **Melissa A. Harclerode, PhD, BCES** is CDM Smith's Sustainability Discipline Leader and could serve as a sustainability representative/ subject matter expert to help facilitate meetings and engagement on this topic. She has proven success helping communities inform and educate residents, including leading town-wide public outreach pertaining to PFAS assessment activities and risk management strategies for Nantucket, MA. This work entails identification of island-wide PFAS sources,

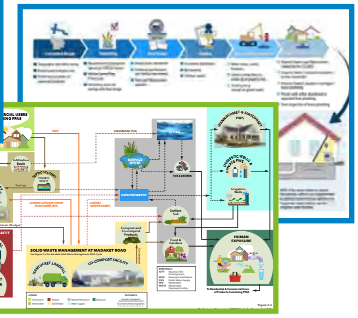
Education Materials



Virtual Meetings

Town-wide Public Communications Coordinator

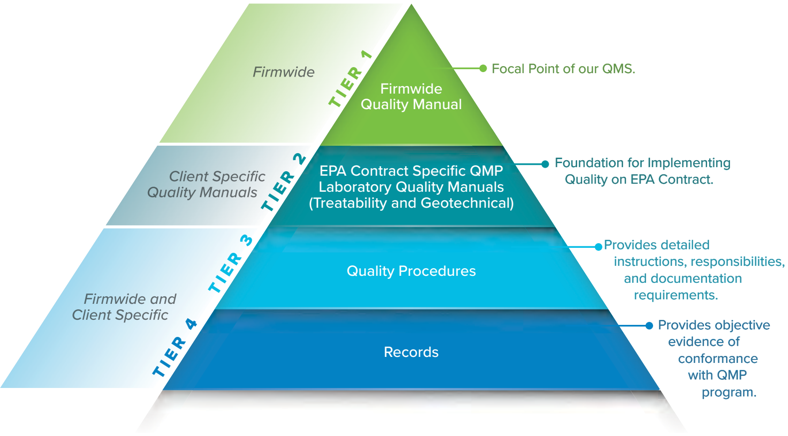
Websites



Infographics

waste haulers/receivers, transport and migration mechanisms, and exposure pathways and routes for a municipal client. As part of this assessment, Dr. Harclerode facilitated a public communication and outreach planning meeting with the client team and PFAS subject matter experts. CDM Smith prepared a public outreach strategy and plan, and developed communication materials (i.e., PFAS assessment fact sheet, human health exposure FAQs, town website updates, press releases, and town community meetings). CDM Smith has successfully performed the PFAS assessment and public communications tasks in a completely virtual setting, using innovative tools to capture stakeholder input and knowledge transfer during virtual meetings.

Quality Management



CDM Smith is a Total Quality Management® firm. Our project managers are trained, holding national Project Management Institute (PMI) certifications, and are well versed in multiple project management tools and risk management processes. Project managers working with client service leaders, senior technical advisors, and the project team follow CDM Smith's four-tiered quality management process. Based on the type of project work (i.e., planning or design) as well as the type of engineering discipline (i.e., water or environmental remediation) and the project risk factors, the quality control activities are planned for each project at the Project Execution Plan (PxP) stage and are performed during the project execution. In order to deliver this project for PWW with the utmost attention to quality, we will fully integrated Quality Assurance/Quality Control (QA/QC) as a core process in our project delivery. We emphasize quality throughout all of our projects with implementation of both detailed guidance documents and a firm-wide cultural commitment to exceeding our clients' expectations for quality.

Health and Safety

CDM Smith's behavior-based Health and Safety Program focuses on injury/illness prevention, safety training, weekly safety meetings, communication and reporting, site inspections, responsible persons, site-specific safety procedures, and hazard recognition and communication. Proactive safety planning is a primary concern for CDM Smith and we recognize the impact of our work product on the PWW safety of operators and users. The emphasis on safety in a project from the initial planning stages, through the design process, and during construction and operations is thoroughly and systematically included in CDM Smith's safety management processes to create a safe construction and operational environment for all stakeholders involved.

Topsham Treatment Facility.

Extensive and Relevant CDM Smith Experience Will Benefit PWW

CDM Smith brings an extensive portfolio of planning, design, construction and operations of water treatment facilities. Locally, we have successfully completed water infrastructure projects for Manchester and Concord, NH, as well as Brunswick and Topsham, ME, and Woburn and Franklin, MA. We have extensive experience conducting evaluations of chemical systems, developing improvements to existing systems, and designing new systems that protect health and safety, reliably meet regulatory requirements, and are cost effective. Below we include highlights of a few of our notable projects that are relevant to PWW and were delivered by our proposed project team members. We've also included contact information for client references who can attest to our firm's capabilities and high-quality performance on these projects.

Merrimack River Pumping and Treatment Facilities

MANCHESTER, NEW HAMPSHIRE

Manchester Water Works (MWW) provides drinking water to the City of Manchester, as well as portions of Auburn, Bedford, Derry, Goffstown, Hooksett, and Londonderry, NH, serving approximately 160,000 customers.

MWW's existing conventional Lake Massabesic Water Treatment Plant (WTP) has an average daily flow of 17 million gallons per day (mgd) and the capacity to operate up to 50 mgd. The plant was last upgraded per a CDM Smith modernization design in 2006. While operations at the Lake Massabesic WTP have been reliable in service and excellent in quality, MWW's average daily demand is approaching the estimated safe yield (20.5 mgd) of Lake Massabesic. As such, an additional water supply – the Merrimack River - is needed to meet future demands. MWW turned to CDM Smith to plan and design the new facilities.

Project Background

In 2001, MWW retained CDM Smith (then CDM) to author the *Water Treatment Plant Performance Evaluation and Capital Improvement Plan* project to establish the basis for how the Lake Massabesic WTP should be upgraded as well as determine where MWW's source of additional drinking water supply for the next 20 to 50 years would come from. In that report, the Merrimack River was identified as the most viable future source of drinking water. MWW installed a radial collector well and riverbank filtration, to form the cornerstone of the new plant.

Project Specifics

In June 2018, CDM Smith kicked off the project and began collaborating with MWW evaluating treatment process options. Multiple goal-setting and process selection workshops were conducted. Before proceeding with the design, construction, and commissioning of a new, 7.2 mgd Merrimack River pumping and treatment facilities, MWW retained CDM Smith to develop the answers to several questions through the work of this Preliminary Design Report:

Ji Im addresses colleagues, Contractor, and MWW staff at recent site visit, educating the audience of the benefits of this new facility.

- Should the Radial Collector Well Site be the location for raw water pumping and treatment facilities, or should the River Crossing Site be the location for the treatment plant?
- What quantitative and qualitative goals should be established for this project?
- Other than membrane filtration, pilot tested in 2017, what other treatment technologies should be considered for the Radial Collector Well water?
- Which treatment process(es) warrant examination through additional pilot testing, and what are the design criteria identified through such pilot testing?
- What is the likely cost of the proposed facilities?

The final design of the new 7.2-mgd plant was completed in 2020. The 20,000-square-foot facility features automated pumping and treatment facilities, greensand filtration, granular activated carbon (GAC) contactors, ultraviolet (UV) disinfection, a clearwell, and various chemical systems including chloramination, with an construction value of $27.3 million. Construction is underway, with project completion anticipated in spring 2023.

Renderings of the new Merrimack River Pumping and Treatment Facilities, for which construction work in Spring 2021 and is scheduled for completion in 2023.

Client

Manchester Water Works
David G. Miller, PE
Deputy Director – Water Supply
1581 Lake Shore Road
Manchester, NH 03109
(603) 792-2851
dmiller@manchesternh.gov

Project Dates

2018 – 2020 (Design)
Construction ongoing

Contract Value

$495,962 (Process Selection, Pilot Testing, and Preliminary Design)

$2,650,000 (Final Design)

$3,350,000 (Services During Construction)

Key Personnel

- David Polcari
- Al LeBlanc (Project Manager)
- Michaela Bogosh
- Jihyon Im
- Sarah Jakositz
- Mark White

RELEVANCE TO PWW:

NH water utility sourced by Merrimack River

Water quality treatment technologies and seven NHDES-approved chemical storage and feed systems designed

Ongoing collaboration with facility operators

All phases of project lifecycle through construction led by CDM Smith

Long-term resiliency planning

Public outreach

Topsham Filtration Facility

TOPSHAM, MAINE

Seeking to replace its 50-year-old Jackson Station Water Treatment Plant and Administration Facilities with a new, modern water treatment plant, the Brunswick and Topsham Water District (BTWD) chose CDM Smith through a competitive, qualifications-based procurement to lead the treatment process selection effort and provide preliminary design services for the new 4-mgd WTP. The project continued with final design, bidding and services during construction.

Project Background

Originally built in 1970 and featuring two groundwater supply wells, the Jackson Station Water Treatment Facility included treatment, administration, and operation facilities. The facility had a major upgrade in 1989. After 50 years in service, however, the aging facility needed to be replaced in its entirety. In addition to aging infrastructure, water quality challenges included high levels of manganese and total organic carbon, an unusual combination for a groundwater supply source, resulting in challenges with formation of disinfection byproducts. The BTWD sought a consultant to design a new Jackson Station WTP and Administration Facilities.

Project Specifics

In December 2017, CDM Smith kicked off the project and began collaborating with the BTWD on evaluating treatment process options. Multiple goal-setting and process selection workshops were conducted, and the BTWD subsequently conducted bench-scale tests of the granular activated carbon (GAC) and pilot-scale tests of fixed bed anion exchange technologies identified by CDM Smith.

Following completion of the testing, CDM Smith prepared estimates of capital and life cycle operating costs for the viable treatment alternatives. The selected approach features a three-stage treatment process – (1) Greensand filtration for iron and manganese removal; (2) fixed bed anion exchange for disinfection byproduct precursor removal; and (3) high-rate manganese polishing contactors. In concert with process selection, CDM Smith consulted with the BTWD on its administration facilities space needs, asset management and computerized maintenance management systems (CMMS), and long-term SCADA planning as part of the overall preliminary design effort.

The final design of the new 4-mgd plant was completed in 2019-2020. The 40,000-square-foot facility features treatment, administrative, customer service, vehicle storage, and distribution operations to be housed within the new District headquarters facility.

On March 31, 2020, the BWTD received construction bids and the low bid of $29,403,172 was accepted shortly thereafter. Construction began in May 2020, with project completion anticipated in Summer 2022. CDM Smith is assisting the BTWD during the construction phase by providing full-time resident inspection and operations and startup assistance.

A rendering of the new Topsham Filtration Facility, for which CDM Smith provided preliminary design and continues service through construction.

Client

Craig Douglas, PE, General Manager
Brunswick & Topsham Water District
Topsham, ME 04086
(207) 729-9956
cwdouglas@btwater.org

Project Dates

2017 – July 2020 (Design)

Construction ongoing

Contract Value

$448,400 (Process Selection and Preliminary Design)

$2,092,854 (Final Design)

$3,065,000 (Services During Construction)

Key Personnel

- David Polcari
- Al LeBlanc (Project Manager))
- Mark White
- Jihyon Im

RELEVANCE TO PWW:

Water quality treatment technologies

Ongoing collaboration with facility operators

All phases of project lifecycle through construction led by CDM Smith

Four chemical systems designed with significant client input and preferences incorporated

Long-term resiliency planning

Public outreach

Horn Pond Water Treatment Plant

WOBURN, MASSACHUSETTS

The City of Woburn had chronic water quality problems for several years. Consumer complaints increased, and several consumers contacted the MassDEP directly with concerns over the safety of the drinking water supply. During public meetings, residents expressed frustration that water quality had continued to deteriorate and had questioned their long-term exposure to elevated levels of manganese and potential health effects thereof. The existing treatment, which consisted of sequestering using a blended phosphate, was no longer adequate to mitigate the situation as levels of manganese in the source water continued to increase.

CDM Smith developed testing protocols and oversaw an extensive bench- and pilot-scale study to evaluate alternative treatment technologies, including granular media and membrane filtration. The Horn Pond facility includes the construction of a 4-mgd water filtration plant for the City's groundwater supply to remove elevated concentrations of iron and manganese in the source water. The new granular media filtration plant includes an addition to the existing treatment facility and a treatment support building to house water department vehicles. Pumping modifications at the facility were also required as well as new on-site storage for process, filtration system and equipment necessary for the operation of the plant and distribution system. In addition to the filtration system, the plant upgrades include ultraviolet light (UV) disinfection for inactivation of pathogens.

Client

John (Jay) Corey, Jr., PE
City Engineer
City of Woburn, MA
(781) 389-7860
JCorey@cityofwoburn.com

Project Dates

2005 – 2011 (Iron and Manganese Filter Project)

2019 - ongoing (PFAS and General Consulting)

Contract Value

$1,467,000

Key Personnel

- Al LeBlanc
- Michaela Bogosh (Project Manager)
- Erin Smith
- Jihyon Im
- Georgine Grissop

RELEVANCE TO PWW:

Water quality treatment technologies

Ongoing collaboration with facility operators

All phases of project lifecycle through construction led by CDM Smith

Long-term resiliency planning

Public outreach including PFAS education

Water System Projects

FRANKLIN, MASSACHUSETTS

CDM Smith has been working with the Town of Franklin for the past decade on several water system evaluation and planning efforts, including facilities planning, treatment and chemical systems design and construction services for the treatment of well fields contaminated with iron and manganese.

Grove Street Water Treatment Plant and Well Field Improvement Design and Construction Services

In 2018, CDM Smith completed a facilities plan for the treatment of groundwater from Well Stations No. 3 and No. 6 for the Town of Franklin. Well Stations No. 3 and No. 6 contain elevated concentrations of iron and manganese. The greatest concern that the Town has is with manganese in Well Station No. 6. Manganese concentrations in Well Station No. 6 are regularly above the 0.3 milligrams per liter (mg/L) Health Advisories issued by the US Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP).

Following completion of the piloting phase, CDM Smith commenced final design of the 1.22-mgd Greensand plant. Final design included two Greensand filters, chemical storage and feed systems, two below-ground reclaimed water tanks, two below-ground washwater supply tanks, reclaimed and washwater supply pumps. Future design considerations were included in the final design of the plant, should water quality change over time and an additional Greensand filter be needed. Additionally, space was allocated in the design for advanced disinfection with UV as well as space for GAC adsorption for treatment of potential contaminants of concern, such as per- and polyfluoroalkyl substances (PFAS).

CDM Smith assisted the Town in applying for a State Revolving Fund (SRF) loan for this project. Four contractor bids were received in August 2019, with the low bid at $10.6 million. Design services were completed in 2019. CDM Smith performed all construction services, oversight, shop drawings and general coordination from 2020- 2021.

Manganese Studies and Solutions

Franklin has faced manganese challenges in the thirteen active wells that serve as the Town's groundwater supply sources. In 2016, the Town removed Well No. 6 from service, as it contained the highest levels of manganese. CDM Smith performed Water quality studies, alternatives analysis, and pilot testing to devise the best suited solution for treatment of Franklin's Wells No. 3 and No. 6, which were important to the overall ability to supply water to the Town. CDM Smith is currently completing an evaluation on the current Franklin corrosion control and sequestering dosing and effectiveness for wells No. 5, 8 and 9. The Town currently utilizes potassium hydroxide to adjust the pH for corrosion control and sodium hexametaphosphate as a sequestering agent for iron and manganese. Additionally, CDM Smith has been tasked with identifying other chemical options to address iron and manganese sequestering, i.e., other agents and associated dosing requirements. CDM Smith will conduct a preliminary sequestration bench scale study at Well No. 9 to evaluate the degree of effectiveness of the current sodium hexametaphosphate treatment. The report will culminate in recommendations for adjustment of current dosing practices, recommendations for the next phase of testing and considerations for long-term planning related to the Lead and Copper Rule Revisions (LCRR).

Client

Douglas Martin, PE
Water & Sewer Superintendent
Franklin Department of Public Works
257 Fisher Street
Franklin, MA 02038
(508) 520-4910
dmartin@franklin.gov

Project Dates

2010 - ongoing

Contract Value

$758,000 (Design)

$1,400,000 (Construction)

Key Personnel

- Michaela Bogosh (Project Manager)
- Al Leblanc
- Erin Smith
- Anne Malenfant
- Georgine Grissop

RELEVANCE TO PWW:

Water quality treatment technologies

Sodium Hypochlorite, Potassium Hydroxide, and Sodium Fluoride Storage and Feed Systems

Ongoing collaboration with facility operators

All phases of project lifecycle through construction led by CDM Smith

PFAS treatment

SRF assistance

Long-term resiliency planning

Public outreach

Carbon Dioxide Feed Tank Replacement for Water Treatment Plant

CONCORD, NEW HAMPSHIRE

The City of Concord owns and operates a 10-mgd water treatment plant, treating surface water from Penacook Lake. The City retained CDM Smith to provide engineering services to replace the existing carbon dioxide feed tank, compressor, and associated piping with two new carbon dioxide (CO2) feed tanks, compressors, and associated piping.

The CO2 system plays a key role in the City's corrosion control strategy. The existing 14-ton tank had served the City beyond its useful life, and the lack of redundancy left the City vulnerable. The existing indoor regulator and injection/diffusion systems remained in place, while two new, smaller six-ton tanks were installed to provide redundancy.

On September 21, 2018, four contractor bids were received, with a low bid of $444,047. The Contractor installed and commissioned the new CO2 tanks and piping prior to taking the existing tank offline, such that the City CO2 supply was uninterrupted through the duration of the project.

Client

Marco Philippon
Water Treatment Superintendent
General Services Department
City of Concord
53 Hutchins Street, Concord, NH 03301
(603) 230-3951
MPhilippon@concordnh.gov

Project Dates

2018-2019

Contract Value

$23,150

Key Personnel

- Alan LeBlanc
- David Polcari (Project Manager)

RELEVANCE TO PWW:

Accurate construction cost estimating

Chemical systems project in New Hampshire

Highly collaborative with client (Marco Philippon)

Long-term resiliency planning

CDM Smith provided redundancy for the City replacing the existing tank with these two, new carbon dioxide feed tanks. Concord's CO2 supply was uninterrupted throughout the duration of this project.

SECTION 3:

Project Team

CDM Smith brings together a multi-disciplinary team of experts to achieve optimum results in terms of cost, function, efficiency, and aesthetics. Water treatment technologies enable utilities to meet stringent regulatory standards and provide consumers with the protection and assurance of quality and purity they demand. CDM Smith builds its water treatment services on a strong technical foundation. We will ***listen*** to you, ***think*** about how to best address your needs, and ***deliver*** a plan that meets your objectives. The proposed team members are ready to apply their combined knowledge and experience to provide PWW with a comprehensive water evaluation and actionable plan of recommendations, tailored to meet your short- and long-term objectives.

As shown in **Figure 3-1**, our Principal in Charge, **David G. Polcari, PE, PMP**, will apply his significant municipal water system consulting experience to oversee the project team, provide strategic direction to project performance and stakeholder outreach as well as perform deliverable quality reviews. **Alan G. LeBlanc, PE** will serve as Project Manager and **Michaela L. Bogosh, PE**, PMP, will serve as Deputy Project Manager. Al and Michaela have formed an effective partnership in these roles on past projects in Manchester, NH and Ayer, MA – Al leads the technical direction of the project and will be actively engaged with PWW, while Michaela provides direct support by performing day-to-day project management and task execution, team and client communications, project schedule and budget monitoring; execution of quality management activities and other associated duties. Al and Michaela have collaborated on numerous successful WTP upgrade projects throughout New England and are eager to work with PWW in this capacity.

CDM Smith's team is further supported by Technical Advisors **Lauren M. Miller, CC-P** (Climate Resilience) and **Mark C. White, PE** (Process). Each are recognized industry leaders with the right combination of experience to provide guidance to PWW throughout this process. As detailed in the bios that follow, these individuals offer our clients highly technical expertise in the areas of chemical systems process, planning and resiliency, process engineering and grant funding, and public relations.

Further detail on our team's qualifications, including support in the roles of several water treatment related engineering disciplines, is provided in the bios below and detailed in the resumes that follow.

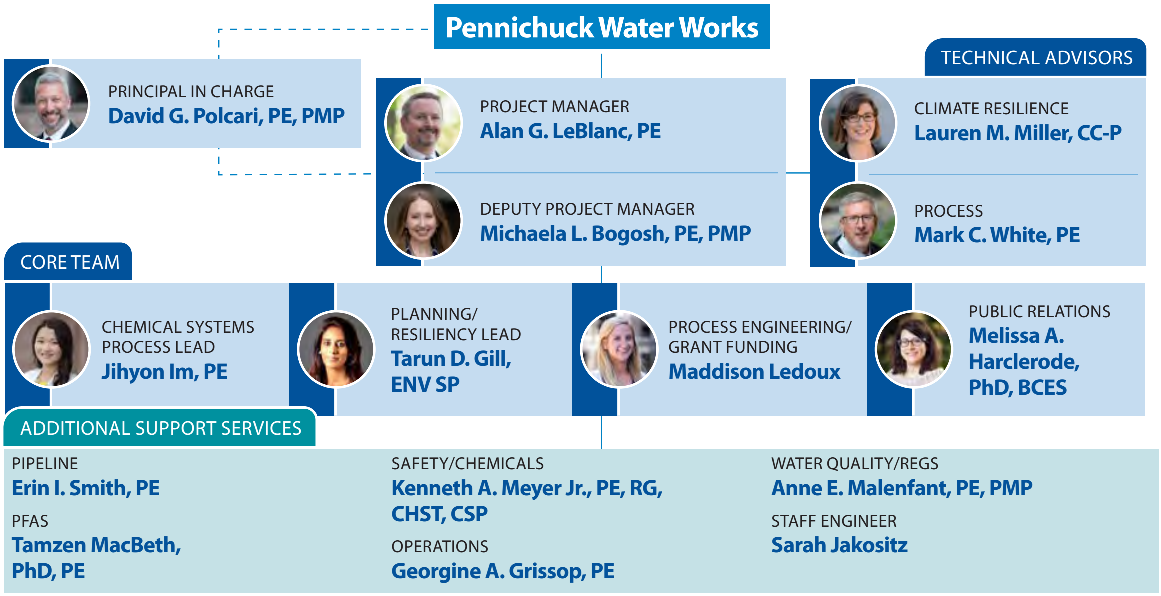


Figure 3-1

Team Leadership

David G. Polcari, PE, PMP | *Principal in Charge*
Mr. Polcari has 34 years of experience in municipal water, sewer, and stormwater work. He has served as principal in charge or managed water treatment, distribution, and asset management projects in New Hampshire and throughout New England. He is dedicated to providing exceptional client service and has served several of his clients in various roles for his entire career. For PWW, Mr. Polcari is the principal-in-charge for our asset management work and was project manager for the AWIA Risk and Resiliency Assessment and On-Call Hydraulic Modeling project. He served as Project Director and facilitated the Process Selection and Preliminary Design for the new 4 mgd WTP for Brunswick and Topsham Water District (Maine), facilitated preliminary design and quality management workshops for the new 7.2 mgd WTP for Manchester Water Works (MWW), and Project Manager for a WTP Upgrade and 5 mgd Expansion in Methuen, MA. Mr. Polcari also recently served as principal in charge for several water projects in Salem, New Hampshire, including a Water Master Plan, several water distribution and storage improvement projects, and a town wide water meter replacement / AMR project.

Alan G. LeBlanc, PE | *Project Manager*
A renowned leader in water supply and treatment, Mr. LeBlanc is passionately committed to delivering safe, quality water as an essential community service. Mr. LeBlanc is a registered professional engineer in New Hampshire and has 28 years of design and construction experience, including municipal water and wastewater treatment, chemical systems design, hydraulic piping and pumping analysis, sanitary and storm sewer collection systems, application of sustainable design concepts, and construction cost estimating. He's helping to lead the charge to study and treat PFAS and other emerging contaminants, doing cutting-edge work that's helping to set the standard for the water industry. For the MWW's new 7.2-mgd Merrimack River WTP, Mr. LeBlanc managed the pilot testing, process selection, and design that features greensand filtration and a GAC polishing step for taste, odor, organics, and potential PFAS removal. For the Brunswick and Topsham Water District's replacement of the Jackson Station treatment and administrative facilities, Mr. LeBlanc managed the process selection and design work. He serves as technical director for several projects executed for the Maine Water Company, including disinfection byproducts reduction, water system master planning, and WTP evaluation. His PFAS treatment planning work includes the 4-mgd Horn Pond WTP in Woburn, MA; the 1-mgd Avon WTP in Brockton, MA; and the 0.38 mgd Lincoln Street Well in Manchester-by-the-Sea, Massachusetts.

Michaela L. Bogosh, PE, PMP | *Deputy Project Manager*
Ms. Bogosh is a New Hampshire-licensed environmental engineer with 10 years of experience in drinking water treatment, drinking water quality, chemical storage and feed systems, water distribution storage design, drainage and sewer pipeline design, wastewater management, and regulatory compliance. Her recent areas of water system specialty include the study and design of water treatment facilities to remove manganese and PFAS as well as treatment upgrades to improve overall water quality. Ms. Bogosh served as the assistant project manager and lead process mechanical engineer in the design of the new 7.2-mgd Merrimack River WTP for MWW, a design that included seven chemical storage and feed systems. She has recently supported utilities like PWW with water treatment and evaluation projects in Franklin, Woburn, and Ayer, MA.

Lauren M. Miller, CC-P | *Technical Advisor – Climate Resilience*
Ms. Miller is the firm-wide Climate Resilience Discipline Leader, leading CDM Smith's climate resilience team and strategic initiatives. With 17 years of experience, she specializes in climate change services, including vulnerability assessments, climate resilience, and adaptation plans and leads the firm's America's Water Infrastructure Act work, coordinating with teams across the country to implement projects in technically consistent manner. For PWW, Ms. Miller is the lead technical specialist for the AWIA Risk and Resiliency Assessment. She was the Project Manager and Technical Lead for the Salem, MA Climate Change Vulnerability Assessment and Adaptation Plan. As a resiliency expert, Ms. Miller is able to bridge both technical and layman worlds and has been a critical leader and resiliency expert for recent projects such as the AWIA RRA and EPR projects for North Texas Municipal Water District (NTMWD); Middlesex Water Company; Fort Worth, TX; Lee County, FL; the Passaic River Basin Climate Resilience Plan; and municipal/federal hazard mitigation plans, vulnerability assessments, adaptation plans for municipalities.

Mark C. White, PE | *Technical Advisor – Process*
Mr. White has more than 25 years of US and international experience in the planning, design, operations and maintenance, and construction of water treatment facilities. He has evaluated and/or designed improvements to more than 40 WTPs totaling more than one-billion-gallons-per-day of capacity. He is well versed in membrane technology and has served as project manager or membrane design for over 400-million-gallons-per-day mgd of membrane filtration treatment capacity, including some of the largest membrane projects in the United States. He served as a technical advisor for both MWW's new 7.2-mgd Merrimack River WTP and the Brunswick and Topsham Water District's replacement of the Jackson Station treatment and administrative facilities.

As a water treatment industry leader, Mr. White serves on various state and national committees, including the American Water Works Association's (AWWA) Water Treatment Facilities Design and Construction Committee and the AWWA Membrane Process Committee. He has authored more than 20 technical presentations on water treatment technologies at AWWA National Conferences and has taught classes on the design of water treatment systems at the University of North Carolina-Chapel Hill and the University of Wisconsin-Madison. In addition, he has authored chapters of drinking water manuals of practice, including the AWWA M53 Manual of Practice for Microfiltration and Ultrafiltration Membranes and the Indian Water Works Association M5 Manual on Augmentation and Upgradation of Water Treatment Plants.

Core Team

Jihyon Im, PE | *Chemical Systems Process Lead*
Ms. Ji Im specializes in drinking water treatment projects for municipal clients and has worked on over 30 studies, design and construction projects in the country. In her eight years of experience, her work has focused on treating and mitigating conventional water quality challenges such as organics, turbidity, disinfection byproducts, iron/manganese, and lead copper as well as emerging contaminants like PFAS. She is experienced in the design of new water treatment facilities, existing plant upgrades, and studies for master planning, treatment evaluations, regulatory review, and water quality analyses.

For MWW, Ms. Im served as a project engineer for the design of the brand new 7.2 mgd radial collector well treatment facility on the Merrimack River. She led the design of seven chemical storage and feed systems as well as worked on the treatment process selection, preliminary design work, final design and construction phase. For the Brunswick and Topsham Water District's new 4 mgd Topsham Filtration Facility in Maine, Ms. Im worked on collaborative water quality goal setting, capital and operational cost projections, and consensus building with stakeholders including District trustees and state regulatory officials in the planning phase. She designed the iron, manganese, and disinfection-byproduct precursor removal processes. She has also worked on numerous design and construction projects with chemical feed and storage systems for various coagulants/polymer, pH adjustment/oxidant, disinfection, and corrosion inhibitor chemicals.

Tarun D. Gill, ENV SP | *Planning/Resiliency Lead*
Ms. Gill has more than 20 years of experience in Utility Master Planning, Hydraulic Modeling, Capital Improvement Program (CIP) Planning and Asset Management, Project Prioritization Programs, System Capacity Evaluations, Demand/Flow Analysis and Projections, Model Training, and Risk-Based Cost/Benefit Analysis. She has managed more than 100 master plans, water resource plans, CIP programs, and system operational studies. She provides strong leadership in the risk and resiliency sector for water resources and environmental projects.

Maddison Ledoux | *Process Engineering/Grant Funding*
Ms. Ledoux is an environmental engineer with experience in preliminary design, final design and planning studies for drinking water and wastewater clients as well as experience completing site inspections to analyze treatment efficiency, monitoring streams and calculating flow rates, implementing asset management programs, and performing bench-scale tests. Her chemical storage and feed work includes experience with zinc orthophosphate, sodium hypochlorite, potassium hydroxide, and sodium fluoride systems. Ms. Ledoux is also familiar with modeling software used to aid in evaluations, studies and process selection including Water!Pro and Biowin. Ms. Ledoux has served as a project engineer supporting Pennichuck's AWIA Risk and Resiliency Assessment and Emergency Response Plans for the Nashua, Londonderry and Litchfield systems. Ms. Ledoux's involvement included collaborating with Pennichuck staff to identify assets at risk and developing a comprehensive plan for how to mitigate vulnerability. Prior to CDM Smith, Ms. Ledoux spent four consecutive summers interning for Pennichuck, contributing to the implementation of an asset management program, inspecting stormwater management sites, and stream monitoring.

Melissa A. Harclerode, PhD, BCES | *Public Relations*
Dr. Harclerode is a technical specialist with 16 years of experience in environmental management across a variety of market sectors including remediation, water resources, solid waste management, and transportation. Specifically, she specializes in the development and application of integrated assessment approaches to comprehensively define sustainability objectives and evaluate environmental, social, and economic impacts of environmental infrastructure and restoration projects. Dr. Harclerode provides technical support and modeling on environmental footprint analysis, life cycle assessment, community impact evaluations, risk communication, public outreach planning, climate change vulnerability assessments, and development of sustainable best management practices. She is currently supporting Nantucket, MA with its public education and stakeholder engagement, identifying short and long-term public communication and outreach needs and action items as part of the Town-wide Assessment.

Additional Support Services

Erin I. Smith, PE | *Pipeline*
Mr. Smith is an environmental engineer with 18 years of experience in water distribution evaluation and design. He is proficient in several hydraulic modeling software programs including Bentley's WaterGEMS. He also has several years of experience in the design and construction oversight of water and wastewater treatment facilities, collection and distribution pump stations, and urban watershed analysis and design. As the project manager for the development of the new hydraulic distribution model of the PWW NCWS, Mr. Smith worked directly with PWW staff to develop and implement a field-testing program to aid in model calibration.

Tamzen MacBeth, PhD, PE | *PFAS*
Dr. Macbeth is an internationally recognized remediation expert with over 17 years of experience in the development, demonstration, design and implementation of innovative, cost-effective remedial strategies for cleanup of hazardous waste contaminated sites. Her work leverages her interdisciplinary academic and research background in microbiology and engineering to advance remediation technologies such as in situ bioremediation, natural attenuation, in situ chemical oxidation, in situ chemical reduction, pump and treat and thermal treatment, alone and in combination to clean up non-aqueous phase liquids (NAPLs), dissolved organic, inorganic, and radioactive chemicals under a variety of regulatory programs. She has served as principal investigator, manager and/or technical lead and advisor for over 100 government, private and international contaminated sites undergoing characterization, design, and remediation at the laboratory-scale, pilot-scale and full-scale. In addition, Dr. Macbeth has led multi-disciplinary teams to support value engineering assessments, including integrating green and sustainable remediation metrics, to select, optimize and/or transition remedies for hazardous waste sites for a variety of government and private clients to achieve successful cleanup. Dr. Macbeth was recently co-author on a guidance document to optimize pump and treat systems for the USACE and EPA by integrating concepts of natural aquifer attenuation capacity, innovative diagnostic metrics and clear exit strategies to break the cycle of endless pump and treat operation at complex sites.

Kenneth A. Meyer Jr., PE, RG, CHST, CSP | *Safety/Chemicals*
Mr. Meyer has over 30 years of diversified health and safety and project/program management experience in the government and commercial sectors. He has strong management skills, including program and engineering management, environmental restoration and remediation, resource management, construction management, community relations, estimating, scheduling, and project planning. Mr. Meyer also has a regulatory compliance and permitting background that includes certifications from OSHA, NEPA, RCRA, MSHA CERCLA, NRC, CAA, and CWA.

In his current role, Mr. Meyer is responsible for the overall management and implementation of CDM Smith's construction health and safety program. This includes oversight of construction, demolition, and remediation projects, initiatives to improve safety culture and performance, health and safety training, and performance reporting. He also coordinates incident investigations, performs audits and provides health and safety training. Mr. Meyer interfaces with senior and corporate management to ensure that health and safety programs are consistently and efficiently implemented throughout CDM Smith.

Georgine A. Grissop, PE | *Operations*
Ms. Grissop has 40 years of experience in drinking water and domestic, industrial, and hazardous wastewater treatment systems. Her experience includes facility and personnel management, compliance reporting, process control, maintenance, and safety. She has directed numerous and diverse plant start-ups, developed facility operations and maintenance (O&M) manuals and operations and maintenance procedures, trained staff on diverse wastewater and water O&M topics, performed facility evaluations, design reviews, environmental and operational site risk assessments, and implemented computerized operational monitoring, control, and maintenance management systems. For the upgraded 4-mgd water treatment facility in Woburn, MA, Ms. Grissop provided O&M services assistance during facility construction and startup. The facility utilizes iron and manganese removal horizontal pressure filtration, potassium permanganate pre-oxidation, potassium hydroxide pH adjustment, fluoridation using fluosilicic acid and disinfection using ultraviolet light.

Anne E. Malenfant, PE, PMP | *Water Quality/Regulatory*
Ms. Malenfant is a drinking water quality and regulatory expert with 22 years working with clients throughout New England, the United States and Europe. Her work has included drinking water and wastewater processes and planning, regulatory review, water quality, and chemistry evaluations and design, all with an eye to maximizing the client's existing assets while planning for the future. Disinfection byproducts (DBPs), lead and copper and polyfluoroalkyl substances (PFAS) are all areas of particular focus and assisting client navigate complex and changing regulations. She has provided her technical and project management expertise to several recent Maine Water Company projects including the Comprehensive System Facilities Plan and Disinfection Byproduct Study and Regulatory Compliance Evaluation for Millinocket; Alternatives Evaluation for the Skowhegan Water Treatment Plant; and Hardness, Chloride, and Sodium Mitigation Evaluation for Camden-Rockland. Additionally, throughout New England, her project work has included numerous DBP studies (Springfield, MA, Brockton, MA, Salem and Beverly, MA, East Providence, RI and Norwich, CT), water quality management for Springfield's 100-mgd (million gallons per day) West Parish Filters plant and project management for a $10 million iron, manganese and PFAS treatment facility in Massachusetts.

Sarah Jakositz | *Staff Engineer*
Ms. Jakositz is an environmental engineer focused on drinking water and water resources projects. She has experience with an array of projects, including drinking WTP design, SWMM5 modeling, WaterGEMS modeling, and Research and Development efforts. She is also familiar with Microsoft Excel, ArcGIS, WaterPro, Stella Architect, and Python. For Manchester Water Works, she was a project engineer for the 5,000 gpm (7.2 mgd) radial collector well treatment facility on the Merrimack River – a new plant on a greenfield site to augment Manchester's existing 40-mgd plant's production. Ms. Jakositz also served as a project engineer supporting Pennichuck's AWIA Risk and Resiliency Assessment where she used asset management data to identify key assets at risk of various threats.

David G. Polcari, PE, PMP

PRINCIPAL IN CHARGE

Mr. Polcari has 34 years of experience in municipal water, sewer, and stormwater work. He has managed water treatment plant improvements; water distribution system analysis and planning projects; water main and distribution system improvement design; wastewater master planning projects; design of sewer separation and rehabilitation measures; combined sewer system evaluation; infiltration/inflow (I/I) studies; sewer system evaluation surveys (SSES); sewer and drainage system design; and Geographic Information System (GIS) development for water and sewer systems. He specializes in pipeline rehabilitation and serves as a CDM Smith resource for trenchless technology.

Principal-in-Charge, Project Manager, Asset Management, AWIA Risk and Resiliency Assessment, and On-Call Hydraulic Modeling, Pennichuck Water Works (PWW), Nashua, New Hampshire. For PWW, Mr. Polcari recently oversaw the management of CDM Smith's work including the AWIA Risk and Resiliency Assessment and Emergency Response Plan project for the Nashua Core system, and the Londonderry and Litchfield systems. The delivery of this project included a very collaborative effort between Pennichuck and CDM Smith staff to meet the objectives. Mr. Polcari also provided management for the Cityworks Migration / Asset Management Project, ands ongoing hydrualic model training and assistance project.

Project Director, Process Selection and Design of New Water Treatment Plant, Manchester, New Hampshire. For the Manchester Water Works' new 7.2-mgd Merrimack River Water Treatment Plant (WTP), Mr. Polcari facilitated the preliminary design and quality management workshops. His work focused on identifying critical success factors for the project implementation and leading a facilitated discussion to determine the evaluation and selection of treatment processes. The $28.3 million plant is expected to serve Manchester and water systems throughout southern New Hampshire, given water supply shortages and PFAS contamination concerns in the region.

Project Director, Process Selection and Design of New Water Treatment Plant, Topsham, Maine. For the Brunswick and Topsham Water District's replacement of the Jackson Station treatment and administrative facilities, Mr. Polcari served as the project director and facilitated the process selection and preliminary design. Greensand filtration, fixed bed anion exchange, and manganese polishing contactors were selected for full scale implementation. The future 4-mgd (million gallons per day) plant's construction bid at $29.4 million, with treatment, administrative, customer service, vehicle storage, and distribution operations to be housed within the new District headquarters facility. The work included collaborative water quality goal setting, capital and operational cost projections, asset management planning, and consensus building with stakeholders, including District trustees and state regulatory officials.

Project Manager, Water Treatment Plant (WTP) Improvements, Methuen, Massachusetts. Mr. Polcari served as project manager several projects at Methuen's water treatment facility. Most recently, he served as project director for upgrade and expansion of the plant from a capacity 10-mgd to 15-mgd. The upgrade included replacement and renovation of all major systems at the facility. Other prior projects included rehabilitation of the existing pretreatment basins including repair of leaks

Education

MS - Civil Engineering, Northeastern University, 1992

BS - Civil Engineering, Worcester Polytechnic Institute, 1988

Registration

Professional Engineer: Massachusetts, (1993); New Hampshire, 2014

Certifications

Collection Systems Operator Grade IV - New England Water Pollution Control Association

NASSCO Pipeline Assessment Certification Program, 2006

Office Location

Manchester, NH

and renovation of existing concrete. Mr. Polcari was also project manager for the replacement and renovation of the five high lift pumps at the plant.

Project Manager, High Service Area Planning and Construction, Methuen, Massachusetts. Mr. Polcari served as project manager for the planning, design, construction and implementation of a high service area in Methuen. Planning phases of the project included development of a report that addressed pressure and storage issues, upgrading aging mains and improving fire flow, and reviewing supply limitations. Several design and construction projects were also completed following the study phase. The most significant project was developed to better serve existing residents located at high elevations in the city. The high service area project isolated a large section of distribution system that was to be served by a higher hydraulic grade line than the current system. Major elements of the project included a new 70 ft tall 4 MG prestressed concrete water tank, a new booster pumping station, facilities for chemical addition and valve and piping improvements. Mr. Polcari also worked closely with the city during the implementation and commissioning phase of the project.

Officer-in-Charge, Water System Master Plan and Meter Reading Project, Salem, New Hampshire. Mr. Polcari served as officer-in-charge for several projects in Salem. The first project involved developing a water system master plan. The master plan evaluated all aspects of water supply, treatment, distribution and operations and maintenance of the town's water system. The plan also identified options for expansion and developed a capital improvements plan. Mr. Polcari served as officer in charge for a town-wide water meter / automatic meter reading project that will fully upgrade Salem's metering system. The project includes approximately 7,000 meters and a radio read Automatic Meter Reading (AMR) system. Mr. Polcari also served as officer-in-charge for a steel water tank painting / rehabilitation project for the town.

Principal-in-Charge, Various Projects, Manchester, New Hampshire. Mr. Polcari is currently serving as principal-in-charge for the Phase 3 CMOM project and an Asset Management project for all wastewater vertical and horizontal assets in Manchester. He recently served as project director for several projects in Manchester, NH including the Chestnut Street Sewer Separation project. The Chestnut Street project consists of design of large diameter storm drains to separate a section of downtown near the former police and fire station that was flooded during an extreme wet weather event. The project is in the heart of downtown and required coordination from many stakeholders including the Verizon Wireless Arena, a federal building and a county courthouse along with many area businesses. The work is being performed in two construction contracts and includes more than 15,000 linear feet of pipe, roadway reconstruction and sidewalk improvements, green infrastructure for stormwater management, and other miscellaneous improvements.

Design Manager, Manchester Water Works, High Service Reservoir Cover Replacement. Mr. Polcari recently managed the design activities for the emergency replacement of the existing floating cover and liner at the 4-MG High Service reservoir on Tower Hill. Due to the emergency nature of the repair, the City chose to use a design-build alternative delivery approach to quickly get the reservoir back in service. Improvements included preparing design documents including plans and specifications for a new floating cover, reservoir liner, and other appurtenances. The entire project, including construction, was completed in approximately two months.

Alan G. LeBlanc, PE

PROJECT MANAGER

Mr. LeBlanc is a civil engineer with 28 years of design and construction experience, including municipal water and wastewater treatment, PFAS removal, hydraulic piping and pumping analysis, sanitary and storm sewer collection systems, application of sustainable design concepts, and construction cost estimating. Mr. LeBlanc served as Chair of the New England Water Works Association Filtration Committee for eight years and has led training courses on filtration and granular activated carbon (GAC) adsorption design and operation for the past 17 years.

Project Manager, Process Selection and Design of New Water Treatment Plant, Manchester, New Hampshire. For the Manchester Water Works' new 7.2-mgd Merrimack River Water Treatment Plant (WTP), Mr. LeBlanc is managing the pilot testing, process selection, and design that features greensand filtration and a GAC polishing step for taste, odor, organics, and potential PFAS removal. The $28.3 million plant is expected to serve Manchester and potentially water systems throughout southern New Hampshire, given water supply shortages and PFAS contamination concerns in the region.

Project Manager, Process Selection and Design of New , Topsham, Maine. For the Brunswick and Topsham Water District's replacement of the Jackson Station treatment and administrative facilities, Mr. LeBlanc managed the process selection and design work. Greensand filtration, fixed bed anion exchange, and manganese polishing contactors were selected for full scale implementation. The future 4-mgd (million gallons per day) plant's construction bid at $29.4 million, with treatment, administrative, customer service, vehicle storage, and distribution operations to be housed within the new District headquarters facility. The work included collaborative water quality goal setting, capital and operational cost projections, asset management planning, and consensus building with stakeholders, including District trustees and state regulatory officials.

Project Technical Leader, Intake Screen Replacement Project, Concord, New Hampshire. As part of CDM Smith's on-call engineering services, Mr. Leblanc was the project technical lead for the design of the mechanical intake screen replacement at the City of Concord's 10-mgd WTP. He oversaw the design documents and drawings for providing a new mechanical screen and relocating the existing manual screen rack. The work required demolition of the existing screen, electrical work, and replacement of a deteriorated existing cast iron slide gate.

Project Advisor, Horn Pond WTP Upgrade, Woburn, Massachusetts. Mr. LeBlanc provided technical guidance for the 4-mgd Woburn WTP design which features ultraviolet (UV) reactors downstream of a filtration system. Construction is complete.

Technical Leader, Pressurized Media Filtration Pilot and Final Design, Franklin, Massachusetts. As the project technical leader, Mr. LeBlanc oversaw the final design of the new 1.22-mgd GreensandPlusTM treatment plant, including the design of the sodium hypochlorite, potassium hydroxide and sodium fluoride chemical storage and feed systems. MassDEP coordination and approval and SRF funding were key elements of the project.

Education

ME - Civil Engineering. Colorado State University, 2007

BS - Civil Engineering. Northeastern University, 1994

Registration

Professional Engineer: Colorado (1999), New Hampshire, Massachusetts, Connecticut, New Jersey, Maryland, Illinois, Maine, Rhode Island and Ohio

State of New Hampshire Water Works Operator, Combined Grade CIA

Certifications

Confined Space Entry Certification

Office Location

Manchester, NH

Project Engineer, WTP Improvements, New Hampshire. Mr. LeBlanc engineered the overhaul of the flash mixing, chemical storage and feed and sedimentation basin washdown systems at the Manchester Water Works' (MWW) Lake Massabesic WTP. The 40-mgd plant is the site of a $28M upgrade that was completed in 2006.

Project Manager/Project Engineer, WTP Evaluations, Various Locations, New Hampshire and Massachusetts. Mr. LeBlanc served as project engineer on water treatment plant evaluations for the Manchester Water Works (MWW) (40-mgd) and the Town of Exeter (3.4-mgd). Review of performance against state and federal regulations, audits of process and equipment reliability, evaluation of future treatment technology alternatives and development of short- and long-term capital improvement recommendations were key components of each project. Further work in Exeter included the core sampling and audit of the plant's gravity filters, the capacity and electrical upgrade of a water booster pumping station and a plant automation evaluation. For the City of Gloucester, Massachusetts, Mr. LeBlanc also managed a system-wide Water Needs Assessment with the City and Massachusetts Department of Environmental Protection (MassDEP) to optimize Total Organic Carbon (TOC) removal and regulatory compliance.

Technical Director, Water Treatment Projects in Maine. Mr. LeBlanc serves as technical director for several projects executed for the Maine Water Company. The work includes disinfection byproducts reduction in Millinocket, Maine, and Camden, Maine; water system master planning in Millinocket, Maine; water treatment plant evaluation in Skowhegan, Maine; and road salt / water quality mitigation in Hartland, Maine.

Technical Director, PFAS Removal Planning in Massachusetts. Mr. LeBlanc serves as technical director for several CDM Smith projects that provided PFAS treatment planning to communities in Massachusetts, including work at the 1-mgd Avon WTP in Brockton, MA; at the 4-mgd Horn Pond WTP in Woburn, MA; and the 0.38 mgd Lincoln Street Well in Manchester-by-the-Sea, Massachusetts.

Project Director, PFAS Removal Alternatives Analysis and Final Design, Ayer, Massachusetts. Mr. LeBlanc oversaw the review of water quality data, establishment of treatment goals, and the design of PFAS treatment at the Town's existing 2-mgd Spectacle Pond WTP. Point of Use device testing for PFAS removal efficacy and coordination with MassDEP are key elements of the project. Granular activated carbon was identified at bench scale as most effective on this site's water. The low Contractor bid of $5.1 million was received in fall 2020, and construction will conclude in spring 2022.

Technical Advisor, PFAS Mitigation, Littleton, Massachusetts. For the Littleton Water Department (LWD), Mr. LeBlanc oversaw the anion exchange and granular activated carbon bench scale testing for PFAS removal from the Spectacle Pond WTP source water and consulted on the blending of Spectacle Pond WTP water with the lower-PFAS Beaver Brook WTP water. LWD has been achieving compliance via blending while its new GAC plant is designed and constructed.

Design Manager, Water Treatment Plant (WTP) Replacement, Annapolis, Maryland. Mr. LeBlanc was the design project manager for City of Annapolis's new WTP. The design build (D/B) project included pilot testing of biological filtration for iron and manganese removal and features replacement of the 1930s-vintage 8-mgd conventional treatment plant with conventional pretreatment and filtration. The project earned LEED Silver certification.

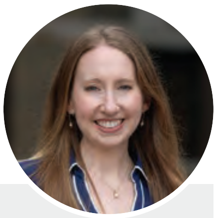
Deputy Project Manager, Water Treatment Plant (WTP) Upgrade Design, Haworth, New Jersey. Mr. LeBlanc was deputy project manager and lead ozone system designer for United Water's $80 million 188-mgd WTP upgrade featuring a new DAF process and a LOX-fed pre-ozone system that replaced the existing air preparation ozone system. SCADA improvements were also a key feature of this D/B project.

Design Manager, Water Treatment Plant (WTP) Upgrade Design, Millburn, New Jersey. Mr. LeBlanc was the design project manager for New Jersey American Water's $72 million 15mgd Canoe Brook WTP. The design-build (D/B) project featured a new LOX-fed preozone system, high rate dissolved air flotation (DAF), granular activated carbon (GAC) filtration, clearwell, pumping stations and residuals handling facilities.

Project Engineer, Buckman Direct Diversion Water Treatment Plant (WTP), Santa Fe, New Mexico. Mr. LeBlanc authored the preliminary design of all chemical systems on this 15-mgd design-build (D/B) assignment. The $125M project featured a new ozonation/membrane filtration plant, diversion works on the Rio Grande and more than 20 miles of raw and finished water transmission pipelines.

Michaela L. Bogosh, PE, PMP

DEPUTY PROJECT MANAGER



Ms. Bogosh is an environmental engineer with ten years of experience in drinking water treatment, drinking water quality, water distribution storage design, drainage and sewer pipeline design, wastewater management, and regulatory compliance.

Project Manager, Final Design, Manchester Water Works, Manchester, New Hampshire. Ms. Bogosh served as the lead process mechanical engineer in the preliminary design of the new 7.2-mgd Merrimack River Water Treatment Plant for Manchester Water Works (MWW). She subsequently became the project manager for the final design phase of work. Treatment processes include two-stage filtration with adsorptive media using greensand filtration and GAC contactors. Enhanced treatment with ultraviolet (UV) disinfection as well as final disinfection through a tank-in-tank clearwell were also included in the design. Ms. Bogosh also led the design of the raw water pumping station, which pulls water from an existing radial collector well to serve as pretreatment through riverbank filtration along the Merrimack River. Final design has been completed and the estimated $32 million project is currently out to bid with an anticipated construction duration of two years.

Project Engineer, Pressurized Media Filtration Pilot and Final Design, Franklin, Massachusetts. As the lead process mechanical engineer, Ms. Bogosh oversaw a subconsultant's pilot testing operation which examined two different pressurized media filtration technologies (GreensandPlusTM and Pureflow© PM-200) for the removal of iron and manganese. Ms. Bogosh then led the process mechanical final design of the new 1.22-mgd GreensandPlusTM treatment plant, including the design of the chemical storage and feed systems for sodium hypochlorite, potassium hydroxide, and sodium fluoride. Ms. Bogosh led the process mechanical coordination with the design team disciplines including structural, electrical, instrumentation and control, and geotechnical.

Project Manager, Per- and Polyfluoroalkyl Substances Water Treatment Plant Conceptual Design, Ayer, Massachusetts. Ms. Bogosh managed the conceptual and final design of perfluorooctanoic acid (PFAS) (per- and polyfluoroalkyl substances) treatment at the Town's existing 2-mgd (million gallons per day) Spectacle Pond Water Treatment Plant (WTP). Bench scale testing consisted of two ion exchange resins and granular activated carbon (GAC) media. Ms. Bogosh was also one of the lead process mechanical design engineers for the conceptual and final design phases. She led the design of the major water treatment processes and other treatment components including treatment of PFAS through GAC contactors. Construction of the $5.1 million project is currently underway.

Project Manager, Concept Design, Littleton Electric Light and Water Departments, Littleton, Massachusetts. Ms. Bogosh served as the project manager for several projects with the Littleton Water Department (LWD) including the concept design for PFAS treatment of the existing Spectacle Pond water supply well. To accelerate compliance with MassDEP's guidelines, Ms. Bogosh led the design to incorporate blending of the Spectacle Pond WTP water with the water from the Beaver Brook WTP, also owned and operated by LWD. The blending design features a temporary pipeline and has delivered water with PFAS less than 20 ppt since May 2020. Ms. Bogosh also led the bench scale testing and PFAS fingerprinting efforts from water collected at the Spectacle Pond water supply well. Bench scale testing conducted of investigating two

Education

MS - Civil Engineering, University of New Hampshire, 2011

BS - Civil Engineering, University of New Hampshire, 2009

Registration

Professional Engineer in Massachusetts (2015, Civil, License # 51786)

Professional Engineer in New Hampshire (2020, Civil, License # 16515)

Certifications

Project Management Professional (PMP #2600621, 2019)

Training

American Council of Engineering Companies (ACEC)/MA Leadership Education Program: Genesis and Emerging Leaders Programs

Office Location

Boston, MA

types of GAC, and two types of anion exchange resin. At the conclusion of the bench-scale testing phase, the team presented the results to LWD and the Massachusetts Department of Environmental Protection (MassDEP).

Project Manager, Temporary Manganese Removal System and PFAS Bench Scale Testing, Norwalk, Connecticut. Ms. Bogosh is managing the installation of a temporary manganese removal system at the existing wellfield operated by the First Taxing District Water Department in Norwalk, CT. The temporary manganese removal system will serve to treat the existing wells with elevated levels of manganese, which had previously been treated through sequestration in the past; however, with increasing levels in more recent years, the use of sequestration has proved inadequate. The existing well field also has elevated levels of PFAS, further compromising the use of the well field as an additional source that serves a critical need during the summer months. Treated water from the manganese removal system will serve as the water supply for the bench scale testing of two GAC media and two anion exchange media in the upcoming study.

Project Engineer, Dissolved Air Flotation Upgrade, Montville, Connecticut. Ms. Bogosh is the primary project engineer for a 4-mgd dissolved air flotation (DAF) upgrade. The DAF will replace upflow adsorption clarification for Norwich Public Utilities' (NPU's) Stony Brook Water Treatment Plant. Ms. Bogosh worked with vendors in sizing the package DAF system, led the layout and design coordination efforts for the new DAF building, and authored all design specifications for the process mechanical equipment.

Project Manager, Various Projects, Providence Water. Ms. Bogosh is the project manager for several projects for Providence Water, including the following:

- **Filter Failure Investigation.**, Ms. Bogosh conducted several investigative assessments to aid in the filter failure investigation at the Philip J. Holton Water Purification Plant, the largest conventional filtration plant in New England at 180 mgd. Ms. Bogosh's field efforts included a hydraulic analysis of the backwash supply system, filter backwash water rise rate tests, and field sampling of underdrain grout. Results of the analyses were summarized in technical memoranda to the client, which included recommendations on filter backwash operational adjustments aimed at improving backwash performance and long-term filter viability.
- **Lime Feeder Replacement.** Ms. Bogosh coordinated and provided final review for the shop drawings submitted for the replacement lime slaker and feed equipment. Ms. Bogosh is serving as the project manager for the construction which began in the summer of 2019.
- **Concept Design for Pretreatment, Residuals and Plant Water.** Ms. Bogosh is serving as the external project manager for the Concept Design for the upgrades to the Philip J. Holton Water Purification Plant's pretreatment and residuals handling systems as well as the existing plant water storage components. She is also the process mechanical lead for the pretreatment component of the work. Pretreatment alternatives being considered in the assessment include conventional sedimentation basins, DAF, high rate plate settlers (HRPS), and magnetic ion exchange (MIEX). The CDM Smith team used a ranking matrix to screen alternatives. A full life cycle cost assessment (LCA) is included in the concept design.

Project Engineer, Trihalomethane Removal System Design, East Providence, Rhode Island. Ms. Bogosh worked on the design of the trihalomethane (THM) removal system (TRS) in the Kent Heights Tank to address continuing high levels of THMs in East Providence's distribution system. As the design engineer, Ms. Bogosh was responsible for the overall design document development and also assisted with construction services during installation of the THM removal aeration system. Ms. Bogosh also coordinated the installation of an online THM analyzer for continuous feedback to the THM removal system, to optimize operation of the removal system.

Project Manager, Water Storage Tank Replacement, Norwalk, Connecticut. Ms. Bogosh managed the design of a new 500,000-gallon elevated water storage tank for the First Taxing District Water Department in Norwalk, CT. Design included a performance specification for the new water storage tank, civil site work, electrical service upgrade, enhanced site security, and integration of communications between the new tank and the District's existing SCADA system.

Project Manager, Advanced Metering Infrastructure, Norwalk, Connecticut. Ms. Bogosh managed the production of design documents for the roll out of the First Taxing District Water Department's new Advanced Metering Infrastructure (AMI) program. Ms. Bogosh worked closely with the client and the sole source meter vendor to determine the optimal bidding documents for execution of the first phase of the AMI work.

Lauren M. Miller, CC-P

TECHNICAL ADVISOR – CLIMATE RESILIENCE

Education

MA - Energy and Environmental Analysis, Boston University, 2011

BS - Environmental Studies, Elon University, 2004

Certifications

Climate Change Professional (CC-P), Association of Climate Change Officers

Utility Risk & Resilience, American Water Works Association

Massachusetts Municipal Vulnerability Preparedness Program Certified Facilitator, 2017

Office Location

Boston, MA

Ms. Miller is the firm-wide Climate Resilience Discipline Leader, leading CDM Smith's climate resilience team and strategic initiatives. She specializes in climate change services, including vulnerability assessments, climate resilience, and adaptation plans and leads the firm's America's Water Infrastructure Act work, coordinating with teams across the country to implement projects in technically consistent manner. She also serves as a CDM Smith's Sustainability Services Representative, a cross-discipline alliance at the forefront of providing innovative sustainable solutions for our clients. In 17 years of experience, she has worked closely with a broad range of client stakeholders, from city department heads to CEOs to facility managers, excelling at building client trust and developing team relationships to create the best possible project outcomes. Ms. Miller is a Climate Change Professional (CC-P), certified by the Association of Climate Change Officers, trained in the Community Resilience Building (CRB) facilitation process through the Massachusetts Vulnerability Preparedness (MVP) program, and certified by the American Water Works Association (AWWA) Utility Risk & Resilience certification to facilitate utility compliance with America's Water Infrastructure Act (AWIA).

Risk and Resilience Expert and Workshop Facilitator, America's Water Infrastructure Act, Pennichuck Water Works (PWW), New Hampshire. Ms. Miller is working with PWW to assist with their compliance with the AWIA to conduct Risk and Resilience Assessments and create Emergency Response Plans for natural hazards (including climate change in some cases) and malevolent acts. Ms. Miller created a facilitated workshop process to conduct with client stakeholders to gain buy-in to the AWIA process, understand on-the-ground vulnerabilities, and learn of stakeholder's primary concerns related to various threat-asset pairs. This workshop facilitation has been successfully executed in person and virtually. She managed the creation of a universal, Microsoft excel-based AWIA Risk and Resilience Assessment tool that may be used for all clients based on AWWA and the U.S. Environmental Protection Agency (EPA) AWIA guidance. This tool quantifies risk based on the threat likelihood, the consequences, and the vulnerability on a threat-asset pair basis.v

Project Manager and Municipal Vulnerability Preparedness Certified Provider, Melrose Hazard Mitigation Plan Update, Melrose, Massachusetts, 2017-2019. CDM Smith conducted the Community Resilience Building (CRB) Workshops as part of the Massachusetts Municipal Vulnerability Preparedness (MVP) program and updated the City of Melrose's Hazard Mitigation Plan (HMP). The HMP is consistent with the Federal Emergency Management Agency's (FEMA) 44 Code of Federal Regulations (CFR) Part 201.6 to be eligible for grant funding through the Hazard Mitigation Grant Program (HMGP). The MVP facilitated workshops were designed to collect input and buy-in on the process from stakeholders across the City on climate change vulnerability and resilience projects within the community. The process also included an open public involvement planning and submittals to required agencies, including the Hazard Mitigation Officer (SHMO) through the Massachusetts Emergency Management Agency (MEMA). The HMP was the first in Massachusetts to incorporate the effects of climate change into the report, and directly incorporated findings from the MVP process. Melrose has acquired funding to implement climate resilience projects identified during the MVP planning process as a result of this project. Ms. Miller served as the project manager and the lead Municipal Vulnerability Preparedness Certified Provider.

Project Manager and Technical Lead, Salem Climate Change Vulnerability Assessment and Adaptation Plan, Salem, Massachusetts, 2012-2014. CDM Smith partnered with Salem for a CDM Smith-sponsored Research and Development project to conduct a Climate Change Vulnerability Assessment and Adaptation Plan. The project established the top three climate change impacts based on downscaled Global Climate Models (GCMs), research from the National Oceanic and Atmosphere Administration (NOAA), and other sources. Ms. Miller led the vulnerability assessment using the ICLEI approach to determine the sensitivity and the adaptive capacity of assets within the City. The climate change adaptation plan outlined specific strategies for the City to make their climate vulnerable areas into climate resilient areas. The sectors included in this work were: water systems, stormwater, transportation, energy, critical infrastructure, and vulnerable populations.

Climate Change and Resilience Expert, Task Manager, Climate Change Planning Study, Hampton Roads Sanitation District, Virginia, 2019-present. CDM Smith is conducting a Climate Change Planning Study for Hampton Roads Sanitation District (HRSD) to provide an effective decision-making tool for wastewater utilities and operators. The plan evaluates the impacts of flooding for current conditions and forecasted increases due to climate change – including extreme precipitation events, sea level rise, and storm surge flooding to over 100 of HRSD's facilities, including wastewater treatment plants, pumping stations, and pressure reducing stations. The plan is utilizing proven, state-of-the-art disaster resilience models and techniques to quantify flood risk on HRSD's infrastructure, highlighting critical performance issues, damage, and cost impacts. The completed project will provide individual project scopes for identified cost-effective climate resiliency improvements to add to HRSD's Capital Improvement Program (CIP). Ms. Miller is leading a team of climate scientists, planners, design engineers, and asset management specialists to deliver a risk-based climate change plan for critical assets that includes flood mitigation options and costs that HRSD can use in their capital improvement plans.

Risk and Resilience Expert and Workshop Facilitator, America's Water Infrastructure Act, Various Clients, Nationwide, 2019-2021. Ms. Miller worked with community drinking water systems nation-wide to assist with their compliance with the America's Water Infrastructure Act (AWIA). Clients include: Middlesex Water Company (NJ) and subsidiaries – City of Perth Amboy (NJ), Pinelands Water and Wastewater Company (NJ), Tidewater Utilities, Inc. (DE), and Utility Services Affiliates, Inc. (Highland Park) (NJ); Southeast Morris County Municipal Utilities Authority (NJ); North Texas Municipal Water District (TX); Fort Worth Water Department (TX); City of Sugar Land (TX); City of San Angelo (TX); Georgetown Utility System (TX); Naperville Water Department (IL); City of Hutchinson (KS); Water One (KS); City of Rockville (MD); New Kent County (VA); Brunswick County (NC); Lee County Utilities (FL); City of Marco Island (FL); Salem Beverly Water Supply Board (MA); Lynnfield Center Water District (MA); and the City of East Providence (RI). These projects included conducting Risk and Resilience Assessments and creating Emergency Response Plans for natural hazards (including climate change in some cases) and malevolent acts. Ms. Miller created a facilitated workshop process to conduct with client stakeholders to gain buy-in to the AWIA process, understand on-the-ground vulnerabilities, and learn of stakeholder's primary concerns related to various threat-asset pairs. This workshop facilitation has been successfully executed in person and virtually. She managed the creation of a universal, Microsoft excel-based AWIA Risk and Resilience Assessment tool that may be used for all clients based on AWWA and the U.S. EPA AWIA guidance. This tool quantifies risk based on the threat likelihood, the consequences, and the vulnerability on a threat-asset pair basis. She is certified by the AWWA Utility Risk & Resilience to facilitate utility compliance with the AWIA.

Mark C. White, PE

TECHNICAL ADVISOR – PROCESS

Mr. White is a registered professional engineer and Board Certified Environmental Engineer with more than 25 years of international experience in the planning, design, operations and maintenance, and construction of water treatment facilities. He has evaluated and/or designed improvements to more than 40 water treatment plants (WTPs) totaling more than one-billion-gallons-per-day of capacity. He is well versed in membrane technology and has served as project manager or membrane design for over 400-million-gallons-per-day (mgd) of membrane filtration treatment capacity, including some of the largest membrane projects in the United States. As a water treatment industry leader, Mark serves on various state and national committees, including the American Water Works Association's (AWWA) Water Treatment Facilities Design and Construction Committee and the AWWA Membrane Process Committee. He is the former chair of the AWWA Membrane Systems Subcommittee. He has authored more than 20 technical presentations on water treatment technologies at AWWA National Conferences and has taught classes on the design of water treatment systems at the University of North Carolina-Chapel Hill and the University of Wisconsin-Madison. In addition, he has authored chapters of drinking water manuals of practice, including the AWWA M53 Manual of Practice for Microfiltration and Ultrafiltration Membranes and the Indian Water Works Association M5 Manual on Augmentation and Upgradation of Water Treatment Plants.

Technical Review, Process Selection and Design of New Water Treatment Plant, Manchester, New Hampshire. For the Manchester Water Works' new 7.2-mgd Merrimack River Water Treatment Plant (WTP), Mr. White is providing technical review of the pilot testing, process selection, and design that features greensand filtration and a GAC polishing step for taste, odor, organics, and potential PFAS removal. The $28.3 million plant is expected to serve Manchester and potentially water systems throughout southern New Hampshire, given water supply shortages and PFAS contamination concerns in the region.

Technical Review, Process Selection and Design of New Water Treatment Plant, Topsham, Maine. For the Brunswick and Topsham Water District's replacement of the Jackson Station treatment and administrative facilities, Mr. White is providing technical review of the process selection and design work. Greensand filtration, fixed bed anion exchange, and manganese polishing contactors were selected for full scale implementation. The future 4-mgd (million gallons per day) plant's construction bid at $29.4 million, with treatment, administrative, customer service, vehicle storage, and distribution operations to be housed within the new District headquarters facility. The work included collaborative water quality goal setting, capital and operational cost projections, asset management planning, and consensus building with stakeholders, including District trustees and state regulatory officials.

Treatment Process Design Lead, Wadi Arab II WTP, USAID Irbid, Jordan. Mr. White served as the treatment process design lead for the design of a new 22-mgd WTP that is being constructed to serve the residents of the Northern Governments Area of Jordan. The new treatment facilities include raw water intake, screening, chlorine dioxide oxidation, pre-sedimentation, coagulation/ flocculation/ sedimentation, dual-media filtration, post-filtration granular activated carbon (GAC) contactors, UV

Education

MSEE - Water Resources Engineering, University of North Carolina at Chapel Hill, 1996

BS - Civil Engineering, University of Illinois, at Champaign-Urbana, 1993

BS - Architecture, University of Illinois at Champaign-Urbana, 1989

Registration

Professional Engineer: Illinois, Wisconsin, New Mexico, and North Carolina (2000)

Office Location

Chicago, IL

disinfection, chemical treatment, and pumping to address a challenging water source, subject to seasonal water quality upsets and taste and odor concerns.

Project Technical Lead, El Hanady WTP, USAID, Egypt. Mr. White served as the project technical lead for the fast-tracked design of the new 4.5 MGD WTP which will treat raw water from the Nile River using inline-chemical coagulation, flocculation, deep-bed mono-media filtration, and chlorine disinfection. The new WTP will provide a new clean source of water for underserved rural communities in Upper Egypt.

Design Engineer, WTP Improvements, Cary, North Carolina. For the town of Cary, Mr. White served as a design engineer for the Cary/Apex WTP improvements and expansion project. This project involved the design of a 24-mgd expansion of the treatment capacity for the system along with an upgrade of the chemical storage and disinfection systems and installation of new ozone facilities. Mr. White developed detailed design of treatment, pumping and chemical feed facilities as well as coordinated design work for the civil, mechanical, structural, electrical, architectural, and HVAC disciplines. As part of a predesign study, he designed and conducted a pilot testing program to evaluate the performance of intermediate ozonation and alternative filter media on the effects of ozone and GAC filter absorbers on the control of taste and odor compounds, turbidity, manganese, and disinfection byproducts.

Design Engineer/Resident Engineer, Residuals Processing Facilities, Cary, North Carolina. Mr. White assisted the town of Cary with the addition of new residuals processing facilities. This $3.3 million construction project involved the addition of equalization, thickening, dewatering, and chemical feed facilities. He served as project engineer on the design of the facilities and served as the onsite resident engineer managing the construction services. As resident engineer his responsibilities included project management, contract administration, project scheduling, cost controls, and facilities startup.

Design Engineer, WTP Improvements, Greenville, North Carolina. For the city of Greenville, Mr. White was a design engineer for the preliminary evaluation and design of improvements and a 12-mgd treatment capacity expansion and ozone system upgrade of the water treatment plant. During preliminary design, he developed testing protocols for and oversaw performance of bench- and pilot-scale treatability studies. In addition, he developed the detailed designed modifications to the chemical storage and feed systems.

O&M Specialist, Zai WTP Improvements, USAID, Amman, Jordan. Mr. White was the O&M specialist for the design-build of emergency improvements to the Zai water treatment plant in Amman, Jordan. This $5 million project involved the fast-track addition of new chemical facilities and improvements to the existing filtration system. Mr. White planned daily construction activities, supervised construction and installation of new equipment, coordinated startup and training activities, provided technical design support during construction, and prepared the O&M manual for the new facilities. Mr. White worked with the laboratory staff at the plant to improve their water quality testing programs. He worked with the Jordanian Ministry of Water and Irrigation and WTP staff to prepare and direct a treatability study during a weeklong water quality crisis.

Jihyon Im, PE

CHEMICAL SYSTEMS PROCESS LEAD

Ms. Ji Im specializes in drinking water treatment projects for municipal clients and has worked on over 30 studies, design, and construction projects in the northeast. Her work is in the design of new water treatment facilities, existing plant upgrades, and studies for master planning, treatment evaluations, regulatory review, and water quality analyses.

Project Engineer, Process Selection, Preliminary Design, and Final Design for Merrimack River Water Treatment Plant, Manchester, New Hampshire. Ms. Im served as a project engineer for the design of the Manchester Water Works (MWW)' brand new 7.2 mgd radial collector well treatment facility on the Merrimack River. For this $28 million project, she led the design of seven chemical storage and feed systems (sodium hypochlorite, sodium hydroxide, aluminum sulfate, polymer, aqua ammonia, fluosilicic acid, and phosphoric acid) as well as worked on the treatment process selection, including pilot testing of pressure filtration and adsorption processes, design, and construction.

Project Engineer, Process Selection and Preliminary Design for New Water Treatment Plant, Topsham, Maine. For the Brunswick and Topsham Water District's new 4 mgd Topsham Filtration Facility (construction bid at $29.4 million), Ms. Im assisted on all aspects of the design work that included the series of pressure filtration and adsorption process for iron, manganese, and disinfection-byproduct precursor removal as well as chemical feed and storage facilities for potassium permanganate, sodium hypochlorite, and sodium fluoride. She worked on collaborative water quality goal setting, capital and operational cost projections, and consensus building with stakeholders.

Project Engineer, Full-Scale Testing of Pre-Oxidation with Chlorine Dioxide, Manchester, New Hampshire. Ms. Im led the full-scale pilot testing of raw water pre-oxidization with chlorine dioxide for manganese mitigation at Lake Massabesic for MWW. In addition to experimental design, facilitation, data analysis, and report writing of the program, Ms. Im designed the chlorine dioxide generator and the temporary chemical feed and storage systems for sodium chlorite and hydrochloric acid.

Project Engineer, Disinfection By-Product (DBP) Investigation, Camden Rockland District, Maine. Ms. Im is serving as a project engineer on evaluating the DBP mitigation measures for the Mirror Lake WTP, which is a microfiltration facility operated by Maine Water Company (MWC). She facilitated the planning for full-scale pre-membrane coagulation testing, which included performing bench-scale jar testing and designing the aluminum chlorohydrate (ACH) coagulant chemical feed and storage system to be used for the full-scale testing. She was also responsible for evaluating the secondary disinfectant switch to chloramination and design of the ammonia feed and storage system.

Project Engineer, Study, Testing, and Final Design for Per- and Polyfluoroalkyl Substances (PFAS) Treatment with Ion Exchange, Ayer, Massachusetts. Ms. Im served as the project engineer for testing, planning, design, and construction of PFAS treatment upgrades at the Grove Pond WTP (2 mgd capacity). She was responsible for the establishment of treatment goals, regulatory review, water quality data analysis, assessment of treatment alternatives, engineering assistance on bench-scale testing

Education

MS – Civil Engineering, University of New Hampshire, 2015

BS – Environmental Engineering, University of New Hampshire, 2013

Registration

Professional Engineer: New Hampshire (2018)

Engineer-in-Training: New Hampshire (2012)

Office Location

Manchester, NH

of granular activated carbon (GAC) and ion exchange (IX), and final design of the treatment facility with IX and chemical feed and storage systems for calcium thiosulfate and zinc orthophosphate.

Process Engineer Lead, Scotts Hills Water and Sewer District Elevated Tank and Wells, Pender, North Carolina. Ms. Im served as the process mechanical lead for designing three groundwater well treatment systems. Each system was rated at 350 gpm and included well pumping systems, sodium hypochlorite and blended phosphate chemical storage and feed systems, and other associated equipment. She was the primary author for the water treatment sections of the Basis of the Design Report as well as the Engineering Report submitted and approved by the State of North Carolina.

Project Engineer, Bench Scale Testing and Final Plant Design for PFAS Removal, Westfield, Massachusetts. Ms. Im served as the project engineer for CDM Smith's work for bench-scale testing of GAC, preliminary design, final design, and construction of the City of Westfield's PFAS treatment facility (4 mgd capacity). For this $5.3 million project, Ms. Im assisted with the design of GAC contactors, sodium hypochlorite and phosphate chemical storage and feed systems.

Project Engineer, Pilot Testing and Conceptual Design of Dissolved Air Floatation, Newark, New Jersey. For the City of Newark's 60-mgd capacity Pequannock Water Treatment Plant, Ms. Im led the pilot testing efforts for evaluating and optimizing dissolved air floatation (DAF) to improve this direct filtration facility's performance. DAF was tested in a number of different pre-treatment chemical conditions. Four different coagulant chemicals and two oxidants including ozone were evaluated for process optimization. She also assisted in the conceptual design and basis of design report of the new facility.

Project Engineer and Process Engineer Lead, Process Train Selection Memorandum and Conceptual Design of Pre-Ozonation for Westminster Water Treatment Plant, Westminster, Colorado. Ms. Im water the primary writer for the overall process train selection memorandum for City of Westminster, CO's greenfield WTP with a 30 mgd capacity expandable to 60 mgd in the future. She led the conceptual design of the intermediate ozonation process responsible for engineering design, calculations, and vendor coordination.

Project Engineer, Glen Drive Water Treatment Plant for Iron, Manganese, and PFAS Removal, Lynnfield, Massachusetts. Ms. Im is currently serving as the project engineer for pilot testing and final design of the iron/manganese removal facility at the Glen Drive WTP. The design of 0.8 mgd groundwater treatment facility includes greensand filters, GAC adsorbers, sodium hypochlorite, potassium hydroxide, and sodium fluoride chemical storage and feed systems, residual lagoons, and backwash supply water storage tank.

Project Engineer, Norwich Public Utilities (NPU) Dissolved Air Flotation (DAF) Improvements, Norwich, Connecticut. Ms. Im served as the project engineer for a design project that calls for a new DAF process and replacement of the existing processes at the 4-mgd Stony Brook Water Treatment Plant. She led the modification of the existing equipment, including upgrades to the ACH and polymer chemical systems, as well as the package clarification and filtration treatment units, such as rehabilitation of the underdrains and replacement of the filter media.

Process Engineer Lead, Conceptual Design of Pre-Ozonation for Longmont Water Treatment Plant Design Build Project, Longmont, Colorado. Ms. Im led the conceptual design of the pre-ozonation process to be considered for a greenfield 45-mgd facility in Longmont, CO. She led the ozone process team through the engineering design, calculations, and vendor coordination.

Project Engineer, Corrosion Control Improvement, Haworth, New Jersey. SUEZ Water contracted CDM Smith to improve the corrosion control system at the 187.5-mgd Haworth WTP. For the bench-scale study with metal coupons to compare zinc ortho-phosphate (ZOP) and phosphoric acid, Ms. Im's responsibilities included dosage calculation of the corrosion inhibitor chemicals to be tested and analysis of historical finished water quality data as well as the test results to determine the compatible chemical and effective dose. For the design of the chemical system, Ms. Im worked on equipment sizing, layout of the chemical system in the existing plant, and researched chemical compatibility of the existing storage tanks and metering pumps to be used for the ZOP upgrade. In addition, Ms. Im assisted in drafting of the standard operating procedure for the chemical system

Tarun Gill, ENV SP

PLANNING/RESILIENCY LEAD

Ms. Gill has over 20 years of extensive experience in utility integrated and master planning, capital improvement program management and prioritization, asset management and condition assessment and conduct of operational and management efficient studies. Tarun has managed over 100 master plans, water resource plans, Capital Improvement Project (CIP) programs and system operational studies. She provides strong leadership in the risk and resiliency sector for water resources and environmental projects.

Utility Planning and Management Services Prior to CDM Smith

Americas Water Infrastructure Act Initiative Technical Leader, Various Municipalities, Massachusetts, Connecticut, and Maine. Ms. Gill led the AWIA initiative for the firm helping more than 35 local municipalities to comply with EPA's AWIA mandate by developing Risk and Resiliency Assessments and Emergency Response Plans. The projects included extensive evaluations of the water systems, monitoring practices, cyber security of the PCS systems, source water quality, storage, treatment and pumping stations, critical assets and infrastructure, risk analysis and emergency preparedness.

Asset Management Planning Grant Program, Massachusetts, Various Municipalities, Massachusetts. Ms. Gill has been leading the asset management planning grant initiative for the firm for over five years, helping numerous local municipalities in completing or updating asset management plans for drinking water, wastewater and stormwater systems. This grant program is a Mass Clean Water Trust and MassDEP funded program assisting communities to develop AM plans as a roadmap to identify and support infrastructure upgrades and improvements for both short-term and long-term horizons.

Technical Reviewer, Capital Improvement Plan, Town of Chatham, Massachusetts. Ms. Gill worked as a technical advisor and reviewer for the Capital Improvement Plan for the City of Chatham. Project includes update of GIS database, model development, calibration, demand scenario modeling and forecasting for future demands, analysis, and recommendations.

Technical Reviewer, Asset Management Plan, Town of Hopkinton, Massachusetts. Ms. Gill served as a technical advisor and reviewer for the development of the Asset Management Plan for water/wastewater and stormwater systems for the Town of Hopkinton. Project includes developing an AMP to create a comprehensive, verified GIS database, establish level of service goals, identify critical infrastructure and opportunities to expand system capacity for all three systems.

Technical Leader, Water, Wastewater and Recycled Master Plan, City of Carlsbad, California. Ms. Gill worked collaboratively as the lead for demand modeling, with the City of Carlsbad, to support their water, wastewater and recycled water master plans. This project includes update of GIS database, AM framework, hydraulic model development, calibration, demand scenario modeling and forecasting for future demands, analysis, and recommendations. Hydraulic Model analysis includes hydraulic analysis of the systems under various operating conditions and identifying system deficiencies for both the water and wastewater systems.

Education

Masters of Science: Water Resources and Environmental Engineering

Bachelor of Engineering: Civil Engineering

Registration

ENV SP

Certifications

AWIA Risk and Resiliency

NIIMS

Office Location

Boston, MA

AREAS OF EXPERTISE

- Utility Master Planning
- Hydraulic Modeling
- CIP Planning and Asset Management
- Project Prioritization Programs
- System Capacity Evaluations
- Demand/Flow Analysis and Projections
- Model Training
- Risk-Based Cost/Benefit Analysis

Technical Leader, Master Plan and As-Needed Modeling Services, City of Santa Monica, California. Ms. Gill worked collaboratively as the project lead, with City of Santa Monica to update its water master plan and develop a roadmap for continued successful performance and operation of critical water system infrastructure. Project includes update of GIS database, asset inventory and assessment, hydraulic model development, calibration, demand modeling and projections, hydraulic analysis, CIP and model training and hydraulic model system. Tasks under the As-needed modeling included system analysis for developer driven demands, model analysis includes hydraulic analysis of the systems under various operating conditions and what-if scenarios.

Project Lead, Potable Water, Recycled Water, Sanitation and Integrated Master Plans, Las Virgenes Municipal Water District, California. Ms. Gill supported LVMWD in providing consultation for the update of their four master plans to align the Utility systems with a common vision. The plans included comprehensive demand tool for assessment of build-out water demands, wastewater flows and recycled water demands opportunities for regulatory compliance, development of hydraulic models, formulation of a comprehensive capital improvement program for each utility and development of Asset Management plans. The plan was performed under a workshop driven process with various stakeholders. The plan provided an implementation-based roadmap to align stakeholder consensus and involvement from various departments.

Project Manager, Master Plan and As-Needed Modeling Services, San Bernardino Municipal Water Department, California. Ms. Gill worked collaboratively as the internal project manager, with the San Bernardino Municipal Water Department to update its water master plan and develop a roadmap for continued successful performance and operation of critical water system infrastructure. Project includes update of GIS database, asset inventory and assessment, hydraulic model development, calibration, demand modeling and projections, hydraulic analysis, CIP and model training and hydraulic model system. Tasks under the as-needed modeling included system analysis for developer driven demands, model analysis includes hydraulic analysis of the systems under various operating conditions and what-if scenarios.

Hydraulic Modeling Lead, Hydraulic Model Development and CIP, City of Houston, Texas. As the modeling group lead for the Department of Public Works (DPW), Ms. Gill facilitated and led the development of the hydraulic models for the City's (North, Central and South) systems. This included GIS integration, Demand Analysis and projections, System analysis, Water quality analysis, identification of system deficiencies and CIP program development.

Maddison Ledoux

PROCESS ENGINEERING/GRANT FUNDING

Education

BS – Environmental Engineering, University of New Hampshire, 2018

Registration

Engineer-in-Training: New Hampshire (2019)

Office Location

Manchester, NH

Ms. Ledoux is an environmental engineer with experience in preliminary design, final design, construction and planning studies for drinking water and wastewater clients as well as experience completing stormwater site inspections to analyze treatment efficiency, monitoring streams and calculating flow rates, implementing asset management programs, and performing bench-scale tests. Her software skills include AutoCAD, Esri, Word, Powerpoint, Excel, and Outlook. Ms. Ledoux is also familiar with modeling software used to aid in evaluations and process selection which include Water!Pro, AFT Fathom, and Biowin.

Project Engineer, Final Design of Greensand Filter WTP, Lynnfield, MA. Ms. Ledoux serves as a project engineer for the design of a new greensand filter water treatment plant for Lynnfield Center Water District to address elevated iron and manganese. Her roles include working alongside the technical lead to design a new treatment building equipped with greensand filter pressure vessels, sodium hypochlorite, potassium hydroxide, and sodium fluoride storage and feed systems designed in accordance with modern-day state, building code, and OSHA requirements. The project also includes post-greensand filter granular activated carbon (GAC) pressure vessels for PFAS removal.

Project Engineer, Conceptual Design and Evaluation of PFAS Treatment Alternatives, Haworth, NJ. Ms. Ledoux served as a project engineer on a conceptual design and evaluation of PFAS treatment alternatives for the 188 MGD Haworth, NJ WTP which is owned and operated by SUEZ Water New Jersey. Ms. Ledoux's primary role was to investigate available PFAS treatment alternatives and assess their feasibility for implementation at the Haworth WTP. Ms. Ledoux performed preliminary sizing calculations, participated in vendor outreach, and performed an alternatives assessment which ultimately led to future recommendations for the facility.

Project Engineer, Design-Build of GAC System for PFAS Removal, Pittsboro, NC. Ms. Ledoux served as a project engineer for the design and construction of a GAC system for removal PFAS. Her primary role is to support the hydraulic technical lead to size the pumps which will feed the GAC system. As part of this evaluation, Ms. Ledoux used AFT Fathom to model the system hydraulics and select the proper pump design criteria.

Project Engineer, Chloramination System Implementation at Water Storage Tanks, Bedford, MA. Ms. Ledoux serves as a project engineer assisting the Town of Bedford with implementation of a proprietary chloramination system for use in distribution system water storage tanks. Her primary role was to assist in permitting and design coordination for the system. These systems will be implemented at two- 1 MG storage tanks in Town. The design includes new sodium hypochlorite and liquid ammonium sulfate storage and feed systems which will be implemented and operational by mid-2022.

Project Engineer, Disinfection By-Product (DBP) Evaluation, Millinocket, Maine. Ms. Ledoux served as a project engineer working on a DBP investigation for Maine Water Company out of Millinocket, Maine. She was responsible for data compilation and analysis of system wide DBP levels and related water quality parameters. The goal of this all-encompassing evaluation was to provide the client with a thorough review of current DBP formation and possible mitigation strategies such as implementation of DBP treatment methods, DBP precursor treatment methods, and optimization of current operating procedures to limit formation. As part of this assessment, Ms. Ledoux performed simulated distribution system (SDS) and coagulant jar testing to evaluate and optimize current and future treatment.

Project Engineer, Testing, Preliminary and Final Design for PFAS Treatment, Ayer, Massachusetts. Ms. Ledoux served as the project engineer for testing, planning, design, and construction of the PFAS treatment upgrade at the Spectacle Pond WTP, a 2 mgd facility in Ayer. She was a primary contributor to preliminary design and evaluation, supported the bench-scale testing of GAC and IX. She continued work as a process mechanical lead during the final design of the PFAS treatment facility and accompanying zinc orthophosphate storage and feed systen. The $5.1M facility is currently under construction with an anticipated completion date in mid-2022.

Project Engineer, Compatibility Evaluation and Corrosion Control Review Study, Springfield, Massachusetts. Ms. Ledoux acted as a project engineer on a compatibility evaluation and corrosion control review of Springfield Water and Sewer Commission’s possible interconnection with Massachusetts Water Resources Authority as part of their long-term drought management plan. Ms. Ledoux performed a review of water quality data and system information and contributed to the desktop study evaluation including lead solubility models to assess key water quality parameters which impact corrosion control. This was performed for both SWSC and MWRA finished water to determine compatibility and aid in recommendations for future considerations if the client decides to move forward with the proposed interconnection.

Project Engineer, American Water Emerging Contaminants Planning Study and Evaluation, New Jersey.

Ms. Ledoux was a project engineer for the New Jersey American Water (NJAW) emerging contaminants planning study. This study was driven by the need to meet anticipated PFAS regulatory compliance and will help NJAW to plan for the long-term impacts these regulations could have. This report provided NJAW with background on emerging contaminants of concern, specifically PFAS, and how these compounds can be treated. This planning study will aid in long-term design efforts for NJAW.

Project Engineer, PFAS Treatment with Ion Exchange, Ayer, Massachusetts. Ms. Ledoux completed the State Revolving Fund application for the Town of Ayer, Grove Pond PFAS treatment facility. Ms. Ledoux also completed an evaluation on the current water quality data and analyzed possible treatment methods to be utilized in the final design of the facility.

Prior to CDM Smith

GIS Intern and Water Supply Engineering Intern, Pennichuck Water Works, New Hampshire (2014-2017). Ms. Ledoux worked as a GIS intern for three summers, assisting in the implementation of a new asset management program. In 2017, Ms. Ledoux transitioned to the Nashua WTP as the water supply engineering intern. She took on a leadership role as the senior intern, completed inspections of stormwater sites to analyze treatment efficiency, and monitored streams to calculate flow rates and help build historical data.

Melissa A. Harclerode, PhD, BCES

PUBLIC RELATIONS

Education

PhD – Environmental Management, Montclair State University, 2016

MS – Environmental Science, Rutgers University/New Jersey Institute of Technology, 2010

BS – Environmental Science and Biology, Muhlenberg College, 2005

Certifications

American Academy of Environmental Engineers & Scientist, Board Certified Environmental Scientist, Sustainability Specialty, 2017

Office Location

Edison, NJ

Dr. Harclerode is a technical specialist with 16 years of experience in environmental management across a variety of market sectors including remediation, water resources, solid waste management, and transportation. She specializes in the development and application of integrated assessment approaches to comprehensively define sustainability objectives and evaluate environmental, social, and economic impacts of environmental infrastructure and restoration projects. Dr. Harclerode provides technical support and modeling on environmental footprint analysis, life cycle assessment, community impact evaluations, risk communication, public outreach planning, climate change vulnerability assessments, and development of sustainable best management practices.

Public Outreach and Risk Communication Specialist, PFAS Town-wide Assessment, Municipal Client. Dr. Harclerode facilitated a Public Communication and Outreach Planning Meeting with the client team and PFAS subject matter experts. The objective of the meeting was to identify short and long-term public communication and outreach needs and action items. Each action item represents a communication and outreach plan component that may be eventually compiled into a proactive public outreach plan. Based on discussions at the meeting, action items were assigned suggested prioritized as either immediate, short-term, intermediate-term, or long-term. Outreach components include a communication team, outreach strategy matrix, PFAS update in the town electronic newsletter, town-specific fact sheet, FAQs, town website updates, social media, and public engagement activities. CDM Smith is initiating development of a public outreach plan and facilitation of a communication team.

Risk Communication Specialist, Water Supply Well, Private Client. Dr. Harclerode collaborated with the client to develop responses to "tough questions" for a public engagement event concerning the presence of 1,4-dioxane and PFAS in drinking water supply wells. Message mapping technique was applied to formulate simple, concise responses that comprehensively contain pertinent information.

Public Outreach Lead, Castle Rock Water Department, On-Call Water Quality Consulting Services. Dr. Harclerode is leading the development of a public communication plan to support the utility in maintaining consumer confidence and trust during the planning, design, and distribution of purified water as part of the drinking water supply. As part of the communication plan development, sustainability drivers were identified and will be integrated into communication goals, metrics, and key messages. She will also provide support in public outreach activities.

Public Outreach Technical Lead, City of Des Moines Iowa, Stormwater Master Plan Phase I. Dr. Harclerode lead the development of a public outreach plan to present the communication and engagement strategy developed to aid City staff to perform effective and meaningful public outreach related to its stormwater management program. The objective of the communication framework is to formalize when and how to engage the Stormwater Advisory Committee (SAC), community members, and other public stakeholders to address stormwater management program priorities with regards to flooding, asset renewal, and water quality. The Plan presents specific public outreach strategies to accompany and facilitate Phase I and II SMP development, and subsequent SMP implementation in alignment with the City's Strategic Plans and regulatory requirements. During Phase I planning, public outreach includes a web-based survey to solicit community flooding information and gauge public perceptions of the City stormwater management program.

Public Outreach and Risk Communication Specialist, Water Line Extension Feasibility Study, Confidential Industrial Client. Dr. Harclerode lead the development of a Community Outreach Plan that presents the communication framework and outreach tools to aid performance of effective and meaningful outreach to residents and property owners. The project team is currently evaluating the feasibility and potential cost of extending the existing city water lines to private properties in areas where groundwater used for potable purposes is affected by VOCs. The objective of the communication framework is to formalize the strategy for informing residents and property owners in the designated areas about the proposed project and facilitate participation in connecting to the public utility. The Plan includes a community and public stakeholder assessment, based on a desktop analysis of demographic data, news media, and social media, to inform outreach strategy development and preparation of public outreach materials.

Risk Communication Specialist, PFAS Contingency Plan and Action Plan, Municipal Client. Dr. Harclerode provided support on development of a PFAS Contingency Plan to support responding to expected upcoming regulations. The plan includes guidance, from risk and public communications perspective, on safe uses of water not treated for PFAS. Subsequently, Dr. Harclerode lead the development of a PFAS Action, a communication framework and compilation of outreach tools to aid effective and meaningful public outreach. The objective of the communication framework is to formalize when and how to engage customers and other public stakeholders about distribution system PFAS sampling results. The Action Plan is a living document that will be continuously updated to incorporate community and public stakeholder needs and concerns throughout outreach strategy implementation.

Sustainable Resilient Remediation Technical Lead, Multiple Client Sectors. Dr. Harclerode provides ongoing technical advisement and performance of sustainable resilient remediation (SRR) assessments throughout the project life cycle for multiple media, including soil, groundwater, surface water, sediment, and air. She also provides regulatory technical oversight review of responsible party SRR assessments. Specific project descriptions available on request, select projects are included below.

Sustainability Technical Lead, Philadelphia Water Department (PWD), Triple Bottom Line Study. Dr. Harclerode led a multi-discipline team to perform an updated literature review for PWD's 2009 Triple Bottom Line study in support of PWD's combined sewer outfall Long Term Control Plan Update. This study evaluated social, economic, and environmental benefits of a range of traditional infrastructure, green infrastructure, and habitat restoration measures. The literature review identified potential enhancements to sustainability metrics, methods, and data sets to support evaluation of stormwater infrastructure improvement alternatives. Sustainability benefit categories evaluated for possible refinement of metrics included, but not limited to, water quality, energy consumption, pollutant emissions, environmental justice, community cohesion, and construction- and maintenance-related disruption impacts to the local community.

Erin I. Smith, PE

PIPELINE ENGINEER

Education

BS - Civil/Environmental Engineering, University of Maine, 2003

Registration

Professional Engineer: New Hampshire, 2008

Office Location

Manchester, NH

Mr. Smith is an environmental engineer with 16 years of experience in water distribution evaluation and design. He is proficient in several hydraulic modeling software programs. He also has several years of experience in the design and construction oversight of water and wastewater treatment facilities, collection and distribution pump stations, and urban watershed analysis and design.

Project Manager, Water Model Development, Pennichuck Water Works, New Hampshire. Mr. Smith developed a new hydraulic distribution model of Pennichuck Water Works (PWW) – Nashua Core Distribution System. The distribution area has 19 individual pressure zones with 378 miles of pipe, 8 storage tanks, and 14 booster stations, serving approximately 15,600 metered connections. Mr. Smith worked directly with PWW staff to develop and implement a field-testing program to aid in model calibration.

Project Manager, Client Representative, City of Woonsocket, Rhode Island. Mr. Smith has been the City of Woonsocket's Client Representative during the design and construction of the City's new 7.5 MGD water treatment plant. The $ 50 million, project includes several miles of new transmission mains, new raw water pump station and a conventional water filtration plant. Mr. Smith has managed to the Client's relationship with the designer and general contractor through the design, permitting and construction phases. The plant is scheduled to be online January 2021.

Project Technical Lead, Wastewater Treatment Facility Expansion, Kingston, Massachusetts. Mr. Smith took on the PTL role for the Kingston, MA Wastewater Treatment Facility expansion. The facility was expanded from a 2 SBR system to a 4 SBR system. Upgrades included headwork screening and girt improvements, several pumping systems, expansion of the facility layout, new GBT, new pump station and effluent disposal structure. The improvements allowed the facility to increase peak hour treatment capacity to 2.25 MGD with an estimated construction cost of $18M.

Task Leader, Organics to Energy, Greater Lawrence Sanitary District, Massachusetts. Mr. Smith led the design efforts to expand GLSD's anerobic digestion form 3 units to 4 as part of the facilities plan to construct a new combined heat and power facility onsite. Mr. Smith aided with the design of the new anaerobic digester, heat exchanger, and the associated pumping systems, process piping and gas piping requirements.

Project Manager, Water Model Development, Springfield Water and Sewer Commission, Massachusetts. Mr. Smith managed the development of SWSC's new hydraulic model. The model includes over 650 miles of distribution piping through several communities and multiple pressure zones. Mr. Smith oversaw the creation of the hydraulic model database to allow for a direct relationship the existing GIS dataset. He developed the field-testing program used to then calibrate the hydraulic model. The model has since been utilized to evaluate the impacts of capital improvements projects such as major commercial developments and pumping stations within the distribution system.

Tamzen Wood Macbeth, PhD, PE

PFAS

Dr. Macbeth is an internationally recognized remediation expert with over 17 years of experience in the development, demonstration, design and implementation of innovative, cost-effective remedial strategies for cleanup of hazardous waste contaminated sites. Her work leverages her interdisciplinary academic and research background in microbiology and engineering to advance remediation technologies such as in situ bioremediation, natural attenuation, in situ chemical oxidation, in situ chemical reduction, pump and treat and thermal treatment, alone and in combination to clean up non-aqueous phase liquids (NAPLs), dissolved organic, inorganic, and radioactive chemicals under a variety of regulatory programs.

Principal Investigator, CDM Smith Internal Research and Development, January 2020-present. Dr. Macbeth is the lead engineer designing and building a pilot plant to treat PFAS-contaminated water using electrical chemical oxidation processes coupled with concentrate technologies including foam fractionation, PerfluorAD™ and nanofiltration.

Project Technical Lead, Morris Dam, Azusa, California, April 2016-present. Dr. Macbeth is the project technical lead developing the technical strategy for Naval Facilities Engineering Command, Southwest (NAVFAC Southwest) for completion of investigation work plans, groundwater monitoring, and reporting to evaluate residual chemical concentrations at the former Morris Dam Research and Development facility near Azusa, CA. CDM Smith is performing groundwater monitoring, a focused remedial investigation (RI) to evaluate perchlorate concentration in soil, a preliminary assessment (PA) and site inspection (SI) to assess the presence of PFAS at the site, and will develop a feasibility study, proposed plan and record of decision for perchlorate.

Technical Reviewer, Montana Department of Environmental Quality (DEQ), 2015-present. Dr. Macbeth serves as the senior technical review in support of oversight of contaminated sites in Montana and development of cleanup programs. Projects include the **S&W Sawmill, Montana DEQ, Darby, MT.** Dr. Macbeth provided technical review and comments to DEQ on the Fate and Transport Study prepared by a PLP for the S&W Sawmill Facility and the subsequent Feasibility Study Data Summary Report. CDM Smith reviewed the Initial Alternatives Screening Table, prepared for DEQ by the PLP, and provided comments relating to the fate and transport, applicability of specific technologies for dioxins and furans and pentachlorophenol entrained in nonaqueous phase liquid (NAPL) and in a groundwater dissolve phase plume. **Yale Oil of South Dakota, Montana DEQ, Billings, MT.** Dr. Macbeth provided technical review and comments on the Fate and Transport Study Work Plan to DEQ. CDM Smith reviewed and commented on the LNAPL Transmissivity Testing Report and the LNAPL Removal Technology Screening and Selection document. **Burlington Northern Missoula Facility, Montana DEQ, Missoula, MT.** Dr. Macbeth provided technical reviews of Fate and Transport plans and reports and technical review and comment on the subsequent FS documents. DEQ requested assistance from CDM Smith in reviewing feasibility study documents and providing assistance with other technical issues at the Facility to address multiple contaminants including LNAPL. CDM Smith reviewed and provided comments to DEQ on the LNAPL evaluation report, natural source zone depletion (NSZD), and bioventing report.

Education

PhD – University of Idaho, 2008

MS – Environmental Engineering, Idaho State University, 2002

BS – Microbiology, Idaho State University, 2000

Registration

Registered Professional Engineer: Idaho, 2006

Training

Occupational Safety and Health Act 40-hour HAZWOPER

8-hour HAZWOPER supervisor

Rad Worker II

Medic First Aid with CPR

Office Location

Helena, MT

Kenneth A. Meyer Jr., PE, RG, CHST, CSP

SAFETY/CHEMICALS

Education
BS – Geological Engineering, University of Missouri, 1984

Registration
Professional Engineer: Missouri, Colorado

Registered Geologist: Missouri

Construction Safety & Health Technologist

Certifications
Certified Safety Professional

Office Location
Denver, CO

Mr. Meyer has over 30 years of diversified health and safety and project/program management experience in the government and commercial sectors. He has strong management skills, including program and engineering management, environmental restoration and remediation, resource management, construction management, community relations, estimating, scheduling, and project planning. Mr. Meyer also has a regulatory compliance and permitting background that includes certifications from OSHA, NEPA, RCRA, MSHA CERCLA, NRC, CAA, and CWA.

In his current role, Mr. Meyer is responsible for the overall management and implementation of CDM Smith's construction health and safety program. This includes oversight of construction, demolition, and remediation projects, initiatives to improve safety culture and performance, health and safety training, and performance reporting. He also coordinates incident investigations, performs audits and provides health and safety training. Mr. Meyer interfaces with senior and corporate management to ensure that health and safety programs are consistently and efficiently implemented throughout CDM Smith.

Alternate SSHO, USMCB - Camp Pendleton – SRTTP and NRTTP O&M, 2012-2019. Mr. Meyer provided training, incident investigation and safety support in accordance with EM-385-1.1. He also provided safety support and coverage during the construction of both the SRTTP and NRTTP.

Alternate SSHO, Joint Base Lewis McChord WWTP Construction 2012-2015. Mr. Meyer provided training, incident investigation and safety support in accordance with EM-385-1.1. He also provided support and oversight for the Accident Prevention Plan.

Alternate SSHO/CQM, Savannah Harbor Dissolved Oxygen Project Construction 2014-2019 US ACE – Savannah District. Mr. Meyer provided training, incident investigation and safety support in accordance with EM-385-1.1. He also provided support and oversight for the Accident Prevention Plan.

Alternate SSHO, Piegan Infrastructure Upgrade Project (GSA)WTP/WWTP Construction 2014-2018. Mr. Meyer provided training, incident investigation and safety support in accordance with EM-385-1.1. He also provided support and oversight for the Accident Prevention Plan.

Prior to CDM Smith

Corporate Environmental Safety and Health Manager/Quality Control Manager/ Corporate Training Coordinator, EnergySolutions/BNG America, Denver, Colorado, 2002-2007. Mr. Meyer established and implemented environmental, safety, and health policies and expectations for nuclear remediation projects and manufacturing operations in seven states under both DOE and NRC governance. He developed and implemented strategic plans and policies to improve environmental safety and health (ES&H) performance. Mr. Meyer also provided leadership and clear, consistent direction to ES&H and Quality Control organizations throughout BNG America.

Georgine A. Grissop, PE

OPERATIONS

Ms. Grissop has 40 years of experience in drinking water and domestic, industrial, and hazardous wastewater treatment systems. Her experience includes facility and personnel management, compliance reporting, process control, maintenance, and safety. She has directed numerous and diverse plant start-ups, developed facility operations and maintenance (O&M) manuals and operations and maintenance procedures, trained staff on diverse wastewater and water O&M topics, performed facility evaluations, design reviews, environmental and operational site risk assessments, and implemented computerized operational monitoring, control, and maintenance management systems.

Operations Specialist, Water Treatment Facility, Lawrence, Massachusetts. For the new 16-mgd water treatment facility in Lawrence, Massachusetts, Ms. Grissop provided O&M services assistance during facility construction and startup. These services included equipment startup, troubleshooting, process guidance, compliance reports, operations and maintenance manual, shift operations, and post-construction advisory services. Also provided was the establishment of a CMMS using JobCal software. A training program, pre-accredited by the Board of Certification of Operators of Drinking Water Supply Facilities for 20 TCHs, was provided. The facility utilizes pre-oxidation with chlorine dioxide, superpulsating clarifiers, greenleaf filtration, potassium hydroxide pH adjustment, fluoridation using fluosilicic acid, and disinfection using ultraviolet light and sodium hypochlorite.

Operations Specialist, Water Treatment Facility UV Disinfection Upgrade, Auburn Lewiston, Maine. For the Auburn Lewiston Water Treatment Facility UV Disinfection upgrade, Ms. Grissop provided equipment startup and testing services, and TCH accredited system training. She also developed a plant O&M manual.

Operations Specialist, Water Treatment Facility, Billerica, Massachusetts. For this 14-mgd water treatment facility, Ms. Grissop provided O&M services during facility construction and startup. These services included conducting training courses, equipment startup, troubleshooting, process guidance, compliance reports, and post construction advisory services. She also provided a computerized plant O&M manual that links text, photos, CADD drawings, and an image database of vendor service manuals in a multimedia format. The facility utilizes pre-oxidation with ozone, filtration, carbon dioxide and potassium hydroxide pH adjustment, fluoridation and chloramination, using sodium hypochlorite and aqua ammonia, for disinfection.

Operations Specialist, Water Treatment Facility, Needham, Massachusetts. For a new water treatment facility, Ms. Grissop provided O&M services during facility construction and startup. These services included conducting training courses, equipment startup, troubleshooting, process guidance, and post construction advisory services. She also coordinated the production of a computerized plant O&M manual that linked text, photos, CADD drawings, and an image database of vendor service manuals in a multimedia format. The 4.6-mgd facility utilizes pressure green sand filtration, sodium hydroxide pH adjustment, fluoridation and sodium hypochlorite disinfection.

Education

MS, Civil Engineering, Northeastern University, 2001

BS, Civil Engineering, Northeastern University, 1998

BA, Environmental Studies, Rollins College, 1993

Registration

Professional Engineer: Massachusetts, 2004

Certifications

Florida Class A Wastewater (License #005623)

Massachusetts Grade 7C (Full) Wastewater Certificate (# 7186)

Massachusetts Grade 4T Water Certificate (#6049) OIT

40-hour OSHA HAZ WOPER Training

Hazardous Waste Supervisor's Course

Confined Space Entry Training

Water /Wastewater Technician I

Office Location

Boston, MA

Anne E. Malenfant, PE, PMP

WATER QUALITY/REGULATORY

Education

MS - Environmental Engineering, Cornell University, 1999

BS - Environmental Engineering, Cornell University, 1998

Registrations

Professional Engineer: Massachusetts (2003)

Connecticut (2020)

Certifications

Project Management Professional (PMP), Project Management Institute (2019)

Office Location

Boston, MA

Ms. Malenfant has 22 years of engineering experience in drinking water treatment and supply and wastewater treatment throughout the United States and Europe. Her expertise includes drinking water and wastewater processes and planning, regulatory review, water quality and chemistry evaluations and design. She has presented papers on surface water and groundwater treatment technologies at regional conferences in New England.

Technical Specialist, Greensand Water Treatment Facility, Franklin, Massachusetts. Ms. Malenfant is a technical specialist for the planning, piloting and design of a 1.2 million gallons per day (mgd) green sand filtration facility. The design considered potential surface water influence on the ground water supply, and the future need to meet surface water treatment requirements, as well as reduction of iron and manganese from the source water.

Project Manager, Disinfection By-Product Water Quality Study and Mitigation, Millinocket, Maine. Ms. Malenfant is the project manager for assessing disinfection by-product (DBP) mitigation options for the Maine Water Company's Millinocket water treatment plant (WTP), including a comprehensive water quality study and options evaluation, implementation of optimization and planning for long term organics GAC post-contactors.

Project Manager, Water Treatment Plant Design and MWRA Interconnection, Lynnfield, Massachusetts. Ms. Malenfant is the project manager for capital improvements to the Lynnfield Center Water District system to solve quality and quantity challenges. A new 1 MGD greensand water treatment facility addresses quality, while an interconnection with Wakefield for MWRA water solves quantity. The project also includes joining the MWRA and navigating the Interbasin Transfer Act.

Project Manager, Water System Master Plan, Millinocket, Maine. Ms. Malenfant was the project manager for the development of a water system master plan for the Maine Water Company's Millinocket water system, including comprehensive assessment of the water treatment plant, distribution system by building and calibrating a hydraulic model, assessing pipeline condition, evaluating fire protection, and overall system pressure adequacy. The Capital Improvement Plan (CIP) was the central component of the Master Plan, covering a 20-year investment period, broken down into four 5-year increments. The plan prioritized the distribution and treatment renewal needs and incorporated them into a balanced schedule that accounted for Maine Water's annual budget capacity.

Project Manager, Water Treatment Plant Alternatives Evaluation, Skowhegan, Maine. Ms. Malenfant is the project manager for evaluating options for making selected improvements to Maine Water Company's (MWC's) existing Skowhegan Division water treatment plant (WTP) versus construction of a new WTP on the existing site. The goal of the project is to provide an engineering review of the issues, aid MWC in its capital planning and recommend a long-term vision for the Skowhegan WTP.

Sarah Jakositz

STAFF ENGINEER

Ms. Jakositz is an environmental engineer focused on drinking water and water resources projects. She has experience with an array of projects, including drinking water treatment plant design, SWMM5 modeling, WaterGEMS and InfoWater hydraulic modeling, and Research and Development efforts. She is also familiar with Microsoft Excel, ArcGIS, WaterPro, Stella Architect, and Python.

Project Engineer, Final Design for New Water Treatment Plant, Manchester, New Hampshire. Ms. Jakositz was a project engineer for the Manchester Water Works' 5,000 gpm (7.2 mgd) radial collector well treatment facility on the Merrimack River – a new plant on a greenfield site to augment Manchester's existing 40-mgd plant's production.

Project Engineer, Millinocket, Maine Water System Master Plan for Maine Water Company. Ms. Jakositz was a project engineer supporting the lead project modeler in developing a WaterGEMS hydraulic model of Millinocket's 155,000 feet of pipeline. Ms. Jakositz updated pipeline data with information from Maine Water's GIS-based mapping and associated database, proposed flow test locations based on provided field flow test data, developed assumed Hazen-Williams C-values for pipe segments, ran calibration runs, and adjusted the model for better calibration.

Project Modeler, Ash Creek Alternatives Study, Bridgeport, Connecticut. Ms. Jakositz was a project modeler whose contributions included updating the SWMM5 model with sewershed field investigations, modeling the stormwater network, cleaning up the model around the area of Ash Creek, calibrating the model, conducting model alternatives., and assisting with TRC presentations and report preparation.

Project Modeler, Wastewater Facilities Plan, Bridgeport, Connecticut. Ms. Jakositz assisted the lead modeler to update, validate, and apply a SWMM5 model of the Bridgeport combined sewer system to evaluate inflows to Bridgeport's East and West Side Wastewater Treatment Plants. She was responsible for assisting with updates to model hydrology, hydraulics, and dry weather inflows.

Project Engineer, SCDOT Scour Critical Assessment and Management System, South Carolina. Ms. Jakositz is responsible for performing scour assessments for the statewide SCDOT bridge waterway scour program.

Project Engineer, FEMA Region II's New York New Jersey Coastal Restudy. Ms. Jakositz is responsible for performing QAQC on model results from ADCIRC modeling that simulates storms along the coast of New York and New Jersey.

Project Modeler, Potable Water Distribution Modeling, Nantucket, Massachusetts. Ms. Jakositz supported the lead modeler in updating the InfoWater hydraulic model for the Town of Nantucket and simulating future expansion project configurations and population and demand projections.

Project Engineer, Trihalomethane (THM) Management, Providence Water. Ms. Jakositz serves as a project engineer supporting on-call data analysis and support related to THM management in the Providence Water distribution system.

Education

MS – Environmental Engineering, University of New Hampshire, 2019

BS – Environmental Engineering, University of New Hampshire, 2018

Registration

Engineer in Training

Certifications

Graduate Certificate in Data Science, University of New Hampshire, 2019

Honors/Awards

American Society of Civil Engineers (ASCE) 2018 New Faces of Civil Engineering

Office Location

Manchester, NH

SECTION 4:

Understanding of the Project Requirements

PWW has been faced with recent challenges at its Nashua WTP, wherein production of the plant's full rated capacity is reportedly limited by the capacity of the plant's chemical storage and feed systems. PWW owns and operates a 32 million gallon per day (MGD) drinking water treatment facility at 200 Concord Street in Nashua, New Hampshire. The facility consists of a plant equipped to receive water from Pennichuck Brook and the Merrimack River via the Merrimack River Intake (MRI).

As per- and poly-fluoroalkyl substances (PFAS) have become regulated in New Hampshire, PWW has begun to use the Merrimack River as its primary water supply source. The variability of the river, with potential influences from climate change to exacerbate variability in the future, has manifested itself within the existing plant in several ways. Changing water quality has been exhibited in higher source water organic content (Total Organic Carbon), turbidity, color, and manganese in the river. This has required doubling of some chemical dosages, notably a doubling of coagulant and an appreciable increase in sodium hypochlorite dosing, and increased frequency of chemical deliveries. The chemical dosing demands and limitations of the existing systems have made it difficult for PWW to produce the plant's full 32 mgd to serve existing and new customers. Given these challenges, PWW initiated this Nashua Treatment Plant Chemical Feed System Upgrades Project to evaluate existing systems' adequacy and long-term viability. CDM Smith differentiators are presented in the following table.

CDM Smith's Differentiators

We know the Merrimack River like no other firm. Plant work and current contact with Manchester, Lowell, Tewksbury, Methuen, Lawrence, and Andover, providing long-term resilient solutions.

Our culture of mentoring is evidenced by CDM Smith President's Award for Mentorship. Two company-wide award winners are part of our core team – David Polcari and Al LeBlanc. With regard to seeking our clients' input, our client references speak to our deliberate collaborative approach, helping create opportunities for staff integration and mentoring.

CDM Smith's mastery of the details matters. Materials compatibility, degradation of sodium hypochlorite, caustic crystallization potential, and small-diameter chemical flow meters are among the dozens of key considerations for chemical system design.

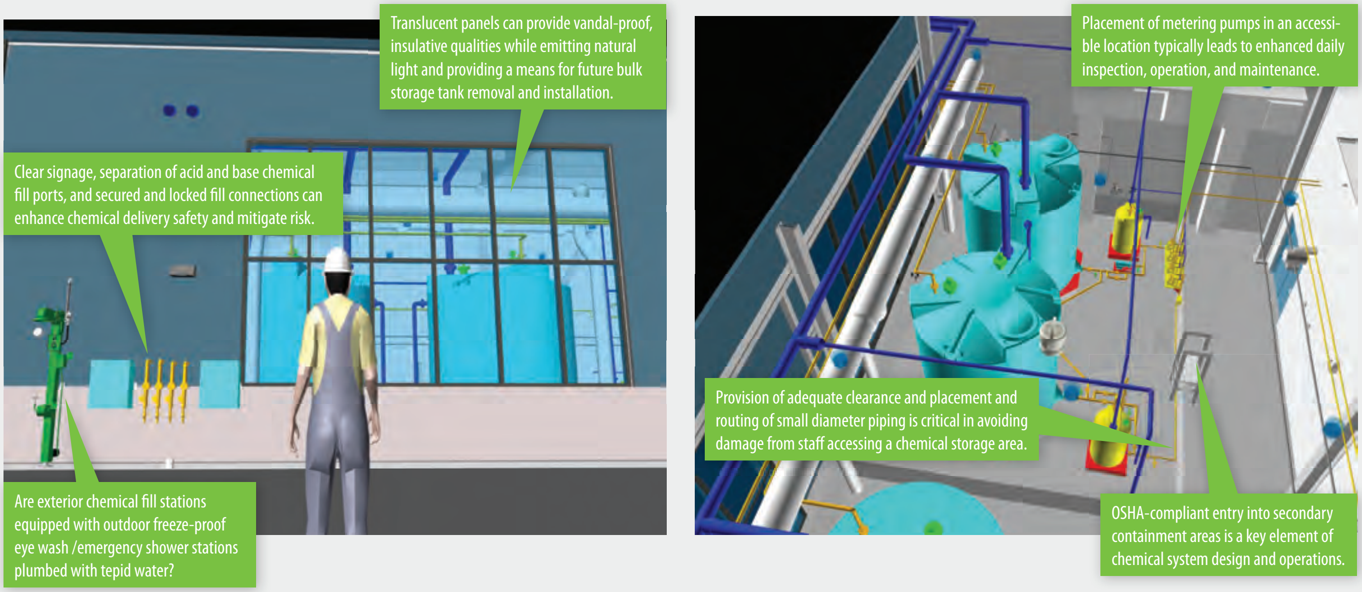
CDM Smith offers extensive experience with both chemical systems experience and PFAS expertise alike. Our thought leadership has overarching goals to help address the challenges of PFAS for our clients and our communities, including developing high-quality communications, and providing technical solution that are efficient, sustainable, and accountable for characterizing, treating, and destroying PFAS.

CDM Smith understands that Pennichuck Water Works faces a myriad of challenges in treating deteriorating source water quality and being able to deliver up to the plant's rated 32 mgd. Several of those challenges include those listed on the table below:

Key Issue	CDM Smith's Approach	Benefits to PWW
Changing and deteriorating source water quality	Our scope of work includes data trending, gathering of input from our in-house climate change and resiliency discipline leader, and conferring with other Merrimack River source water communities regarding water quality data trends and future projections.	PWW will be provided with a data-driven analysis of its own source water quality trends. Recommended adjustments for the future water quality (and in turn chemical dosing) will be informed by climate change projections and viewpoints of peer utilities using the same source.
Aging equipment	CDM Smith will develop a detailed inventory of major chemical systems equipment that includes year of installation, manufacturer, make/model, capacity, and maintenance history.	Rigorous, detailed inventories of existing equipment and detailed basis for replacement equipment characteristics and cost.
Establishing modern-day compliance with applicable guidelines, codes, and regulations	New Hampshire Department of Environmental Services (NHDES) adopts the Ten States Standards by reference. Accordingly, CDM Smith will use these standards as a checklist during its Condition Assessment work in Task 2. We will deploy a master electrician and senior building-mechanical engineer to evaluate PWW's status with the current edition of the National Electrical Code (NEC) and the applicable building, plumbing, and energy codes.	Compliance with regulations in the recommended plan will position PWW well for future stages of regulatory and funding approvals. CDM Smith's history of effectively coordinating with key DES staff that will have an impact on the project.
Avoiding avoidable surprises	The value of experience is evident when the number and scale of "surprises" is minimized as a job progresses through the project life cycle. CDM Smith's experience, coupled with activities such as our Task 5 consultation with Nashua fire officials, will mitigate these surprises, which can represent cost and schedule impacts to a project like PWW's.	Confidence that scope, schedule, and budget risks have been reasonably mitigated at the planning state through informed, appropriate, collaboration.
The details matter	CDM Smith's approach is to deploy senior experts in the process-mechanical, electrical, and building-mechanical disciplines now – at the planning phase.	Subtle issues can be identified at the planning phase via the early deployment of expert personnel, resulting in a cost-effective evaluation.

Figure 4-1 depicts key considerations for chemical storage and feed systems that we will apply to PWW's evaluation. The rendered images are taken from our 2021 design of Manchester Water Works' new Merrimack River WTP, and represent best practices that encompass the latest requirements of the Ten States Standards, building, and fire codes.

Figure 4.1: Key Considerations for Chemical Storage and Feed System Design



Translucent panels can provide vandal-proof, insulative qualities while emitting natural light and providing a means for future bulk storage tank removal and installation.

Clear signage, separation of acid and base chemical fill ports, and secured and locked fill connections can enhance chemical delivery safety and mitigate risk.

Are exterior chemical fill stations equipped with outdoor freeze-proof eye wash /emergency shower stations plumbed with tepid water?

Placement of metering pumps in an accessible location typically leads to enhanced daily inspection, operation, and maintenance.

Provision of adequate clearance and placement and routing of small diameter piping is critical in avoiding damage from staff accessing a chemical storage area.

OSHA-compliant entry into secondary containment areas is a key element of chemical system design and operations.

PWW will benefit from additional aspects of our approach including engagement of key specialists at CDM Smith, engagement of Operations and Maintenance (O&M) personnel at PWW, and a deliberate review of safety considerations, which will further enhance this project.

Public Relations, Education, and Communications

Our core project team of Al LeBlanc, Michaela Bogosh, and Ji Im, supported by our in-house communications specialist Dr. Melissa Harclerode, are ideally suited for this assignment given their mastery of the subject matter and their ability to communicate complex concepts in simple terms for the public to understand. Empathy to public concerns and personal viewpoints are key, and CDM Smith's professionals have proven their ability to connect with a broad audience.

It is ALL about the collaboration!

CDM Smith's approach to projects such as PWW's is to collaborate extensively with our clients to ensure the work represents the goals and understanding of all involved and considers the detailed input of the persons closest to the daily challenges and project objectives. Our proposal includes references for several projects featuring very high levels of client engagement – notably the Town of Franklin, MA, Manchester Water Works, and Brunswick & Topsham Water District. Key leaders and members of our core PWW team delivered these projects. All of these clients offered frequent, extensive input to the design work, greatly benefiting the overall project.

We view our collaborative approach as a differentiator that will benefit Pennichuck.

Climate Change and Resiliency

Despite varying viewpoints on the cause of climate change, the data indicates warming weather and more frequent, intense precipitation events and prolonged drought events are occurring relative to past weather records. It is likely that climate change will continue to impact water quality and treatment requirments.

Application for Funding

The primary objective of our approach and detailed scope of work is to position Pennichuck Water Works well to confidently apply for state and federal funds with a well-founded, collaboratively developed chemical storage and feed systems plan.

Pennichuck's Operations and Maintenance Personnel

CDM Smith finds that our clients' O&M personnel often possess the most granular, detailed, practical observations on system performance. This insight is only gained by engaging those staff, and CDM Smith's Task 2 condition assessment work is crafted with the expectation that some or all of these staff are made available for discussion on the day of our "SWAT team" condition assessment.

Health and Safety – The Fundamental Requirement

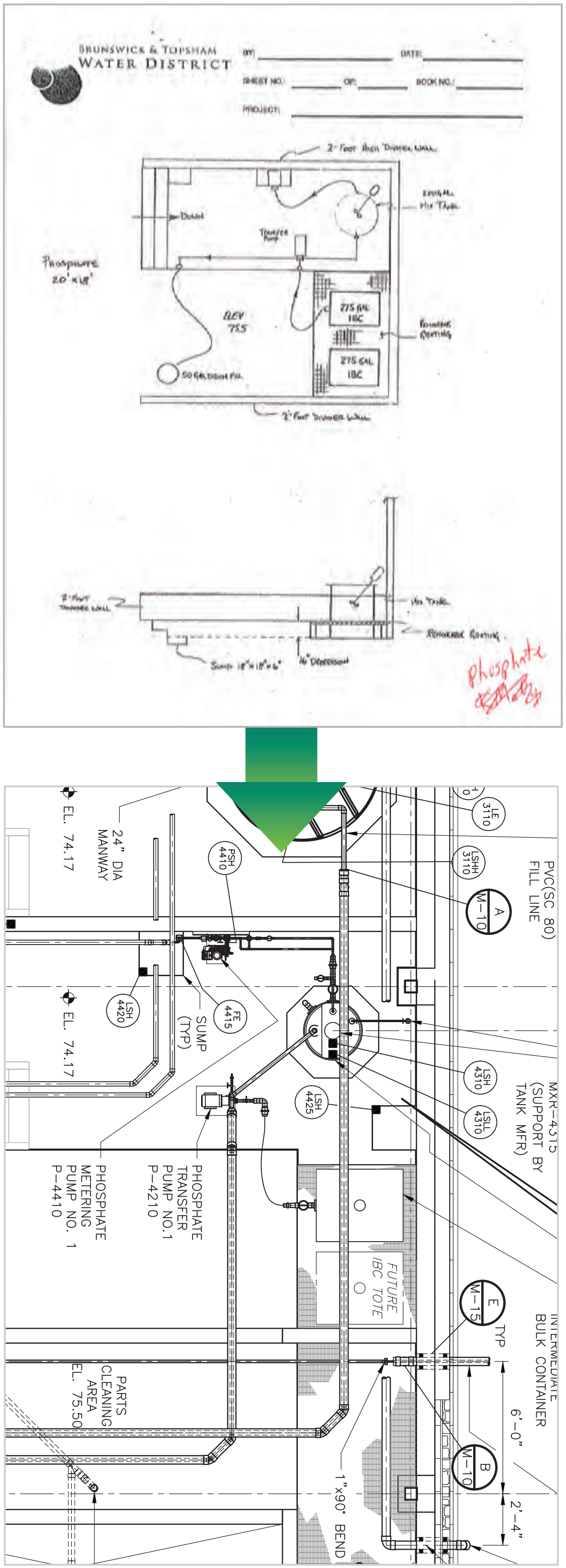
Without safe operations, water utilities have no ability to deliver safe water. Our approach features a focus on health and safety – attention to eye wash / emergency shower adequacy, fire suppression system sufficiency relative to modern codes, compliance with the National Electrical Code, adequacy of ventilation systems, and provision of proper egress into and out of chemical storage areas. The deployment of experienced professionals at this stage of project planning is money well spent in CDM Smith's view.

A Collaborative and Comprehensive Technical Approach

We are proud of our recent past work, which is marked with client collaboration leading to the success of our projects. At Manchester Water Works' Lake Massabesic WTP (New Hampshire's largest water treatment plant) we learned of MWW personnel designing and fabricating their own sedimentation basin washdown system, and we implemented a more robust version of it in the design. In Franklin, Massachusetts we involved operations staff in collaborative design review meetings, and gained valuable input while staff felt a sense of involvement and ownership of the design. At the Brunswick & Topsham Water District in Maine, the Owner provided highly specific input into the preferred layout for chemical systems in their new plant. At Pennichuck, CDM Smith looks forward to sharing the results of our work at each stage of the project, comparing those results to Pennichuck's own findings, and exchanging design ideas throughout the job. We expect a highly successful product as a result.

CDM Smith will request a variety of data and information from PWW to execute the work, including:

- Access to the Nashua WTP
- Water production records for each supply source
- Historical source water quality data
- Historical chemical dosages
- Safety Data Sheets (SDS) for chemicals used at the Nashua WTP
- Disinfection byproducts (DBP) Data
- Facility record drawings (aka as-built drawings)
- Shop drawings for chemical storage tanks, day tanks, transfer pumps, and metering pumps
- Chemical supplier contact information and current-year chemical purchase cost
- Electrical power costs ($/kWh)
- Proprietary equipment preferences and requirements (e.g., Watson Marlow Bredel peristaltic feed pumps)



CDM Smith's chemical systems design for the Brunswick & Topsham Water District (BTWD) exemplifies the collaborative, detailed approach we propose for Pennichuck. BTWD developed its own chemical system layout sketches for review and discussion, and CDM Smith's final design reflected BTWD's layout and arrangement preferences with a limited number of enhancements and adjustments.

SECTION 5:

Detailed Scope of Work and Budget

CDM Smith has custom tailored this scope of work to provide PWW with a defined pathway for reliably treating challenging and ever-changing source water quality conditions, such that the full 32 mgd capacity can be delivered. Our scope of work is written with recognition that risk management and resiliency planning for critical water system assets such as water treatment plant chemical systems is critical to integrate in near-term and long-range planning. The tasks detailed herein are intended to provide a clear accounting of current water quality, current and future chemical storage and feed requirements, an assessment of the existing systems' physical disposition, and a conceptual plan and cost model for PWW's planning and securing of funds. Our work is proposed to be developed in close and constant collaboration with PWW personnel.

We developed the proposed scope of work with the following key assumptions:

- Chemical product alternatives analysis would be limited to the following: Bulk sodium hypochlorite versus onsite generation of sodium hypochlorite; 25% sodium hydroxide versus 50% sodium hydroxide; and liquid sodium permanganate versus dry potassium permanganate.
- CDM Smith's scope, schedule and level of effort assumes that one new structure housing chemical storage and feed systems on the existing site will be part of the solution selected by the PWW as the preferred alternative.
- The existing plant has sufficient utility and backup/emergency power for the new facilities; and no modifications will be required to the utility service to the plant or electrical distribution system within the plant.
- Elements of the plant performance such as hydraulic capacity, raw water pumping, dams, water demand projections, and process evaluation and optimization are excluded, as they have been evaluated by others or are being handled under separate contracts.
- Design, bidding, construction, and commissioning of chemical systems improvements will occur in a future authorization. Services related to those phases of work are not included herein.

Proposed Tasks

CDM Smith will conduct evaluation and field review activities to collaboratively determine with PWW the chemical system improvements that will be implemented. CDM Smith will complete the following tasks:

Conduct Project Kickoff Meeting

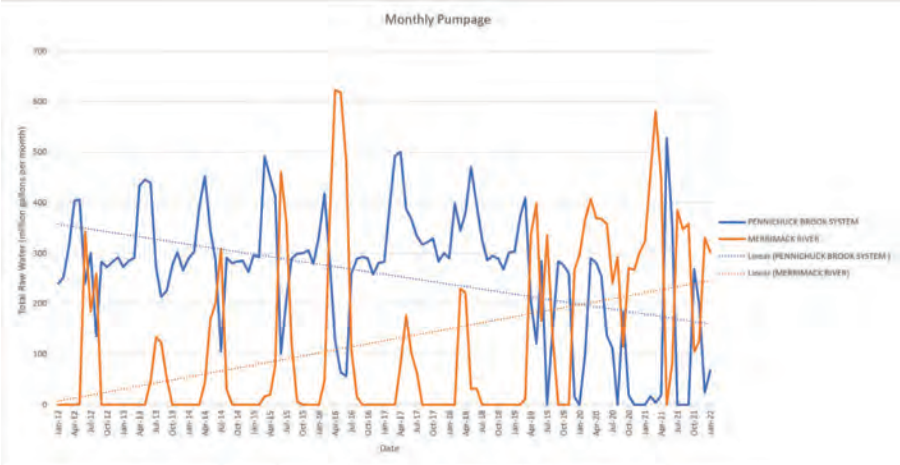
- Workshop to be held at the PWW Nashua WTP
- Duration up to four hours
- Attended by CDM Smith Project Manager, Deputy Project Manager, Project Engineer, and Staff Engineer
- Among the objectives of this kickoff meeting will be to establish critical success factors, which will guide the direction of the project and make clear PWW's objectives.
- A key agenda item in this meeting will be to discuss the minimum, average and maximum plant flow rates that will be considered in this project.

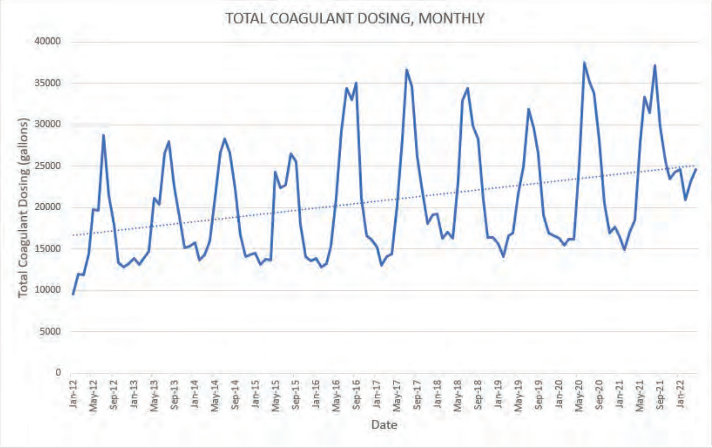
Task 1 | Conduct Desktop Evaluation

Prior to the project kick-off meeting, CDM Smith will review the outcomes of the Risk and Resiliency Assessment (RRA) and Emergency Response Plan (ERP), previously developed by CDM Smith for PWW as part of the America's Water Infrastructure Act (AWIA) project, for potential impacts to the chemical storage and feed systems. During the Desktop Evaluation of the chemical systems, these potential impacts will be taken into consideration as the comparison of the existing storage and feed capabilities are made to the future requirements. Impacts from climate change will likely be observed in the future as temperatures rise and storm events become more intense. As such, impacts to water quality from increased water temperature and flooding will be considered.

Using data furnished by PWW, CDM Smith will evaluate the following in desktop analyses for all chemicals used at the Nashua WTP:

- Source water quality trending and comparative analysis
- Chemical dosing and usage trends for all chemicals used at the Nashua WTP
- Computation of minimum, average, and maximum storage volume and feed rate requirements
- Comparison of existing available storage and feed capacities to the required volumes and rates.





CDM Smith's Desktop Evaluation task will examine the upward trends in Merrimack River use and coagulant dosing over this 10-year window. We will do the same for sodium hypochlorite and all other plant chemicals. Using our experience with numerous other Merrimack River communities, and input from our in-house climate resilience experts, CDM Smith will develop forward-looking chemical storage and feed projections for the project's planning horizon. These trends and projections will be collaboratively discussed in detail with Pennichuck Water Works during the project workshops.

Task 2 | Perform Condition Assessments

Building upon the work of Task 1, CDM Smith will assess the condition of the chemical systems and key ancillary systems. Following the field assessment, outreach to equipment vendors and chemical suppliers. The work includes the following tasks:

- Deployment of our core team members to assess existing conditions and proposed improvements at the plant. The observations from this assessment will help formulate CDM Smith's overall recommendations and planning-level costs.
- Contact storage tank, transfer pump, metering pump, and other feed equipment sales representatives.
- Interview PWW's chemical suppliers to verify chemical availability, current pricing, standard delivery volumes, and supply chain considerations.

In consideration of resiliency, CDM Smith will evaluate the potential impacts found in Task 1. Potential considerations include provisions for increased likelihood of flooding from more intense storms and rainfall volume, as well as changes in water quality from both flooding and increased water temperatures.

Task 3 | Conceptual Design Development

Given the computations from Task 1, and the findings in the field and from the marketplace in Task 2, CDM Smith will prepare its recommendations for the conceptual design as follows:

- Development of conceptual design plan, including:
    - one demolition drawing each for the two existing chemical areas,
    - one new work drawing each for the two existing chemical areas,
    - one new work floor plan for a new chemical building on site, and
    - one general GIS-based site plan indicating the location of new structures.

The concept designs developed for the chemical storage and feed systems will take into account impacts from climate change by incorporating robust features and providing for enough flexibility in the systems such that PWW is able to readily adapt to changes in water quality that are predicted in the future.

Post-Chemicals - Zinc Orthophosphate

Task 4 | Draft and Final Report

The full body of work will be summarized in an engineering report, with the final edition to be signed and sealed by a New Hampshire-registered Professional Engineer. Summarizing the work of Tasks 1, 2 and 3, and capturing the input from PWW in our collaborative workshops, this task includes:

- Authoring of a draft report of findings and recommendations
- Construction cost estimating, in development of an Opinion of Probable Construction Costs (OPCC) and in turn the development of an Opinion of Probable Project Cost (OPPC).
- Independent Technical Review by senior personnel within CDM Smith who have not been otherwise participating in the work of this project. A mandatory element of CDM Smith's quality management program, these independent reviewers will provide a check on the project team and added value to Pennichuck.

Resilient design features that have been incorporated to address impacts from climate change discussed above will be summarized in the report.

CDM Smith will prepare and submit a draft and final report presenting the findings of the study capturing PWW review comments on the draft, including discussion and findings from all previous tasks.

The work of Task 4 will be written such that Pennichuck can use the document as an engineering basis for funding applications.

Optional Value-Added Task 5 | Enhanced Condition Assessment and Meeting Among PWW, CDM Smith, and City of Nashua Fire Officials

Expanding the level of detail provided in the Task 2 Condition Assessment work is likely to identify ancillary matters in this early stage of planning, enabling PWW to plan its work and capital expenditures to address them. As a value-added optional task CDM Smith proposes deployment of an expanded "SWAT team" of specialists for one-day site visit, including a senior process-mechanical engineer, a building mechanical engineer (addressing HVAC, plumbing and fire protection), and a master electrician to assess existing conditions and proposed improvements at the plant. These specialists will be accompanied by members of our core team, and their findings will help formulate CDM Smith's overall recommendations and planning-level costs.

Continuing our theme of "avoiding the avoidable surprises", while not mandated in PWW's Request for Proposals, CDM Smith's notes that building codes give the Authority Having Jurisdiction (AHJ) latitude to require certain provisions within buildings or chemical storage and feed facilities by applying their own judgment, discretion, or local practices. We have found that consulting with the AHJ early commonly brings issues to the table that can be addressed during the planning or design phase of a project, with cost allowances to address that input. We have programmed this into the project as a value-added activity after the above work and overall plan are developed and agreed upon, after PWW's review of the draft report is complete.

Project Management

There are several elements to CDM Smith's project delivery model that effectively streamline project and quality management including:

Collaborative Progress Meetings

At approximately one-month intervals, an in-person meeting will be convened to report on progress, findings, and to identify areas where additional information is required.

We have noted key meetings and workshops with PWW in our proposal and schedule presented in Figure 5-2. The initial project kickoff meeting will define goals, communication strategies, success factors and key delivery approaches for the project. These meetings and project workshops have been developed to gain vital timely input from Pennichuck staff, share critical project data with the team, and ensure that project delivery remains on track with the project goals. Tasks involved include meeting scheduling and coordination, preparation of meeting agendas at least 24 hours in advance of meetings, preparing presentations (as necessary), facilitating meetings, and preparing and timely distribution of meeting summaries. Meeting summaries will document the discussion topics, actions, and decisions.

Meetings with a focus on information exchange, inclusion of junior and senior staff, mentorship, and partnership is the cornerstone of CDM Smith's culture and prioritized in our approach to this project. Pennichuck's team has already developed its own evaluations of the chemical storage and feed systems, and our workshop-based approach is intended to exchange information in a detailed, open manner at each meeting. CDM Smith's staff-level engineers will participate in meetings led by our project manager, and we anticipate PWW's attendance and active participation will mirror that.

Quality Management Plan

Our Quality Management Plan will be tailored to PWW's needs to ensure the successful delivery of the Project by aligning project budget, schedule, and quality goals through clearly defined and readily implementable processes.

Project Controls

Deputy Project Manager Michaela Bogosh will support Project Manager Al LeBlanc by providing day-to-day responsibility to PWW, closely and continuously managing the study work, costs and schedule, reporting tasks, and communications in monthly project progress reports.

Cost Control Tools and Reporting

Information from the workplan and schedule will be entered into our in-house project management controls system (EcoSys) to produce project reports tailored to suit PWW's needs. We will provide summary reports that include complete, up-to-date information to track progress, and provide early identification of any deviations from the budget and schedule to allow for timely corrective actions.

Quality Assurance

Al LeBlanc will lead the project team in incorporating CDM Smith's established QMP and process throughout completion of the project tasks. Key elements include:

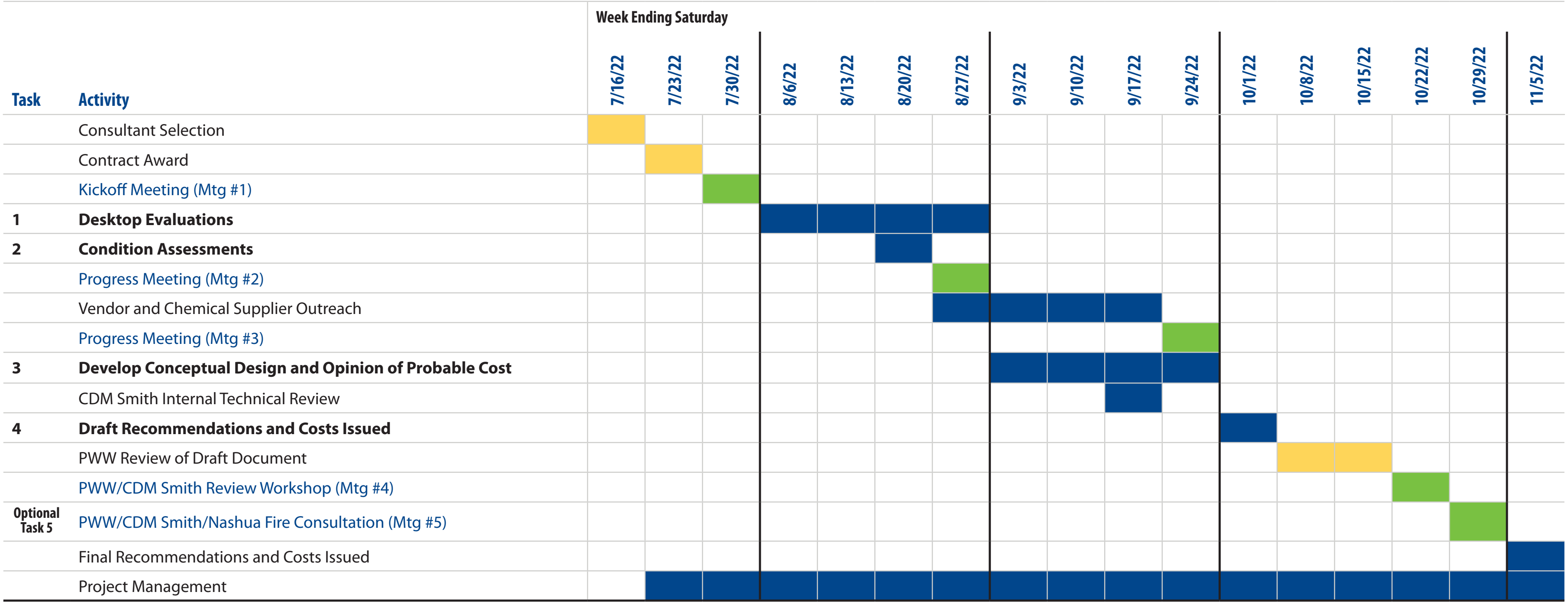
- Kickoff Workshop, including a statement of the project mission/goals, identification of team member roles, and discussion of risk management.
- Establishment of the Project Work Plan, providing the basis for quality reviews and checks throughout delivery, and application of appropriate PWW and CDM Smith standards.
- Technical Review Committee (TRC) involvement during the study to incorporate value and innovation from discipline experts.
- Opinion of Probable Construction Cost (OPCC) development by credentialed estimators, with back-checking from our core project team and ongoing checks throughout.

CDM Smith's collaborative approach to PWW's project will be continuous. In addition to monthly workshops, we propose a series of one-hour check-in calls (via Microsoft Teams) in the second weeks of July, August, and September. The goal of these calls will be to bridge the gap between in-person meetings and to ensure that communication of ideas, data needs, and progress is continuous both to and from PWW staff.

FIgure 5.1 Estimated Budget

		Principal in Charge/Project Manager/ Technical Advisor	Deputy Project Manager/Process Lead	Process Engineer/ Staff Engineer	Global Resource Center Drafter	Sr. Engineer	Estimator	Administrative Support	Hours	Budget
Task	Description	$275	$175	$110	$65	$250	$130	$110		
1	**Conduct Desktop Evaluation**	18	54	72				6	150	$24,000
2	**Perform Condition Assessment**	14	26	56				6	102	$18,000
3	**Concept Design Development**	20	36	52	60	6	40	22	236	$29,000
4	**Draft and Final Report**	16	36	60				18	130	$19,000
Total		**68**	**152**	**240**	**60**	**6**	**40**	**52**	**618**	**$90,000**
Optional Task										
5	**Advanced Conditions Assessment**	20				26			46	$12,000

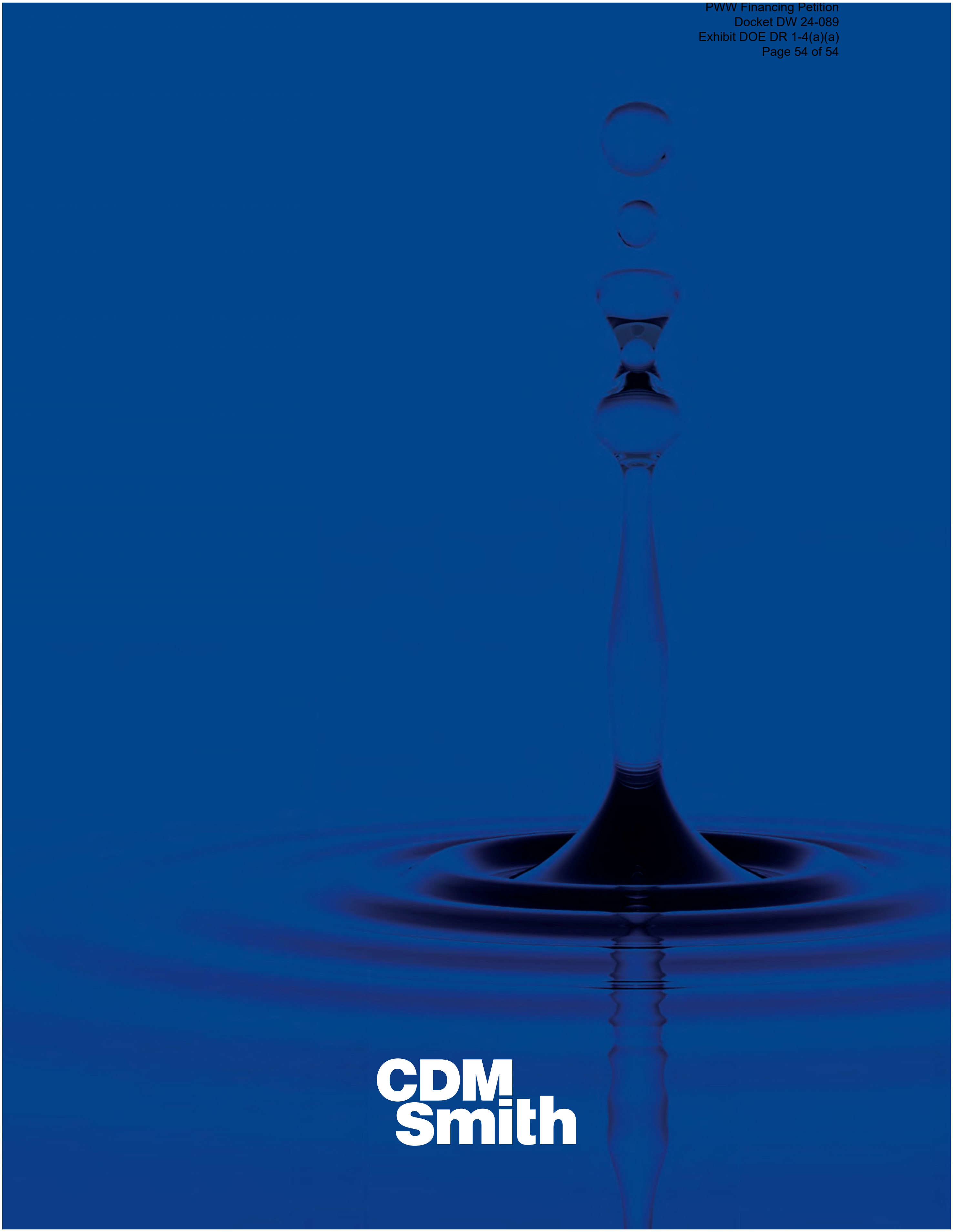
Figure 5.2 Proposed Schedule



		Week Ending Saturday																
Task	**Activity**	7/16/22	7/23/22	7/30/22	8/6/22	8/13/22	8/20/22	8/27/22	9/3/22	9/10/22	9/17/22	9/24/22	10/1/22	10/8/22	10/15/22	10/22/22	10/29/22	11/5/22
	Consultant Selection	🟨																
	Contract Award		🟨															
	Kickoff Meeting (Mtg #1)			🟩														
1	**Desktop Evaluations**				🟦	🟦	🟦	🟦										
2	**Condition Assessments**						🟦											
	Progress Meeting (Mtg #2)							🟩										
	Vendor and Chemical Supplier Outreach							🟦	🟦	🟦	🟦							
	Progress Meeting (Mtg #3)											🟩						
3	**Develop Conceptual Design and Opinion of Probable Cost**								🟦	🟦	🟦	🟦						
	CDM Smith Internal Technical Review										🟦							
4	**Draft Recommendations and Costs Issued**												🟦					
	PWW Review of Draft Document													🟨	🟨			
	PWW/CDM Smith Review Workshop (Mtg #4)															🟩		
Optional Task 5	PWW/CDM Smith/Nashua Fire Consultation (Mtg #5)																🟩	
	Final Recommendations and Costs Issued																	🟦
	Project Management		🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦

Legend

🟨 PWW Activity
🟦 CDM Smith Activity
🟩 Collaborative Workshop Event



CDM
Smith

CEI Proposal

Pennichuck Water Works

Nashua Treatment Plant
Chemical Feed System Upgrades

Prepared For:
Pennichuck Water Works
25 Walnut Street
PO Box 428
Nashua, NH 03061-0428

Prepared By:
Comprehensive Environmental Inc.
21 Depot Street
Merrimack, NH 03054

Submittal Due Date/Time:
June 10, 2022
2:00 PM
Submitted Via Email

COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED

21 Depot Street
Merrimack, NH 03054
603.424.8444

June 10 2022

Mr. John J. Boisvert, P.E., Chief Engineer
Pennichuck Water Works, Inc.
25 Walnut Street
P.O. Box 428
Nashua, NH 03061-0428

Transmitted Via Email: john.boisvert@pennichuck.com, hannah.marshall@pennichuck.com

RE: CEI Proposal Submittal
Nashua Treatment Plant Chemical Feed System Upgrade

Comprehensive Environmental Inc. (CEI) is pleased to provide Pennichuck Water Works (PWW) with the following proposal to provide Professional Engineering Services to assist with the Nashua Treatment Plant Chemical Feed System Upgrade Project.

CEI is an award-winning civil engineering and environmental services firm with main offices in Merrimack, NH, Bolton, MA and New Britain, CT. Founded in 1987, CEI has been providing premier engineering and environmental services to Federal, state, municipal and private clients including water suppliers for over 30 years throughout the Northeast.

CEI's Drinking Water Division has been providing similar services to water utilities throughout the region for several decades with a staff of industry experts in water supply planning, treatment and distribution with specific expertise in process engineering.

CEI's project team with be led by Principal Engineer and Project Manager, Michael Ohl. With over 30 years of drinking water experience, Mr. Ohl leads CEI's Drinking Water Division and has led numerous planning, treatment and distribution engineering projects throughout New England. He will be assisted by Project Director, Sebastian Amenta who has 40+ years of public utility engineering expertise. They will be supported by CEI's staff of over 35 professional engineers, scientists and technical experts.

For this assignment, CEI has added several subject matter experts to enhance CEI's process engineering team. Carina Hart has specific experience with the PWW treatment plant and facilities from previous work and will assist the team with providing process chemistry. Dr. Jeanine Dudle is an expert in water quality and treatment and will assist in evaluating the efficacy of the chemicals used and any potential interactions due to proximity of injection locations. Ron Maness is a process engineering expert with significant large treatment plant experience and will provide technical review and QA/QC assistance.

CEI has been providing civil and environmental engineering services to PWW for over 20 years, with several team members working on some of CEI's original projects with PWW. Our team is very familiar with the PWW system and supply. We are fully committed to this project and to providing the technical excellence and elevated service and responsiveness that our clients have come to expect from CEI. Additionally, we believe CEI's project team of industry experts will provide a quality and cost-effective solution to the PWW chemical capacity issues.

We appreciate the opportunity to propose on this project and look forward to continuing our work with PWW. Please feel free to reach out to myself or CEI Project Manager Michael Ohl at 603-424-8444 or epannetier@ceiengineers.com, samenta@ceiengineers.com or mohl@ceiengineers.com, with any questions or if we can provide additional information.

Sincerely,

COMPREHENSIVE ENVIRONMENTAL INC.

Eileen Pannetier
President

Enclosure: CEI Proposal via email

CC: Hannah Marshall, EIT

Table of Contents

1.0 Statement of Interest

CEI Commitment to Pennichuck Water Works

CEI has been providing engineering and environmental services to Pennichuck Water Works for over 20 years. Our Project Team is very familiar with the Pennichuck system and supply and understands both the short and long term goals of this project. Our key project staff were selected based on their experience, qualifications and ability to 100% commit to this project, prioritizing Pennichuck's needs and providing the technical expertise and responsiveness that our clients have come to expect from CEI.

This Statement of Interest confirms our commitment to this project and providing Pennichuck with the highest level of service from our project team.

About CEI

CEI is an award-winning civil engineering and environmental services firm with main offices in Merrimack, NH, Bolton, MA and New Britain, CT. Founded in 1987, CEI has been providing premier engineering and environmental services to Federal, state, municipal and private clients including water suppliers for over 30 years throughout the Northeast. CEI is employee-owned with a technical staff of approximately 35 including professional engineers (civil, environmental, geotechnical and transportation), environmental scientists, Certified Floodplain Managers (CFM), wetlands scientists, Certified Senior Ecologist (CSE), Certified Lake Manager (CLM), drinking water/wastewater facility operators, plan/peer reviewers, construction administrators, grant/funding specialists, hydrologists and various other technical staff including those expert in CADD, MicroStation, GIS and select survey including aerial drone services.

Our broad engineering and environmental services include:

- Civil Engineering
- Water/Wastewater Engineering
- Geotechnical Engineering
- Structural Engineering
- Hydraulics & Hydrology
- Stormwater Engineering
- Comprehensive Permitting
- Flood Management
- Transportation/Traffic
- Plan/Peer Review
- Utilities/Infrastructure/Asset Management
- Wetlands/Ecological Services
- Facility Compliance
- Inspection/Construction Services
- Master Planning
- Investigation & Remediation Services
- Comprehensive Field Services including Sampling & Monitoring
- Mapping/Survey

2022 Best Firms To Work For

1.0 Statement of Interest

Industry Recognition

- CEI is proud to be a nationally ranked 'Best Firm to Work For' in Civil Engineering, Environmental Services, Geotechnical Services and/or Multidiscipline Services yearly since 2010. This award recognizes outstanding professional support, benefits and workplace environment for staff.
- Engineering Excellence Award Finalist by the American Council of Engineering Companies (ACEC) for multiple projects.
- Construction Management Association of America Public Project of the Year Award ($50M-$100M) for CEI's role as Owner's Representative (environmental services) for the MWRA design-build of the Norumbega Covered Storage Project in Weston, MA.
- Journal of the New England Water Works - Cover Spotlight Project – Kingston Water Treatment Facility

CEI takes pride in developing effective, high quality, responsive solutions to our clients' needs and issues. This commitment to quality has resulted in the award of multi-year contracts from many of our clients. Since the firm was incorporated in 1987, the percentage of our business from repeat clients has more than tripled and our company has continued to grow throughout periods of recession. We know that our continued growth is dependent on providing the highest quality engineering services to our clients, on time and within budget.

CEI has a unique focus on our clients. We identify ourselves by what we provide for our clients, and take pride in key aspects of our company including:

- Responsive, Quality Service
- Experienced Technical Staff
- Up-To-Date Regulatory Information
- Quality Professional Services On Time & Within Budget

CEI Team

For this assignment CEI has enhanced its process engineering staff by adding Carina Hart, of Hart Consults; Janine Dudle, PhD from WPI; and Ron Maness, process engineering consultant. Ms. Hart has specific experience with the Pennichuck Water Treatment Plant and facilities from her previous work. Her expertise in piloting and chemical dosing will be utilized as part of this assignment. Ms. Dudle is an expert in water quality and water treatment. She will assist in evaluating the efficacy of the chemicals used and any potential interactions due to proximity of injection locations. In addition, she may recommend alternative locations for the chemicals used at the facility. Lastly, Mr. Ron Maness has over 40 years of experience in the water industry and brings years of specific large treatment plant experience and facility optimization. Mr. Maness is a former Infilco Degremont employee and is familiar with the PWW treatment systems.

We believe CEI's staff of drinking water experts and the above team of experts will provide a quality and cost-effective solution to the PWW chemical capacity issues.

2.0 Past Experience & References

CEI has provided civil and environmental engineering services for Pennichuck Water Works for over 20 years. With little staff turnover, many of CEI's key staff have been at CEI since we started working with PWW and are very familiar with the both the watershed and system. Having completed over 50 projects with PWW through these years, CEI values the longstanding professional relationship the firm and individual staff have cultivated throughout this time.

CEI's drinking water engineering and consulting services include water supply studies, master plans and capital improvement plans; asset management; water conservation and drought management; distribution planning, design and construction services; pumping station planning, design and construction services; treatment facility planning, design and construction services; pilot testing; vulnerability assessment and emergency response training; hydraulic modeling and investigation; water storage analysis; water audits; and watershed protection planning.

CEI has provided similar services to many of our existing clients. Following this section, we have provided 5 similar projects with client contacts/references. These include:

1. **Kingston Water Department – Project Manager, Michael Ohl**

   Key CEI support staff include Sebastian Amenta, Matthew Lundsted, Stephanie Hanson, Mike Carmasine, Pareena Deva

2. **Auburn Water District – Project Manager, Michael Ohl**

   Key CEI support staff include Sebastian Amenta, Mike Carmasine, Pareena Deva, Rick Cote, David Roman

3. **West Boylston Water District – Project Manager, Michael Ohl**

   Key CEI support staff include Sebastian Amenta, Mike Carmasine, David Roman

4. **Providence Water – Project Manager, Sebastian Amenta (prior firm)**

5. **City of Fall River – Project Manager – Carina Hart (subcontractor)**

Iron & Manganese Treatment Facility
Town of Kingston, MA

Journal
of The New England Water Works Association
Our 134th Year
Volume 129 No. 1
March 2015

Comprehensive Environmental Inc. (CEI) worked with the Kingston Water Department in Kingston, MA to construct a new water treatment facility to remove manganese from the Trackle Pond Well. The water treatment facility has a design capacity of 1.5 mgd (expandable to 3 mgd) with a primary treatment process utilizing pressure filtration. The facility includes pumps, chemical feed systems (oxidation/disinfection and pH adjustment), pressure filtration system, disinfection, residuals management, instrumentation, controls, and SCADA system. The facility is an approximately 4,450 square foot slab-on-grade masonry superstructure with brick siding and salt box style roof. The pressure filters and associated piping, valves and instrumentation are located in the main process area. Individual rooms are provided for storage of potassium hydroxide, sodium hypochlorite, electrical equipment and control equipment. The facility is designed with the operators in mind, as such, all piping and equipment are located on one level and an overhead door is provided to facilitate efforts involved with installation of the fourth filter in the future. This facility was designed with Green Energy innovations including incorporation of photovoltaic panels on the roof and provisions for a ground mounted photovoltaic system in the future. The facility has a historic structural look while providing state-of-the-art functions and features expected in today's treatment facilities.

CEI served as the designer and engineer-of-record; completed all permitting and design and provided bid, construction and funding administration services. CEI's scope included the design of all site, process, architectural, structural, geotechnical, plumbing, heating, ventilation, electrical, instrumental and controls needed for a fully functioning facility. This facility was completed through the successful teamwork of the Town of Kingston; Comprehensive Environmental Inc. (designer and engineer of record), Lin Associates, Inc. (architectural and structural design); SAR Engineering, Inc. (HVAC/Electrical Design); P-Three Inc. (Owner's Project Manager); and Barbato Construction Co., Inc. (contractor).

CEI actively involved the Client throughout the design and construction process. Notably, CEI involved the Client at all levels from the Board of Water Commissioners to the operators, who are the end users of the facility, during design and construction. Operator input during design and construction is invaluable since they approach these types of facilities from different perspectives than engineers or those in management.

Currently, CEI is completing the construction phase of a second water treatment facility for removal of manganese at two other Kingston supplies (Grassy Hole Well and 1-86 Well).

Client Reference

Matthew Darsch, Water Superintendent
Kingston Water Department
22 Elm Street
Kingston, MA 02364
(781)585-0504
mjdarsch@kingstonmass.org

West Street Wells Treatment

Auburn Water District, Auburn, MA

The Auburn Water District (District) retained CEI to complete treatment feasibility, pilot testing and a conceptual design for treatment systems to remove arsenic, iron and manganese from the West Street Wells. The levels of arsenic, iron and manganese in water from both Well No. 11 and Well No. 12 have steadily increased since the wells went on-line in 2007 to levels that exceed the Maximum Contaminant Level (MCL), Secondary Maximum Contaminant Levels (SMCLs) and Health Advisory Levels, respectively, for these contaminants. In response to the elevated levels of arsenic which exceed the MCL of 10 micrograms per liter (ug/L), the District took these wells off-line in May 2013, until such time that a treatment removal system is on-line, therefore the District requested an expedited schedule for completion of this work. The primary treatment process utilizes pressure filtration with GreensandPlus™ and anthracite media for the removal of arsenic, iron and manganese.

Pilot testing confirmed that the proposed treatment processes would successfully remove arsenic, iron and manganese. The pilot study was also used to determine potential backwash waste water quality in order to design and permit the residuals handling systems. Based upon the levels of arsenic in the backwash wastewater, it was necessary to keep the backwash wastewater fully mixed when discharging to the municipal sewer system, in order to comply with the requirements of the Sewer Use Discharge Permit that was obtained through the Upper Blackstone Water Pollution Abatement District (UBWPAD). Ultimately, CEI designed a wastewater force main extension that connects to the municipal sewer collection system, which in turn discharges to the UBWPAD facility in the neighboring Town of Millbury.

The backwash waste is temporarily retained in below grade basins which were designed with a stationary mixing system (header with directional nozzles) to ensure equalized and fully mixed wastewater prior to discharge to the municipal sewer collection system via submersible pumps and the sewer force main. These basins also allow temporary storage of the backwash wastewater in case of any issues within the municipal sewer collection system (including a system lift station immediately downstream of the filter backwash wastewater discharge).

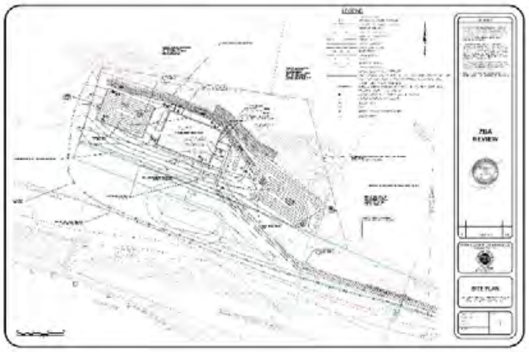
Client Reference

Greg Woods, Superintendent
Auburn Water District
75 Church Street
Auburn, MA 01501
(508) 832-5336
gwoods@auburnwater.com

Oakdale Well Water Treatment Facility

West Boylston Water District

CEI worked with the West Boylston Water District to construct a new water treatment facility to remove manganese from the Oakdale Well, one of its two primary water supplies. CEI specifically provided engineering services from piloting/conceptual design through facility construction. The water treatment facility has a design capacity of 1.0 mgd with a primary treatment process utilizing pressure filtration with adsorptive media (GreensandPlus). The facility includes chemical feed systems (oxidation/disinfection and pH adjustment), pressure filtration system, disinfection, residuals management, instrumentation, controls, and SCADA system. The pressure filters and associated piping, valves and instrumentation are located in the main process area. Individual rooms are provided for storage of sodium hypochlorite, electrical equipment and control equipment. The facility design incorporated the existing potassium hydroxide area located within the existing pump station, in order to facilitate bulk chemical deliveries.



The facility and site design accounted for an extremely constricted site, located along the Quinipoxet River and within the Watershed Protection Area of Wachusett Reservoir, controlled and managed by the Massachusetts Department of Conservation and Recreation (DCR) as a primary water supply for the Massachusetts Water Resources Authority (MWRA). The facility was tucked up against the toe of an existing slope in order to keep it outside of the primary protective zone (200 feet buffer from Quinapoxet River). These site constraints required the analysis of filter backwash handling options, ultimately resulting in the selection of discharge of settled solids to the nearby sewer system and infiltration of the clean supernatant onsite.

The facility is designed with the operators in mind, with stairway access to a pump/pipe gallery for the residuals handling systems and all other piping and equipment located on one level. This facility was designed with Green Energy innovations including provisions for future photovoltaic panels on the roof. The facility has a historic structural look while providing state-of-the-art functions and features expected in today's treatment facilities.

CEI served as the designer and engineer-of-record; completed all permitting and design and provided bid, construction and funding administration services. CEI's scope included the design of all site, process, architectural, structural, geotechnical, plumbing, heating, ventilation, electrical, instrumental and controls needed for a fully functioning facility. This facility was completed through the successful teamwork of the District; Comprehensive Environmental Inc. (designer and engineer of record), CGKV (architectural design); Lin Associates, Inc. (structural design); SAR Engineering, Inc. (HVAC/Electrical Design); and Waterline Industries (contractor).

Client Reference

Michael Coveney, Superintendent
West Boylston Water District
183 Worcester Street
West Boylston MA 01583
(508) 835-3025
mcoveney@westboylstonwater.org

Chemical Feed System Study & Design
Providence Water Supply Board

Providence Water sells water to approximately 76,800 retail customer connections including houses and businesses in Providence, Johnston, North Providence, Cranston and East Smithfield, RI. Additionally, they provide water to 7 wholesale communities serving a number of additional municipalities within the State. Combined, Providence Water presently supplies approximately 60% of the state's drinking water.

Finished water is transmitted from the Philip J. Holton treatment plant to the distribution system through two major transmission lines. The treatment plant is the largest conventional treatment facility in New England at 144 MGD capacity.The first major transmission line, the 90-inch diameter Scituate Tunnel and Aqueduct, transports water from the treatment plant to the distribution system. The second major transmission line is the 78-inch (and later expands to 102-inch) Supplemental Tunnel and Aqueduct. The capacity of the 90-inch line is 100 MGD and the capacity of the 78 and 102-inch lines is 77 MGD.

Providence Water has six storage reservoirs in its system. The capacity of these reservoirs ranges from 1.0 MGD to 43.4 MGD. Although the majority of the system is fed by gravity, Providence Water does own and operate various pump stations throughout the system to pump water to services areas at higher elevations.

Chemical Feed System Feasibility Study & Design

CEI's Project Supervisor, Mr. Sebastian Amenta served as Project Director for a study for the Providence Water Supply Board that involved evaluating the functionality and economics regarding the chemical feed systems at the Phillip J. Holton water purification facility. The study looked at two major chemical feed systems. Their water treatment plant used hydrated lime which was stored in two concrete lined brick silos and delivered to the slaking station via an air conveyance system. The other chemical of concern was sodium fluoride which was delivered via large cardboard canisters. The study involved evaluating the age of the equipment, its functionality to deliver the chemical as required, and recommendations for rehabilitation or replacement of the system.

The study concluded that the lime system was efficient and could be rehabilitated to meet the water treatment plant goals. The study also indicated that the canister system for sodium fluoride was very cumbersome and costly from a labor handling and management perspective. The study recommended the switchover to hydrofluosilicic acid as the most cost effective and least labor intensive alternative.

The Providence Water Supply Board agreed with the recommendations and went on to the implementation stage. Mr. Amenta oversaw the study phase and design phase for this project and provided technical input and QA/QC.

WTP Piloting and Upgrades, Scituate, RI

Mr. Amenta served as Project Director for the piloting and filter expansion of the Phillip J. Holton water purification plant. The water plant was in need of replacement of its filter media, filter bottoms, and gallery piping. There was concern that the changing of the filter media would preclude the removal of manganese from the raw water. In order to address this issue, piloting was completed with GAC filter media at an elevated pH to ascertain whether manganese removal would still occur in the new filters. Mr. Amenta and staff worked with water quality specialist John Tobiason of UMASS Amherst to verify that the treatment for manganese removal would be as good or better after GAC filter replacement.

In addition to replacing the media, new filter bottoms, inlet channels, and pipe gallery were replaced due to their advanced age and inability to comply with regulatory changes. The new filters also included air water backwash to minimize the amount of backwash water used. In addition, the new piping gallery provides for filter to waste capabilities to enhance finished water quality. The upgrade also included additional points of access for pipe repair and equipment repair within the lower pipe gallery.

Client Reference:

David C. Bowen, P.E.
Narragansett Bay Commission, Engineering Manager
One Service Road
Providence, RI 02905
Office: (401) 461-8848 ext. 362; Cell: (401) 374-2056
dbowen@narrabay.com

Fall River Water Department & Treatment Plant, Fall River, MA

Ms. Hart has worked with the City of Fall River for over 18 years doing a variety of services including treatment optimization, energy efficiency evaluations, regulatory compliance, master planning, and commissioning services.

Specific activities have included hands-on operation and modifications to treatment within the plant for regulatory compliance and chemical system commissioning. Specifically, the carbon dioxide system for alkalinity addition with sodium hydroxide was optimized over several months and seasons to function in automatic mode. Clear well retention time for disinfection contact time and 100-foot sampling was evaluated using a comprehensive tracer study. Water quality monitoring equipment was evaluated and optimized over time to accurately monitor particle count, turbidity, and conductivity for chemical dosing and treatment optimization. Evaluations and compliance sampling plans were developed for the lead and copper rule and disinfection byproduct rules, including modeling of retention time in the distribution system. Ms. Hart worked directly with laboratory personnel to establish daily water quality sampling protocol and record keeping, standard operating procedures based on water quality, and efficient compliance reporting methodology.

Ms. Hart assisted in the development of the Fall River Masterplan to evaluate existing capacity and treatment followed by the detailed design of the Howe Street water storage tank and pump station, treatment and distribution system modifications based on recommendations. Water storage tank mixing systems for water quality age were designed and installed.

Energy evaluations were conducted throughout the water treatment plant and for pumping systems in the raw water collection and raw and finished water pumps. Energy consumption was measured and modifications including pump rebuilds were recommended to reduce electricity use and calculations were provided for incentive funding through National Grid.

Emergency repair of the high lift finished water distribution pumps were conducted including thorough evaluation of the piping and ancillary connections including valves and flow control connections. Detailed specifications for pump rebuild were developed prior to the removal, rebuild, and replacement of components of the pumps. On site start-up and commissioning of the replacement pumps was conducted.

Client Reference:

City of Fall River Massachusetts
Department of Public Works
Contact: Paul Ferland
pferland@fallriverma.org
(508) 324-2320

3.0 Project Team

The CEI Team consists of subject matter experts with specific project experience in their area of expertise. Leaders in their field, CEI's project team was developed specifically to address the goals and concerns Pennichuck has with this project. Senior level professionals predominate the team and are foremost in their fields. Key members are supported by a select team of experienced project engineers and scientists. Additionally, CEI has leveraged several subcontractor industry experts as partners for specific roles on this project as noted below.

Roles and Responsibility

CEI's key project staff are highlighted below with a team organization chart and key resumes attached to this section.

Eileen Pannetier, EJD, PMP – President, Contract Manager

Led by CEI Contract Manager and President, Eileen Pannetier founded CEI in 1987 and has grown the company to 35+ staff with 3 offices throughout New England. She is a recognized water quality expert and has served as Contract Manager for dozens of successful drinking water projects, including several with Pennichuck. She is a former Water Commissioner and is a Past Chairman of the New England Water Works Association Water Resources Committee. She will provide contract support and assist in ensuring that the most qualified staff are available to support this project. Ms. Pannetier works out of CEI's Merrimack, NH office and is 100% available to assist on this project.

Sebastian Amenta, P.E. – Project Director, Engineering Lead

Mr. Amenta has over 40 years of engineering and consulting experience throughout the northeast. Focused on public sector clients including utilities, his expertise is in water supply, wastewater and geotechnical evaluation and design. He has supervised the preparation of water system evaluations, water supply investigations, distribution systems analyses, safe yield analyses, and water treatment process formulation and design. His experience includes completing the Chemical Systems Study and Water Treatment Plant Piloting and Upgrade for the City of Providence Water Supply Board a 144 MGD WTP. Mr. Amenta is based out of CEI's New Britain, CT office and will serve as Program Director where he will support CEI Project Manager Mike Ohl and lead CEI's engineering efforts.

Michael Ohl, P.E. – Project Manager, Science Lead

Mr. Ohl has over 30 years of Project Management experience in all areas of drinking water planning, engineering and consulting. He is a CEI Principal Engineer and leads CEI's drinking water engineering division having led major treatment and distribution projects including planning, piloting, cost-estimation, design, engineering and permitting through to complete bid services and construction services. Specific project highlights include:

- Kingston, MA – Treatment facilities (two locations for 4 separate sources) using pressure filtration, including conversion of chemical feed from lime to potassium hydroxide. Reuse and repurposing of existing chemical feed facilities recognizing historical infrastructure investment. Extensively involved from initial piloting through startup/testing and subsequent operations.

3.0 Project Team

- Pistapaug Pond WTP, Wallingford, CT. Treatment process IDI Superpulsator (similar to PWW) for surface water supply, using ferric chloride as primary coagulant. Involved on project from pilot study through construction and startup/testing.
- Pawtucket, RI – Treatment process using upflow contact clarifier for surface water supply. Extensively involved during construction and through startup/testing and subsequent 2-week demonstration period, actively operating the facility to waste non-stop to simulate in-service performance.
- Exeter, NH – Conversion of facility to upflow contact clarifier for combination supply (surface water and river water options). Focus on chemical feed system retrofit.
- Fitchburg, MA – Regional Water Filtration Facility and Falulah Water Filtration Facility using upflow contact clarification for surface water supply.

Mr. Ohl brings both significant technical and project management experience to this project including noteworthy client services. He is based out of CEI's Bolton, MA office and will serve as Project Manager and Science Lead.

Ron Maness – Technical Review, QA/QC

Mr. Maness has over 40 years of water treatment processes experience serving as an independent contractor and technical sales support capacities. His contract operations experience includes projects where he provided creative process control improvement strategies resulting in improved water quality and cost savings to those facilities. He has worked WTP's from 1 to 120mgd and was instrumental in solving Indianapolis Water's ongoing taste and odor problems. Mr. Maness is familiar with virtually all treatment technologies and worked for Infilco Degremont and has familiarity with the pulsator clarifier units. He is a CEI subcontractor and provides QA/QC and technical review role for this project.

Carina Hart, CEM, ENV SP – Process Chemistry

Ms. Hart is Owner and Chief Engineer of Hart Consults, a drinking water and wastewater consulting engineering firm. She has over 18 years of diverse experience that covers all aspects of the drinking water and wastewater industry including feasibility evaluation, process selection and design, pilot study projects, full-scale design and construction. Ms. Hart is familiar with the Pennichuck Water Treatment Plant from her previous work with PWW. Her expertise in process chemical feed systems will be utilized to review the chemical use and physical nature of the chemical feed systems. She is a CEI subcontractor and provides the process chemistry review role for this project.

Jeanine Dudle (formerly Plummer), PhD, P.E. – Chemical Efficacy

Ms. Dudle has a PhD in civil engineering with a focus on drinking water treatment and optimization. In addition to providing engineering consulting services for public utilities, she is an Associate Professor in Civil and Environmental Engineering at Worcester Polytechnic Institute where she has over 20 years of experience teaching courses in water chemistry and drinking water treatment. Ms. Dudle is a CEI subcontractor and her project role will be to evaluate the chemicals, inject pints and their efficacy relative to optimum dosing location.

Matthew Lundsted, P.E., CFM – Principal Engineer, Planning Lead

Mr. Lundsted has over 30 years of civil and environmental engineering experience in the public sector with projects including drinking water, wastewater, hazardous waste remediation and transportation. He is an expert in integrating resiliency and climate change in CEI's planning projects and engineering designs. He is based out of CEI's Merrimack, NH office and will lead CEI's planning team with a focus on resiliency and climate change.

Stephanie Hanson, PMP, CSE – Principal Scientist, Public Relations Lead

Ms. Hanson is a CEI Principal Scientist with over 20 years of consulting experience. She has worked primarily with public clients at the local, state and Federal level providing technical expertise related to water resources, watershed management, stormwater, site assessment and permitting. She has worked on a diverse set of public education and outreach projects including several for Pennichuck, including managing their 5th grade watershed presentation program, video development and community based marketing. Ms. Hanson is based out of CEI's Merrimack, NH office and will work with the project team on Public Relations efforts including leading education tasks and assisting with presentation development.

Michael Carmasine, P.E. – Project Engineer

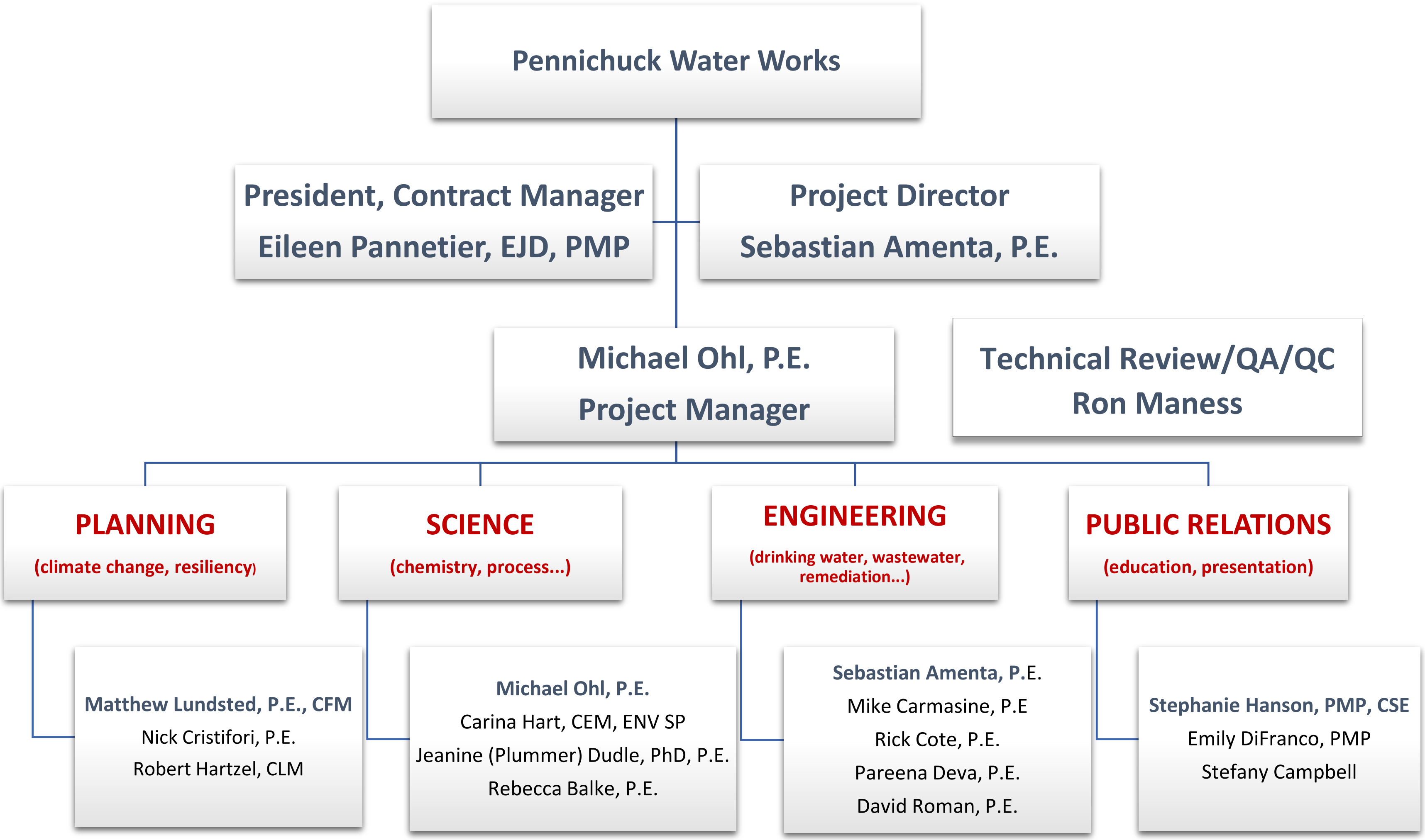
Mr. Carmasine is a CEI Project Engineer with experience in all aspects of design and construction of public utility systems. He has worked on the design and has provided construction inspection for several water supply projects which improved system hydraulics and updated aging infrastructure. He is based out of CEI's Bolton, MA office and will assist with Project Engineering.

Multidiscipline Expertise

CEI's in-house staff of over 35 technical experts provide a multidisciplined background, allowing the firm to lead a wide variety of projects. With experts in civil, environmental, geotechnical, structural, transportation and chemical engineering, CEI also has expertise and project experience that has included water treatment, hydrology, geology, environmental science, remediation and permitting.

In specific situations where electrical and mechanical expertise is required (often on our drinking water projects), we have an excellent working relationship with several subcontractors that meet our high internal quality, cost and schedule standards. These include partners for MEP, historic/archeological, drilling, select survey, LEED/sustainable buildings, interior design, analytical laboratories and several other areas of expertise where needed.

Organizational Chart



Pennichuck Water Works

President, Contract Manager
Eileen Pannetier, EJD, PMP

Project Director
Sebastian Amenta, P.E.

Michael Ohl, P.E.
Project Manager

Technical Review/QA/QC
Ron Maness

PLANNING
(climate change, resiliency)

Matthew Lundsted, P.E., CFM
Nick Cristifori, P.E.
Robert Hartzel, CLM

SCIENCE
(chemistry, process...)

Michael Ohl, P.E.
Carina Hart, CEM, ENV SP
Jeanine (Plummer) Dudle, PhD, P.E.
Rebecca Balke, P.E.

ENGINEERING
(drinking water, wastewater, remediation...)

Sebastian Amenta, P.E.
Mike Carmasine, P.E
Rick Cote, P.E.
Pareena Deva, P.E.
David Roman, P.E.

PUBLIC RELATIONS
(education, presentation)

Stephanie Hanson, PMP, CSE
Emily DiFranco, PMP
Stefany Campbell

Eileen Pannetier, EJD, PMP

President, Contract Manager

Ms. Pannetier is President and CEO at CEI with over 35 years of contract management and consulting experience. She has a broad range of environmental experience involving drinking water, water resources, hazardous waste investigation and remediation, wastewater, stormwater and regulatory compliance. Specific experience includes drinking water treatment projects under the Safe Drinking Water Act, wastewater/stormwater projects under the Clean Water Act, and transportation projects under FHWA. She serves as Contract Manager for multiple water supply related contracts and is responsible for assigning the best qualified staff to each project so that the work is accomplished effectively and efficiently.

Education
Bachelor of Arts
Biology
MESA College, Colorado

Environmental JD

Master of Science
Biology
University of Northern Colorado

Professional Registrations and Service
American Society of Civil Engineers
American Public Works Association
Society of American Military Engineers

Selected Project Experience with CEI

Contract Manager, Treatment & Distribution Engineering Services, West Boylston Water District, MA. Contract Manager for various treatment and distribution projects for the West Boylston Water District. These have included CEI's design of the pressure filtration facility for the removal of manganese at the Oakdale Well Water Treatment Facility and the design, permitting and construction of the North Main Street Water Main Replacement.

Contract Manager, Trackle Pond Water Treatment Facility, Kingston Water District. Contract Manager for the design, permitting, bid, construction, startup and operations of this 3 mgd water treatment facility. This completed project was highlighted on the cover of the New England Water Works Journal.

Contract Manager, West Street Well Treatment Facility, Auburn Water District. Contract Manager for CEI's treatment feasibility, pilot testing and a conceptual design for treatment systems to remove arsenic, iron and manganese from the West Street Wells.

Program Manager, BPA Water On-Call, U.S. EPA, Region 1. Since 2012 CEI has been part of an on-call team to provide assistance to the U.S. EPA on a variety of stormwater, TMDL, water quality and drinking water projects.

Contract Manager, Clean Water Needs Surveys (CWNS) and Drinking Water Needs Survey & Assessment (DWINSA), Various MA Communities. Contract Manager for CEI's statewide contract to provide MassDEP with water, wastewater and stormwater municipal infrastructure needs surveys and assessments based on EPA's survey protocol.

Program Director, NH Statewide Water Resources Management Plan. CEI was selected to work with the NH DES in preparation of a statewide Water Resources Primer to assist the state's legislature in understanding broad water resource issues. This Plan contains an overview of existing statewide water resources, and the measures currently taken to protect these resources including existing, proposed and new regulations. This project has enhanced CEI's already strong understanding of comprehensive water resources issues in New Hampshire and is being reviewed statewide to make future water resource related decisions.

Program Manager, Hazardous, Toxic and Radiological Services (HTRW) On-Call Contract, U.S. Army Corps of Engineers, North Atlantic Division. Ms. Pannetier is currently serving as the Program Manager for this $2.5M Multi-Year IDIQ contract to provide the ACOE with a full array of HTRW services including on-call hazardous waste assessment and remediation tasks throughout their North Atlantic Division.

Program Director, Various Projects, Pennichuck Water Works. Program Director for a variety of drinking water, watershed and water quality projects completed for Pennichuck Water Works. Projects have included: water supply emergency response planning, vulnerability assessment, stormwater BMP

Total years of experience: 40 years With CEI: 32 years engineering/design, public outreach projects, sediment impact studies and dredging feasibility studies, watershed tributary and groundwater sampling and monitoring program and watershed restoration planning and TMDL development.

Contract Manager, Engineering & Environmental Services Contracts. Contract Manager for various state and Federal agency on-call contracts for both engineering and environmental services. These have included:

- NH Office of the State Quartermaster
- MA Army National Guard
- MA Air National Guard
- NAVFAC – Washington D.C.

Program Manager, Civil Engineering On-Call Services, MA Department of Conservation & Recreation. CEI currently holds a multi-year on-call engineering contract with the MA DCR. CEI has been assigned numerous water resource and stormwater related tasks including work at Wachusett Reservoir, Cochituate State Park, Douglas State Forest and Town Line Brook.

Program Manager, Impaired Waters Program, MA Department of Transportation. CEI is currently providing the MassDOT with civil engineering and environmental services under a multi-year on-call services contract. As part of this program, CEI has designed and engineered stormwater BMPs, completed permitting, developed plans and specifications, and provided construction oversight.

Contract Officer, Perchlorate Groundwater Investigation & Remediation, Westford, MA. Contract Officer for groundwater perchlorate investigation/remediation. The contamination had occurred due to blasting upgradient of the well in a highly-fractured bedrock area. Using a design/build process, CEI installed a resin-based Treatment System and developed Contract Document and Bid Specifications. CEI also worked with MA DEP and the Town to obtain State Revolving Fund money under the expanded program using ARRA dollars.

Contract Officer, Groundwater Well Treatment Design & Implementation, Scituate, MA. VOCs and radon were detected at levels higher than the anticipated EPA MCL levels in Scituate's Well #19. CEI first evaluated several alternatives to determine the most cost-effective options considering the relatively low levels of contamination, and to address a second nearby well. The alternative that was the least costly was a venturi air stripper, which was not yet approved for use in Massachusetts. CEI got the technology approved and designed and the units have now been constructed.

Additional Project Experience

- Project Manager, Aquarion Water Company, various water supply projects.
- Water Quality Expert, EPA Headquarters Panel, Review of New York City water supply.
- Project Manager, Town of Orleans Water Supply Master Plan, Hydraulic Network Modeling and Capital Improvement Planning for the Town of Orleans Massachusetts.
- Project Manager, Merrimack Village District Water Supply Master Plan, included hydraulic analysis and capital improvement plan.
- Project Manager, Tri-Town Master Plan Source Water Supply Evaluation, Towns of Braintree, Randolph, and Holbrook, Massachusetts's water supplies (about 80,000 persons).
- Project Manager, Development of Emergency Response Planning and Agricultural Best Management Practices for Quabbin, Wachusett and Ware River watersheds for MDC/MRWA.
- Project Manager, Development of a surface water protection strategy statewide for the NH Department of Environmental Services to satisfy EPA's Source Water Assessment Program.
- Project Manager, Review of Iron and Manganese Problems in Orleans, Massachusetts wells.
- Project Manager, Evaluation of Groundwater Supply Sources for Town of Orleans, MA.
- Project Manager, Evaluation of Emergency Water Source Planning, Sudbury Reservoir, Massachusetts Water Resources Authority.
- EPA Headquarters, comment document for 10-state standards draft revisions.

Sebastian Amenta, P.E.

Project Director, Engineering Lead

Mr. Amenta has over 40 years of experience in managing and executing civil engineering projects. His expertise includes geotechnical, water resources and utility systems engineering. Mr. Amenta supervised the preparation of water system evaluations, water supply investigations, distribution systems analyses, safe yield analyses, and water treatment process formulation and design. His duties also include the supervision, as well as analyses and establishment of design criteria for aquifer studies, feasibility studies, and pump stations.

Selected Project Experience

Project Director, Chemical Systems Study, Providence Water Supply Board, Providence, RI. Mr. Amenta served as Project Director for this feasibility study to evaluate the functionality and economics of the chemical feed systems at the Holton treatment facility in Scituate, RI. The study involved evaluating the age of the equipment, its functionality to deliver the chemical as required, and recommendations for rehabilitation or replacement of the system.

Project Director, WTP Piloting and Upgrade, Providence Water Supply Board, Providence, RI. Mr. Amenta served as Project Director for the piloting and filter expansion of the Phillip J. Holton water purification plant. The water plant was in need of replacement of its filter media, filter bottoms, and gallery piping. There was concern that changing of the filters would preclude the removal of manganese from the raw water. In order to address this issue, piloting was done with new GAC filter media at an elevated pH to ascertain whether manganese removal would still occur in the GAC filters.

Project Executive, Supplemental Water Supply Feasibility Assessment Phase I, RIWRB and Providence Water Supply Board (PWSB). Project Executive for the assessment of supplemental water supplies to service the Providence Water System under an emergency condition that results in the loss of water supply. The two-year study included an in-depth evaluation of the Providence water system, a Risk and Needs Assessment, an Alternatives Screening Report, and a Feasibility Assessment of potential water supply sources including drilling of test wells and pump tests for numerous possible water supply sites.

Education

Bachelor of Science
Civil Engineering University of Connecticut
Master of Science
Civil Engineering
University of Connecticut
Advanced Engineering Certificates,
Environmental Engineering
University of Hartford

Professional Registrations and Service

Professional Engineer
Certified Health and Safety Site Supervisor

Project Director, Pump House Rehabilitation and Condition Survey, Otis Air National Guard Base, MA. Project Director for a condition survey and design improvements of an existing 1.8 mgd production well and pump house. The well water was treated with gaseous chlorine and soda ash. Design improvements included demolition of these two systems and replacement with liquid chlorine and a potassium carbonate system. Potassium carbonate was selected based on a bench scale treatability study. Other design improvements included demolition of a diesel engine and right angle gear drive and design/installation of a new natural gas generator, new surge control valve and instrumentation.

Project Manager, Home Farm Well, Shrewsbury, MA. Project Manager overseeing the work efforts including a comprehensive test well program, and Zone II delineation. The second phase included the drilling of the large diameter test wells, and pumping testing in accordance with MA DEP protocols. The test well was pumped at over 2 mgd. A MODFLOW model was developed to assess groundwater impacts, which was integral to the Water Management Act permit submittal.

Project Director, Snake Pond Water Treatment Facility, Gardner, MA. Project Director for improvements including greensand for filtration, chemical additions system for potassium permanganate, and sodium hydroxide. The new facility has backwash storage facilities for recycling of the supernatant, and a force main connection to the sanitary sewer. The well can be used to its full capacity of 1.3 mgd with iron levels as high as 10 parts per million.

Project Manager, Newport Utilities Optimization Study, Newport, Rhode Island. Project Manager for study of all functions of water and wastewater utility department including facilities evaluation, capital improvements, O&M practices, personnel requirements, and financial analysis.

Project Engineer, Water System Development, Town of North Smithfield, RI. Project Engineer for the North Smithfield Water Authority for the ongoing development of a water system for North Smithfield. Work initially included preparation of a water supply report for the Town. Other work has included investigation of water supply sources; identification and evaluation of well sites; and design of new water distribution facilities.

Project Manager, Logan Airport Pump Station, Boston, Massachusetts. Project Manager for the study, design and construction of a new water pump station to serve the fire and domestic needs of the airport. The existing pump station was over 50 years old and energy inefficient. The study phase included an assessment of demands, pressure variations, and fire flow needs. A hydraulic model was developed in order to evaluate pressure changes, and water hammer and shock wave propagation. The design included VFD's on both domestic and fire pumps and the installation of a back-up surge attenuation system.

Project Manager, Water System Planning and Development, East Hampton, CT. Mr. Amenta oversaw groundwater exploration efforts, provided overall technical review and also assisted the Town in procuring two federal grants (totaling over $2M).

Project Director, Connecticut Water Company, Water Treatment Feasibility Evaluation, Clinton, CT. Project Director for a treatment feasibility evaluation of wells for the Connecticut Water Company (CWC). The project involved evaluation of methods to treatment for water containing elevated levels of uranium, radium, radon, iron, manganese and hardness. Evaluation included capital, operation and maintenance and life cycle cost analysis for several alternatives. The project was completed within two weeks to meet the CWC's expedited schedule.

Project Manager, Water System Improvements, Bradley International Airport, Windsor Locks, Connecticut. Evaluation of alternatives for supplying water to Bradley International Airport and adjacent industries. In preparing a model of the distribution system, C-value tests, pressure surveys, and well pump tests were conducted to obtain base information.

Project Manager, White Bridge Upper and Lower Wellfield Explorations, New Britain Water Department, CT. Project Manager and technical lead for 2-1/2 inch test well explorations and aquifer evaluation. The project included over 25 test wells and 12 short term pump tests to assess aquifer capabilities. The ultimate development will consist of 9 gravel packed wells with a maximum capacity of 6 mgd.

Technical Review, North Kingstown Well #10 Replacement, North Kingstown, RI. Technical oversight and review of exploration and pump testing program for replacement of a high capacity well in a highly variable aquifer. Project has closed in on a suitable well location that will achieve the volume desired by the client and free of pumping sand.

Project Manager, John S. Roth Water Treatment Plant, Middletown, Connecticut: Expansion of the treatment plant capacity from 4.0 mgd to 9.0 mgd. The program included the design of new replacement wells raised above the 100-year flood level. Permitting included an assessment of flood impact from filling within the Connecticut River stream channel encroachment line.

Selected Publications, Speeches & Moderations

- Paul Aldinger, Sebastian Amenta, Paul Carver, Block Island, Rhode Island "Water Supply Development" - National Well Water Association, July 29, 1986
- Sebastian Amenta, Robert Wardwell "Water Diversion Permitting in Connecticut, The Quinnipiac River Utility Projects" – Journal of Environmental Permitting, Spring 1994

Michael P. Ohl, P.E.

Project Manager, Science Lead

Mr. Ohl is a Senior Registered Professional Engineer and Principal at CEI with experience in all areas of municipal engineering. He has served as a water resources engineer since 1988, with an expertise in the area of water supply, treatment and distribution as well as wastewater engineering. In his present position, he is responsible for the planning, design, and construction services for the installation and rehabilitation of water mains, storage tanks, gravel packed wells, pumping stations and the construction and renovations of water treatment facilities. He has been extensively involved with water distribution modeling (development and use), feasibility studies and water rate studies including cost projections, analyses of alternative rate structures, and procurement and administration of funding programs. Mr. Ohl has been responsible for the design and construction of water treatment projects for numerous communities. His involvement has included preliminary assessment and cost estimation, pilot testing of treatment alternatives, facility design and layout, construction services including start-up and testing of equipment and treatment systems, process and controls systems troubleshooting, and preparation of facility operations and maintenance manuals.

Education

Master of Science
Environmental
Engineering
Worcester Polytechnic
Institute

Bachelor of Science
Civil Engineering and
Bachelor of Science
Wood Products
Engineering
State University of New
York

Professional Registrations and Service

Registered Professional
Engineer
Certified Floodplain
Manager
Massachusetts Water
Works Association

Selected Project Experience

Project Manager, West Boylston Water District, Water Treatment Facility, West Boylston, MA. Project Manager and lead technical expert for the conceptual design of a 1-mgd water treatment facility for the Oakdale Well. Primary treatment process is pressure filtration with adsorptive media (GreensandPlus) with retrofit of chemical system in existing pump station to minimize capital and O&M costs. Project included the analysis of filter backwash handling options, ultimately resulting in the selection of discharge of concentrated/settled solids to the nearby sewer system and infiltration of the clean supernatant onsite.

Project Manager, Town of Kingston, Manganese Removal Water Treatment Facility (Trackle Pond Well), Kingston, MA. Project Manager for the design, permitting, bid, construction, startup and operations of a 3-mgd manganese removal water treatment facility. Primary treatment processes include pressure filtration with adsorptive media and chemical feed systems. The 4,200-sf facility structure is a masonry building with brick exterior and salt box roof. The project includes installation of solar power systems with panels located on the roof of the facility and ground mounted adjacent to the facility.

Project Manager, Town of Kingston, Manganese Removal Water Treatment Facility (Grassy Hole Well and 1-86 Well), Kingston, MA. Project Manager and lead technical expert for the design and permitting of a manganese removal water treatment facility for the Grassy Hole Well and 1-86 Well. Primary treatment processes include pressure filtration with adsorptive media and chemical feed systems. The proposed site layout addressed historical localized flooding of the site near the existing pump station. The existing lime feed building was converted to a sodium hypochlorite storage and feed system, to minimize space requirement in new facility.

Project Engineer, Town of Wallingford, Pistapaug Water Treatment Facility Construction, Wallingford, Connecticut. Project Engineer for the piloting and construction of a 12-mgd surface water treatment facility, which consists of a separate raw water pumping station, water treatment plant, and a 3-million-gallon storage tank. The primary treatment process is the IDI Superpulsator clarifier. Nine separate chemical systems are available for use, including chlorine dioxide as a pre-oxidant to reduce THM precursors.

Senior Project Engineer, City of Pawtucket, Water Treatment Facility, Pawtucket, Rhode Island. Senior Project Engineer and start-up/commissioning manager for a 25 mgd surface water treatment facility and associated raw water pumping station. The primary treatment process is an upflow contact clarifier with associated deep bed GAC filter. Chemical systems are provided for coagulation, pH and alkalinity adjustment, and disinfection. This project also included design of a 5-million-gallon prestressed precast concrete storage tank at the treatment facility. In addition to the raw water from the Happy Hollow surface water reservoir, design also integrated the blending of raw water from a series of groundwater supplies, with specific treatment for removal of radon via aeration and manganese via oxidation. Raw water pump station design capacity of 31.6 mgd accommodated through 4 horizontal split case pumps, utilizing Hydraulic Institute Standards for suction/discharge manifold design and piping layout. Design challenges included the design and construction of a new intake structure utilizing the existing gatehouse to minimize disturbance within the reservoir, while maintaining raw water flows to the existing water treatment plant.

Project Engineer, Town of Clinton, Water Treatment Facility, Clinton, Massachusetts. Project Engineer for the construction phase of a 4.5-mgd surface water treatment facility, which includes modifications to an existing raw water pump station and intake. The primary treatment process is Kinetico's direct filtration system using proprietary ceramic media. Automatic monitoring and control of the process is accomplished using an integrated SCADA system. Coordinated outstanding permit issues, including a permit application for process residuals discharge to the MWRA wastewater treatment plant and design/construction of lagoons for on-site waste treatment and handling. Existing pump station was retrofitted for use as the raw water pump station, with temporary pump use required to facilitate pump changeover from finish water service to raw water service, while maintaining supply of potable water to the Town at all times.

Project Engineer, City of Fitchburg, Water Treatment Plant Design, Fitchburg, Massachusetts. Project Engineer for design of a 6-mgd surface water treatment facility (Falulah) and a 12-mgd surface water treatment facility (Regional). Facility locations were selected to maintain the existing gravity flow from the surface water reservoirs to the distribution system and to treat two geographically distinct series of reservoirs. The primary treatment process is an upflow contact clarifier with associated multimedia filter. Chemical systems are provided for coagulation, pH and alkalinity adjustment, disinfection and fluoridation. Provisions have been made for the future addition of ozone and GAC. A supervisory control and data acquisition (SCADA) system has been designed to provide automatic monitoring and control of the treatment processes and of remote facilities throughout the distribution system. This project also includes the design and construction of two 1-million-gallon prestressed precast concrete storage tanks at one of the treatment facility sites and of a 2-million-gallon cast-in-place concrete storage tank at the other treatment facility site.

Project Engineer, City of Fitchburg, Water Treatment Plant Construction, Fitchburg, Massachusetts. Project Engineer for the construction of the 12-mgd regional surface water treatment facility, including on-site field observation and coordination of the project with the City and contractor. Project liaison with local community officials, since the project site is located in the adjoining community of Westminster and ultimately provides potable water to both communities.

Project Manager, Wareham Fire District, Maple Springs Water Purification Plant, Wareham, MA. Project Manager for the peer review for a 3.0-mgd water treatment facility (expandable to 4.5-mgd) designed by others, including re-design/re-bid services and construction phase services. Facility provides iron and manganese removal treatment, UV disinfection, chlorination, and corrosion control (rehabilitation of an existing lime feed facility).

Project Manager, Dennis Water District, Water Treatment Facility Design-Bid-Construction, South Dennis, Massachusetts. Project Manager for design of a selected pressure filtration facility utilizing Greensand Plus media based on a pilot study conducted in 2007. Project included evaluation of system hydraulics and design modifications to existing pump stations to accommodate the "pump-through" treatment facilities. Reuse of existing chemical feed facilities minimized the treatment facility layout and associated construction cost. Facility design included instrumentation and controls to integrate the District's 10 groundwater supplies (to be treated) with the new treatment facility, while maintaining the District's existing SCADA system controls

Michael P. Ohl, P.E.

Project Manager, Science Lead

Project Manager, Town of Dartmouth, Greensand Filtration Facility, Dartmouth, Massachusetts. Project Manager and engineer for the construction phase of a 1000-gpm filtration facility, which is the town's third greensand filtration facility and was integrated with the existing SCADA control system. Provisions were made for future expansion, to accommodate the anticipated filter vessels required for a known test well site in the vicinity.

Project Engineer, Town of North Kingstown, PRV/Disinfection Facility, North Kingstown, RI. Project Engineer for the evaluation, conceptual design and final design of a Pressure Reducing Valve/Booster Pump/Disinfection facility. This facility incorporates pressure reducing, booster pumping and disinfection for transfers from to or into the primary pressure zone which is the lower elevation zone, depending on which zone has demand needs. This design provides a single integrated facility which replaces an existing below grade booster pump station.

Project Manager, Centerville-Osterville-Marstons Mills Water Department, Pumping Station No. 23 and Treatment Facility, Osterville, MA. Project Manager for the design of a groundwater pumping station and treatment facility. The facility pumps approximately 700-gpm of water from a gravel-packed well via a vertical turbine pump with variable frequency drive unit and associated appurtenances. Water is treated at the facility with potassium hydroxide to increase the pH and provide corrosion control. Provisions were made for the addition of sodium hypochlorite for disinfection and a corrosion inhibitor as needed. The approximate 875-sf facility structure has a slab-on-grade foundation, masonry block superstructure with a truss roof.

Senior Project Engineer, Connecticut Water Company, Ion Exchange Treatment Evaluation and Operations Consultation Soundview System, Connecticut. Senior Project Engineer for a treatment evaluation for wells for the Connecticut Water Company. Evaluated methods of treatment, including ion exchange, for water containing elevated levels of uranium, radium, radon, iron, manganese and hardness. Provided capital, operation and maintenance and life cycle cost analysis. Provided operations consulting services for the Soundview System treatment facility that uses ion exchange resin. Designed new cartridge filtration system for use upstream of the ion exchange system to increase runtime and decrease operating costs.

Project Engineer, Town of Westford, Perchlorate Treatment Facility, Westford, Massachusetts. Project Engineer for the design and construction of a 1,300-gpm ion exchange treatment facility for the removal of perchlorate. The process utilizes two pressure vessel trains designed to operate in series. The facility consists of a 1,500-square foot pre-engineered metal building with slab on grade concrete foundation, treatment process and associated equipment and site work. Provided funding assistance for the construction of the project which will be funded in part through the Drinking Water State Revolving Fund.

Selected Publications, Speeches & Moderations

- M. Ohl, “Manganese Revisited – Beyond the Secondary Limit,” NEWWA Spring Conference, Worcester, MA, April 4, 2012.
- M. Ohl, “Treatment of Perchlorate in Groundwater,” NEWWA Annual Conference, Newport, RI, September 27, 2011.
- K. Berger, M. Ohl, C. Crocker, “An Analysis of Optimizing Storage Within an Existing Water System,” Journal of the NEWWA, Vol. 123, No. 3, September 2009.

Ron Maness

Water Process-Professional Consultant

Education:
BS, Civil Engineering, Valparaiso University – Valparaiso, IN, 1978

Background:
The majority of the 43-year career herein outlined has been associated with municipal water treatment processes and equipment sales. Oversight, management and/or technical sales support have been provided for a large number of design/build projects, proposals and presentations. While employed in the contract operations industry, projects were provided with creative process control improvement strategies resulting in improved water quality and cost savings to those facilities. Nearly all types of municipal water treatment processes have been engaged during this term. Specialties involve solids contact clarification and hollow fiber membrane processes (both MF and UF), and reverse osmosis (RO).

Experience:

H2O Innovation, Quebec City, Quebec, Canada
2014 – 2020: Serving H2O Innovation as an independent consultant and acting Regional Sales Manager. H2O Innovation is a leading OEM in membrane systems, including; UF/MF, RO/NF and MBR.

Harn R/O SYSTMS, Venice, FL
2011-2014: Serving Harn R/O Systems as an independent consultant, but exclusive to their interests and operation. Harn R/O Systems was a leading OEM, in the US market, for the design/fabrication of RO membrane systems. As a business development manager, the goal was to expand Harn's 41-year-old reverse osmosis business and to include the manufacturing of microfiltration / ultrafiltration membrane systems. This involved building a representation network, where none existed previously.

ZENON ENVIRONMENTAL / GE Water & Process Technologies, Oakville, Ontario, Canada
2005-2009: Serving as the Regional Sales Manager (Commercial Developer) for GE/Zenon promoting the sale of UF, RO and EDR products for drinking water and wastewater treatment in MT, WY, CO, NM, TX, OK, LA, MS and AR. GE/Zenon engages the traditional municipal sales process, utilizing manufacturers representatives (MR). This region has six MR firms under contract. The Commercial Developer position involves; interfacing with the MR firms, developing and presenting technology offers to clients, consultants and state agencies, leading a GE/Zenon applications engineering and regional service team, and developing proposals for municipal bids. Sales in this region since 2005 have involved a diverse spectrum of applications, including the SWRO pilot program for Brownsville, TX.

VEOLIA WATER / USFilter, Naperville, IL
2003-2004: Served as Water Technology Manager for Veolia Water Systems and as Project Director of the Tampa Seawater Desalination Facility, remediation program. The Tampa effort involved a corps team of 6 people and an extended team of approximately 20. Responsibilities included providing project oversight to the team and performing the primary liaison duties with Tampa Bay Water, the former Covanta operations staff, Veolia management, and the French Veolia technical staff. Other responsibilities included presentations to the Tampa Bay Water Board and developing the proposal for the remediation bid.

2001-2003: Served as Director, then Vice President of Water Technology, in the Major Utilities Group of USFilter Operating Services.

- Led the Water Quality team during the proposal phase and transition of the Indianapolis Water project (the largest public-private municipal water operations contract ever awarded). The Indianapolis water system is comprised of three reservoirs, conveyance canals, wells and river source which collectively, are categorized as a world-class source for taste and odor causing compounds. Through collective efforts and for the first time in three years, Indianapolis did not experience a taste and odor event during the summers of 2002 and 2003. The White River WTP has a capacity of 120 mgd. The Eagle Creek WTP has a capacity of 15 mgd. The Fall Creek WTP has a capacity of 20 mgd and treats river water, and the Geist Reservoir WTP has capacity of 20 mgd. The management strategy executed was based on algae identification, algae counts, organic compound monitoring and basic water quality testing to identify triggers which prompted taste and odor events.
- Championed the water quality incentive program, which was part of the Indianapolis management agreement. This effort resulted in the receipt of full payment of all 10 water quality incentives in 2002.

- Conducted piloting of process improvements and implemented full-scale chemical trials resulting in significant cost savings and improved water quality.
- Provided Indianapolis Water with a resource assessment including development of a long-term plan for well field expansion, increased production capabilities for future growth, increased production capabilities, process control improvements and cost savings.
- Provided support to various other Veolia projects such as the Tampa Bay Surface Water project (60 mgd) enabling the plant to meet the performance test production goal, in January 2002. Discovered and corrected a design oversight that allowed the operation to avoid extensive liquidated damages.
- Supported due diligence, DBO, proposal and presentation efforts for the San Diego County Municipal Water "Twin Oaks" project and the Blue Hills, Bahamas seawater desalination project. Worked within a multidisciplinary team of consultants and contractors and lead the technical group within each team.

2000-2001: Served as a Director of the Corporate Projects Group for USFilter, with involvement in numerous DBO projects including: Tampa Desal 1, Tampa Desal 2 (both of the preceding projects have involved treatment of seawater with RO technology), Houston Northeast WTP, Pawtucket, RI, Lawrence, MA, Indianapolis, IN, and Tampa Surface WTP. During this term, assistance was provided to numerous USFilter and Vivendi divisions and business centers, including Companie de Aguas, for an operations bid for approximately 130 WTP's in Puerto Rico. Assignments involved the assessment of municipal water treatment applications with regard to the most cost-effective methods of treatment, and in consideration of EPA regulations, and project specific requirements.

1997-2000: Served as the Southeast Regional Sales Manager for USFilter's Memcor Business Center in Richmond, VA. During this term, the following hollow fiber membrane projects (representing a cross section of projects sold) were developed (the indicated dates represent the start up date for each facility):

- New Market, Virginia – 1-MGD MF Process (1998)
- Dayton, Virginia – 3-MGD MF Process (1999)
- City of Salt, Kingdom of Jordan – 6-MGD MF Process (2000)
- Carthage, North Carolina – 1.5-MGD MF Process (2001)
- Monroe, Georgia – 9-MGD MF Process (2002)

INFILCO DEGREMONT, INC. (IDI), Richmond, VA
1989-1997: Served as a Product Manager and Sales Manager for various IDI products providing technical sales presentations to clients, consultants and state agencies, worked with all IDI MR's to promote the sale of these products, and developed proposals for municipal bids.
Assignments included:

- Product Manager for the DensaDeg Clarification technology
- Product Development Manager for the Advent Package Plant Process
- Sales Manager for the Aquasource Ultrafiltration Membrane Technology

CHICAGO BRIDGE & IRON, CO.
1985-1989: Employed by Walker Process, Aurora, Illinois, division of Chicago Bridge & Iron Co. Served as the Southeast Regional Sales Manager for the ClariCone solids contact clarification process. Responsibilities included:

- Application of the ClariCone technology within a 13-state region
- Set up, operate and report pilot studies
- Present the ClariCone technology to clients, consultants and state agencies
- Worked with seven different manufacturing representative firms
- Develop proposals for municipal bids

1981-1985: Assigned to the Australian division of Chicago Bridge & Iron Co., CBI PTY LTD.

- Technical Liaison for the Worsley Alumina Project, located in Perth, Western Australia
- Engineering Supervisor at the Blacktown Engineering Facility, located near Sydney, New South Wales.

The Australian assignment terminated with an 8-month assignment to the CBI Sales Training Program in Oak Brook, IL.

1978-1981: Employed by Chicago Bridge & Iron Co., Oak Brook, Illinois, and enrolled in their engineers training program. During this term, served assignments associated with the construction, manufacturing and construction of thin wall metal plate structures for fluid and dry material storage.

CARINA L HART

Owner & Chief Engineer
CEM, ENV SP

HART CONSULTS
EXPERTISE IN WATER AND WASTEWATER SOLUTIONS, LLC

PROFILE

Ms. Hart is the Owner of Hart Consults.

Diverse experience base expands from design of drinking water and wastewater treatment plants, facility planning, to hands on pilot study evaluations and construction inspection.

Ms. Hart has extensive experience in Project Management, Marketing and Business Development to maximize revenue and ensure the success of the Team in a variety of projects.

CONTACT

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Chart@HartConsults.com

CERTIFICATIONS

Certified Energy Manager (CEM)

OSHA 10-hour Construction Industry Outreach Training

NFPA 70E Electrical Safe Work Practices

Confined Space Training

NASSCO PACP/LACP & MACP Certified (exp)

GPRO Green Professional Training

Basic and Advanced Motor Training

Pump & VFD Training

Envision ENV SP

EDUCATION

Worcester Polytechnic Institute (WPI)
Bachelor of Science in Civil & Environmental Engineering (2000 – 2004)

COMPANY PROFILE

Hart Consults, LLC is a Connecticut based certified Women Business Enterprise (WBE) offering expertise in drinking water and wastewater consulting engineering. Owner and engineering consultant, Carina Hart, has over 18 years' experience and has worked alongside some of the brightest municipal and consultant water and wastewater clients in the industry. Hart Consults, LLC offers innovative planning and evaluation services, design assistance, and construction administration. Ms. Hart's diverse experience covers all aspects of the drinking water and wastewater industry including feasibility evaluation, process selection and design, pilot study projects, full-scale design and construction.

SELECT PROJECT EXPERIENCE

Pennichuck Water Works, Merrimack, NH, Chemical addition design for disinfection of well sources to be blended with plant effluent. Well sites were disinfected using sodium hypochlorite, proposed changes included blending with plant effluent using chloramines, design included the addition of ammonia dosing pumps and consideration of the potential effects of water quality and the release of scales with changing water chemistry in the respective section of the distribution system.

Fall River Water Department & Treatment Plant, Fall River, MA, Ms. Hart has worked with the City of Fall River for 18 years doing a variety of services including treatment optimization including coagulant chemical addition and carbon dioxide alkalinity system. Clearwell tracer study, lead and copper sampling program, disinfection byproduct sampling and reduction program, development of the masterplan including the water treatment plant, water storage tanks, booster pump stations, and reservoir transfer stations. Design and construction of the Howe Street Water Storage Tank including booster pump station. Emergency replacement of high lift pumps was conducted including specification development, oversight of replacement and startup of pumps.

Jamestown Water Department, Jamestown, RI, Design of a GE/Zenon Ultrafiltration membrane at the Jamestown Water Treatment Facility for the removal of Natural Organic Material (NOM), iron and manganese for difficult to treat surface water sources. Detailed design included chemical addition pumps and storage systems and laboratory area. Project preceded with a multiple season pilot study with the selected ultrafiltration membrane process including day to day operation of the pilot unit, water quality analysis and evaluation and final results report. Pilot evaluation included treatment of multiple surface and well source water and chemical addition optimization. Ms. Hart also participated in the design and construction of a new water storage tank and vault in Jamestown and assisted with disinfection byproduct reduction evaluations in the distribution system.

PUBLICATIONS & PRESENTATIONS

"Commissioning for Sustainable & Efficient Operation in the Water Industry" Presented at CT AWWA ATCAVE, March 2022

"Energy Efficiency Funding for Wastewater Facility Upgrades" Presented at CAWPCA Virtual Workshop, November 2020

"The Benefits of Strategic Energy Management at Wastewater Treatment Facilities" Presented at NEWWA/NEWEA Information Technology & Asset Management Fair, November 2019

"Sustainable Wastewater Facilities & Infrastructure: A Creative Approach to Energy Management & Cost Control" Presented at the New England Environment Association (NEWEA), January, 2019

"Roadblocks to Renewables" Presented at the New York Environment Association (NYWEA) / New York State Branch American Water Works Association (NYSAWWA), Joint Energy Conference, November, 2016

"The Real Efficiency of Your Pumps" Presented at New England Water Works Association (NEWWA) December Monthly Meeting, December, 2015

"Aeration System Optimization / Dissolved Oxygen Study at the Deer Island Treatment Plant" Paper Presented at the New England Water Environment Association (NEWEA) 2014 Annual Conference & Exhibition, January 2014

"Uniquely Solving a Nagging Lead Problem in Fall River" Paper Presented at the NEWWA/RIWWA Joint Conference: November, 2013

"Well No. 4 Water Treatment Plant Process Evaluation and Testing, Holliston, MA" Paper Presented at New England Water Works Association (NEWWA) Spring Joint Regional Conference & Exhibition, April 2012

"Pilot Study of Disc Filtration Technologies for Phosphorus Reduction at the Clinton WWTP"

Groton Utilities, Groton, CT, Preliminary design of a dissolved air floatation (DAF) facility for Groton Utilities drinking water treatment facility in Groton, CT. Project included the design of a Leopold DAF process followed by deep bed filtration for the removal of organic material and manganese from surface water sources. Additional pilot evaluation was conducted using a variety of different filter medias to optimize treatment. Pilot studies included chemical addition optimization and effect of disinfectants on finished water stream and pre-oxidants on raw water stream. Project was preceded by a comprehensive pilot study with the DAF process to evaluate proper loading rates and coagulant dose followed by various oxidation chemicals for manganese removal. An additional pilot study was conducted to analyze multiple filter media types and configuration for removal of manganese. Project responsibilities included optimizing filter loading and configuration, day to day operation of the filters including water quality analysis and evaluation.

Portsmouth Department of Public Works, Madbury, NH, Pilot study and evaluation for the removal of dissolved organic material and iron from a surface water drinking water source. Evaluation included Infilco Degremonts dissolved air floatation process (DAF) and ultrafiltration membranes from Zenon/GE. Processes were followed with multiple configurations of filtration technologies including biological activated carbon with ozone, granular activated carbon, and dual media sand and carbon. Ms. Hart's responsibilities included on-site operation, management, and sampling/testing to monitor performance and progress. Evaluation was summarized in report format including complete pilot results, performance with different coagulants, polymers, and pH adjustment technologies and included recommendations for the design moving forward.

Manchaug Water District, Manchaug, MA, Full-scale design, pilot study, and feasibility study for the removal of iron and manganese from ground water source drinking water. Multiple iron and manganese filtration technologies were evaluated for efficacy. Full-scale design included the production of 100% plans and specifications of the plant. Responsibilities include operating the pilot study, producing detailed design for process piping and chemical addition, followed by construction inspection and additional construction services. Pilot study for iron and manganese removal filtration systems including Pureflow iron oxide media and Hungerford & Terry Greensand Plus media.

Westborough Wastewater Treatment Plant, Westborough, MA, Full-scale design at the Westborough Regional Wastewater Treatment Plant for phosphorus removal through a tertiary ballasted clarification process, ACTIFLO®, including 100 percent plans and specifications. Ms. Hart led and managed the Pilot Study at the Westborough Regional Wastewater Treatment Plant for the reduction of phosphorus through tertiary treatment. The study evaluated four state-of-the-art phosphorus reduction technologies. The study concluded with a report summarizing the methodology, results, recommendations, and full-scale cost assessment. Ms. Hart oversaw a team of three engineers who monitored progress of each technology by collecting and testing samples, collected operational data, and evaluated performance. Daily responsibilities included providing tours of the pilot plant to outside design engineers, municipalities, and board of directors.

Holliston Water Department, Holliston, MA, Pilot study for well location in Holliston including evaluation of Dissolved Air Floatation (DAF) followed by filtration, ballasted flocculation followed by filtration and immersed ultrafiltration membranes for the removal of iron, manganese, and

Paper Presented & Published at the 84th Annual Water Environment Federation Technical Exhibition and Conference: New Orleans, LA, October 2012

"Comprehensive Evaluation of Phosphorus Removal Technologies for the MWRA Clinton Wastewater Treatment Plant" Paper Presented at the New England Water Environment Association (NEWEA) Annual Conference: Boston, MA, January 2011

"Unique Approach to Selection of Optimal Low Level Phosphorus Technology": Paper Presented & Published at the 82nd Annual Water Environment Federation Technical Exhibition and Conference: Orlando, FL, October 2009

"Pilot Study Selection and Start-up Made Easy" Paper Presented at NEWEA 2008 Annual Conference & Exhibition, January 2008

"From Pilot to Plant: Membrane Treatment of Difficult Water Quality" Paper Presented at NEWWA Spring Joint Regional Conference & Exhibition, April 2007

organic material. Pilot responsibilities included oversight of testing and process modifications, management of data collection and analysis, and oversight of pilot staff.

Barnstable Fire District, Barnstable, MA Water Storage Tank, The Barnstable Fire District encountered bacterial issues associated with one of the water storage tanks (WST) resulting in an extended Boil Water Order for the service area. Ms. Hart acted on-site to troubleshoot the bacteria issues, coordinate testing and sample collection with the Fire District and Massachusetts Department of Environmental Protection (DEP), and coordinate communication with the public. Following the boil water order, Ms. Hart investigated alternatives for the rehabilitation of one of the standpipes including installation of mixing systems and the operation of the pump station with the WST to prevent chlorine degradation and reduce water age in the tank.

Massachusetts Water Resources Authority (MWRA), Clinton, MA, Preliminary phosphorus reduction technology evaluation, pilot study, followed by full-scale design at the MWRA's Clinton wastewater treatment facility. Evaluation included the assessment of all available technologies and more thorough evaluation of specific technologies applicable for the MWRA wastewater treatment facility. Pilot testing of two applicable technologies for phosphorus removal, and full-scale design of the selected disc filtration method to reduce phosphorus. Ms. Hart coordinated the design team disciplines including process, mechanical, electrical, architectural, and plumbing to provide a cohesive design for full-scale implementation at the Clinton facility. Design was developed through a facility plan followed by bid ready plans and specifications for construction.

Gloucester Water Department, Gloucester, MA, Ms. Hart acted as a full-time resident project representative (RPR) for the construction of multiple projects within Gloucester including drinking water pipeline installation, water storage tank installation, valve vault installation, water treatment plant rehabilitation for two plants. Project included the coordination of multiple construction teams throughout the City, review and approval of payment requisitions, leading monthly construction meetings, and coordinating site activities.

Regional Water Authority, New Haven, CT, Completed multi-year energy evaluation and electric use and rate structure evaluation for 26 drinking water facilities owned and operated by the Regional Water Authority (RWA). Analysis included field data collection and analysis followed by recommendations for future operations and system improvements to assist the RWA in prioritizing their capital improvements plan. Subsequent evaluations were conducted based on specific projects during design to achieve incentive funding for energy efficiency projects.

Gardner Water Pollution Control Facility, Gardner, MA, Conducted energy evaluation and solar photovoltaic array evaluation for the Gardner WPCF to determine the potential energy saving alternatives and conservation measures. An assessment of the water pollution control facility unit processes as well as a review of the existing operational strategies. Energy saving measures were recommended and the savings/payback periods were determined.

Taunton Water Pollution Control Facility, Taunton, MA, Conducted energy evaluation of the plant during facility planning to determine energy saving methodologies and capital improvement projects to assist in capital improvement prioritization. Evaluation included assessment of renewable energy projects including solar photovoltaic and hydro turbine installation.

JEANINE D. DUDLE (FORMERLY PLUMMER)

Department of Civil and Environmental Engineering, 100 Institute Road, WPI
Worcester, MA 01609; Phone: 508-831-5142; Email: jddudle@wpi.edu

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Credentials

Education:	Ph.D. in Civil Engineering, Univ. of Massachusetts, Amherst, MA (1999) M.S. in Environmental Engineering, Univ. of Massachusetts, Amherst, MA (1995) B.S. in Civil & Environmental Engineering, Cornell University, Ithaca, NY (1993)
Positions:	Associate Professor, Dept. of Civil and Environmental Engineering, WPI (current) Principal Engineer, Water Quality & Treatment Solutions, Inc., Brookfield, MA (2016-17) Water Quality Engineer, Northeast Water Solutions, Inc., Exeter, RI (2015-16)
PE/Boards:	Licensed PE in Environmental Engineering in MA, CT, and RI. Board of Directors, American Water Works Association

Selected Research, Teaching, and Consulting Projects

Student Research and Design Projects on Water/Wastewater Treatment Optimization
Supervised over 40 student projects on water quality and treatment, including projects assessing coagulation chemistry and chemical optimization. Examples include:

- Treating algal-laden drinking waters with ferrate
- Optimizing CoMag® system operations at the Billerica, MA treatment plant
- Utilizing GAC and MIEX to improve TOC removal
- Water quality and manganese control for the Russell F. Tenant water treatment facility

Student Teaching and Design Projects on Water Chemistry and Treatment
20 years of teaching experience in water chemistry and drinking water treatment. Courses included fundamental concepts of chemical equilibrium, acid/base chemistry, solubility, complexation, and redox; and applied drinking water treatment (e.g., physical and chemical unit processes including disinfection, coagulation, clarification, filtration, membranes, air stripping, adsorption, softening, corrosion control, and other advanced processes). Supervised design projects to provide conceptual design of treatment plants using lake, river, and groundwater sources, considering water quality and variability in the design.

Corrosion Evaluation and Corrective Action, Confidential Client, Southwest
This project assessed corrosion control issues at a condominium complex in the Southwest U.S. The complex received municipal water and further treated the water by reserve osmosis, chemical disinfection and corrosion control. The facility was experiencing significantly accelerated corrosion rates and leak failures. Using historical data and an on-site evaluation, worked with NWSI to assess the raw potable and finished water characterization, evaluate drivers of corrosion and recommend corrective actions.

Engineering Evaluation of Corrosion Control Programs, Equity Residential Apartments, Multiple Locations in MA and VA
NWSI was retained to evaluate the corrosion control programs in multiple apartment complexes on the east coast. Conducted on-site inspections and assessed water quality from historical municipal data, corrosion vendor reports and samples collected on-site. Completed desktop corrosion index calculations. Worked with the lead engineer to evaluate the current status of each system with regard to corrosion/scale in the systems and corrosion control program effectiveness.

TMDL Compliance: N and P Loadings from OWTSs, Fieldstone Properties, Exeter, RI
NWSI was retained to assess N and P loadings from a proposed residential development with on-site wastewater treatment systems, for compliance with state TMDL regulations. Evaluated historical P and N

loadings in the watershed, and worked with the RI Department of Environmental Management to develop a model for calculating P transport.

Waste Minimization and Process System Upgrades, Confidential Client, East Coast
This project evaluated a manufacturing facility with regard to waste stream production and regulatory compliance. A complete audit of the facility was conducted to identify potable water demands and chemicals used in water treatment equipment, review cleaning processes and chemistry, and characterize waste streams. Recommendations for waste minimization, process consolidation and improved regulatory compliance were provided. Served as a technical reviewer.

Discolored Water Study, Confidential Client, West Coast
This project was an examination of discolored water issues in customer taps for a utility which uses both surface water and ground water sources. Role was to analyze water quality data provided by the utility, prepare a draft technical memorandum on the analysis of potential causes, and participate in meetings with the utility and city officials to develop preliminary recommendations for improving water quality.

Pilot Infiltration Gallery Pumping Test & Water Quality Evaluation, Pascoag Utility District, Pascoag, RI
This project involved the exploration and development of a new public water supply well in Pascoag. NWSI designed and installed a pilot infiltration gallery along a riverbank and installed monitoring wells, piezometers and staff gages for surface and groundwater monitoring. Oversaw the constant rate pumping test, which was designed to quantify and characterize the nature of flow between the stream, gallery, and surrounding aquifer. Analyzed groundwater elevation data from 1.5 months of testing to determine drawdown characteristics and safe well yield. Conducted water quality sampling to meet regulatory requirements, and analyzed water quality characteristics to provide a preliminary evaluation of treatment needs to the client.

Facility Improvement Plan and Nitrate Control (2015 – 2016), Central Beach Fire District, Central Beach, RI
This project assessed the public water system needs for a 30-year operating window for a small groundwater system. The evaluation focused on source water protection and reduction of nitrates in the public water supply. I was involved with on-site inspections, and used historical data to conduct an assessment of nitrate contamination as impacted by precipitation, on-site wastewater treatment systems, and pumping rates in Central Beach and the neighboring community. Conducted a technical review of the recommendations for nitrate treatment technologies that were developed by NWSI.

Selected Publications and Presentations

Addison, E.L., Gerlach, K.T., Spellman Jr, C.D., Santilli, G., Fairbrother, A.R., Shepard, Z., Dudle, J.D. and Goodwill, J.E., 2021. Physicochemical implications of cyanobacteria oxidation with Fe (VI). *Chemosphere*, *266*, p.128956.

Plummer, J.D.; Fleming, R.; and Najm, I. Treatment Changes to Reduce Trihalomethane Concentrations after an Operational Evaluation Level (OEL) Exceedance. *AWWA Water Quality Technology Conference*, Portland, OR, Nov. 12-16, 2017.

Plummer, J.D. and Najm, I. 2017. Cyanotoxins Removal with Drinking Water Treatment Technologies. *New England Water Works Association Spring Joint Regional Conference and Exposition,* Worcester, MA, April 5-6, 2017.

Plummer, J.D. and Ferrari, R.F. 2016. Nitrate Contamination of Groundwater: Impact of On-Site Wastewater Treatment. *AWWA Water Quality Technology Conference*, Indianapolis, IN, Nov. 13-17, 2016.

Plummer, J.D. and Ferrari, R.F. 2016. Developing A New Water Source Using A Riverbank Infiltration Gallery. *AWWA Annual Conference and Exposition*, Chicago, IL, June 19-22.

Plummer, J.D., Ferrari, R.F.; Prasad, H. 2015. Impact of municipal water characteristics on corrosion of steel and copper piping. *AWWA Water Quality Technology Conference,* Salt Lake City, UT., Nov. 15 – 19, 2015.

Plummer, J.D.; Long, S.C.; Charest, A.J.; and Roop, D.O. 2014. Bacterial and viral indicators of fecal contamination in drinking water. *Journal of the American Water Works Association,* 106(4): E200-E211.

Matthew Lundsted, P.E., CFM

Principal Engineer, Planning Lead

Mr. Lundsted is a Principal Engineer at CEI with over 33 years of civil engineering experience in the public sector. With expertise in municipal utilities, culverts/small bridges, transportation, construction/bid services, cost estimation and green infrastructure, he serves as Program Manager for a number of municipal infrastructure and DOT projects throughout NH and MA.

As a Certified Floodplain Manager, he is expert in integrating resiliency and climate change in CEI's planning projects and engineering designs. He has worked on drinking water, wastewater, stormwater, roadway/culvert and remediation related projects throughout his career with a focus on resiliency and constructability. He has chaired the Contoocook River and North Branch River Local Advisory Committee under New Hampshire's Designate Rivers Program.

Education
B.S. Civil Engineering
University of Connecticut

Professional Registrations and Service
Registered Professional Engineer in MA, CT, NH
Participant- MA Governor Baker's Small Bridge and Culvert Working Group- 2018-19
Certified Floodplain Manager (CFM)
Certified Construction Inspector
Contract Claims Avoidance and Handling

Selected Project Experience

Project Manager, Drinking Water Treatment Facilities for Four Existing Wells, Scituate, MA. CEI did several drinking water treatment projects for the Town of Scituate, including two corrosion control facilities and treatment for Volatile Organic Compounds (VOCs) and radon at a third well. For the VOC treatment, CEI first evaluated several alternatives to determine the most cost-effective options considering the relatively low levels of contamination, and to address a second nearby well. The alternative that was the least costly was a venturi air stripper, which was not yet approved for use in Massachusetts. CEI got the technology approved and designed and the units have now been constructed. The stripper has several advantages, including significantly reduced capital and operations costs, because it uses the velocity of the pump to power a cyclone separator, eliminating the need for costly blowers. Gases are then vented to the outside. The treatment is also flexible in that units can be added if contamination increases. It is also not susceptible to iron and manganese fouling.

Project Manager, Water Main Rehabilitation and Replacement, Braintree, MA. This project, completed in 2007, included design and construction services for water main work including replacement of approximately 3,800 linear feet of existing 6-inch water main with a new 12-inch water main and tie all related services, hydrants and side street connections to the main along Middle Street from Union Street to Liberty Street; replacement of approximately 900 linear feet of existing 6-inch main with a new 12-inch main along Liberty Street between Stetson Street and Lincoln Street; replacement of approximately 600 linear feet of existing 6-inch main serving the Morrison school with approximately 850 feet of 8-inch water main to provide a looped connection to Mayflower Road.

Lead Design Engineer, Pennichuck Square Stormwater Design Project, Town of Merrimack, NH. CEI worked with Pennichuck Water Works and the private owner of this commercial mall within the surface water watershed to design and construct Low Impact Development (LID) drainage elements. CEI used multiple LID elements, including a large biofilter, rain gardens, a wet pond and dry wells for roof leaders and leaching catch basins for areas that commonly flood. As a result, stormwater runoff from the site has been reduced by 88%, nearly eliminating pollution into adjacent tributaries from the site and instead treating and recharging water through natural cleansing.

Project Manager, Water Main Installation & River Crossing, Wilton, NH. This CEI project includes design and installation of a new water main crossing of the Souhegan River in Wilton, NH in three distinct phases and includes bid and construction services. Bid services include advertisement, plan reproduction and distribution, answering prospective bidder's questions, performing the bid opening and making a bid recommendation. Administrative construction services on behalf of the project proponent Wilton Water Works include holding a preconstruction meeting, submittal review, monthly requisition processing and change order processing. On-site inspection services include daily inspection, completion of a daily inspection report, photo documentation of construction progress, holding construction progress meetings, semifinal inspection, development of punchlist and final inspection and final completion of the project.

Project Manager, Wachusett Reservoir Direct Discharge Study & Design, MA DCR. CEI is currently working with MA DCR on a project to protect the drinking water in the Wachusett Reservoir from polluted stormwater runoff and accidental spills that could enter storm drains and outfalls. There are currently three project areas identified in this Wachusett Reservoir Direct Discharge Phase II Study completed by CEI now in design following the MassDOT design process.

Project Manager, Design & Construction Inspection, Cleaning & Lining of Water Mains, Scituate, MA. Mr. Lundsted acted as PM of this project designed to improve the hydraulic loss experienced in this area and restore adequate fire protection to several areas of the community by lining the interior of old cast iron pipes with cement. This was a less costly approach than replacing the existing water mains. CEI developed the plans and specifications for the cleaning and lining of several sections of approximately 5,400 linear feet each of cast iron pipe, provided bidding services and coordinated construction services in concert with Town Staff.

Project Manager, Green Infrastructure/Nitrogen Stormwater BMPs, U.S. EPA and Towns of Barnstable & Chatham, MA. Throughout 2014 and 2015 CEI, as part of an on-call team, worked with the U.S. Environmental Protection Agency (EPA), the Town of Chatham, and the Town of Barnstable (Hyannis) to design and install Green Infrastructure (GI) Stormwater Best Management Practice (BMP) Retrofit Education and Outreach Projects consisting of hybrid bioretention and gravel wetland systems installed in each town. This project helps treat stormwater runoff and reduce nonpoint source pollution from entering the nearby nitrogen-impaired waters of Oyster Pond (Chatham) and the Hyannis Inner Harbor (Barnstable). Now online, BMPs help reduce nitrogen and other water quality parameters while also serving as a demonstration project to help encourage area developers, planners and engineers to use green infrastructure techniques similar to this in future designs.

Principal Manager, Mashapaug Pond Restoration/Green Infrastructure Stormwater BMPs for U.S. EPA. CEI worked with the U.S. EPA and WaterVision to design and implement stormwater controls to help improve the water quality of Mashapaug Pond. Utilizing bio-infiltration, CEI's design incorporated green infrastructure best management practices (BMPs) for stormwater control. This project serves as a showcase project for public and private stakeholders to promote green infrastructure BMPs as an effective technique for stormwater control and watershed management for water quality.

Technical Review, Infiltration & Inflow Study, New Britain, CT. QA/QC for the performance of an Infiltration & Inflow study for the City of New Britain. The Phase I study will assess extensive inflow to the sanitary sewer system via limited flow metering. A pilot program for private source reduction will also be conducted.

Project Manager, Hubbard Street Combined Sewer Separation, Ludlow, MA. Funded through an SRF loan, CEI provided design and construction services for the Hubbard Street Combined Sewer Separation Project under the project management of Mr. Lundsted. As PM oversaw full public bid services, administrative construction services (preconstruction and progress meetings, material submittal review, contractor requisition review, loan reporting, etc.), oversight of full-time on-site inspection as well as redesigns of several components of the project due to utility conflicts encountered during construction.

Project Manager, Sewer System Evaluation Survey (SSES), Scituate, MA. Funded through an SRF Loan, CEI conducted a sewer system evaluation survey to inventory existing conditions, conduct flow monitoring, provide recommendations for further infiltration/inflow study, ranking of systems for repair, manhole studies, additional house-to-house inspections, TV testing and flow isolation.

Project Manager, I/I & Sewer System Rehabilitation for 10-Year Program, Scituate, MA. Working for the Town of Scituate, Mr. Lundsted designed system repairs to reduce infiltration in a coastal section of town with high groundwater issues.

Client Manager, CSO-Separation Review, Ludlow, MA. Several sewer projects including peer review of proposed multi-million dollar CSO separation and preparation of sewer State Revolving Loan Fund program documents.

Stephanie Hanson, PMP, CSE

Principal Scientist, Public Relations Lead

Ms. Hanson is a Principal Scientist and Certified Senior Ecologist with 24 years of consulting experience. She is a certified Project Management Professional (PMP) with technical expertise in the areas of water resources, watershed management, stormwater, site assessment and permitting. She has primarily worked with public clients at the municipal, state and Federal level. Additionally, she has managed a diverse set of public education and outreach projects, state funded grants, and Federal on-call contracts.

Selected Project Experience

Project Scientist, Norumbega Covered Storage 115 Million Gallon Covered Storage Construction Project, Environmental Compliance & Oversight, MWRA Owners Representative. Responsible for onsite inspection of environmental management and implementation of extensive permitting for $95M, 5-year state infrastructure design-build construction project. Implementation issues included oversight and review of NEPA compliance; public outreach/communication; multiple wetland/vernal pool replication projects; stormwater controls for runoff; and compliance with permitting for major drinking water infrastructure in large metropolitan area.

Project Manager, 5th Grade Watershed Education Program, Pennichuck Water Works. Project Manager for this Watershed Education Program within the Nashua School District. The purpose of the program is to increase awareness about watershed protection by teaching students about the water cycle, the Pennichuck Brook Watershed and stormwater pollution prevention. The program was developed to fit smoothly into the District's education curriculum and to meet the State's science standards, therefore targeted 5th grade students in the District. The program includes a series of classroom presentations, including a hands-on groundwater model used to demonstrate groundwater movement and pollution pathways. A Live Online presentation was developed in 2021 to comply with Covid restrictions while still bringing this program to the students.

Project Manager, Watershed Outreach Video Series, Pennichuck Water Works. Funded through a NH DES Source Water Protection Grant, CEI worked with Pennichuck staff to develop a series of 4 online videos that included script and storyboard development; professional videography, editing, narration and subtitles; focus group comments; and final production. CEI worked with Pennichuck to announce the project and make the videos available to the public for viewing. Topics included: what is a watershed and stormwater, how stormwater impacts a watershed, what Pennichuck has accomplished in the watershed through the years and what can you do to help protect the watershed.

Project Manager, Community Based Social Marketing Program for Fertilizer Reduction, Pennichuck Water Works. Worked with Towns of Amherst and Merrimack, NH and funded by NH DES, CEI worked to develop and implement CBSM program that included working group facilitation, community surveys, slogan and logo development, workshop production, grant management and outreach and education. Program will serve as showcase project for other education and outreach programs throughout the region.

Project Scientist, Water Treatment Facility, Kingston Water District. Project Scientist for resource area delineation and permitting for CEI's design for this 3 mgd water treatment facility. This completed project was highlighted on the cover of the New England Water Works Journal.

Education
Master of Science
Environmental Science
Concentration: Ecology/Wetlands
University of New Haven

Bachelor of Science, Environmental Geoscience
Boston College

Professional Registrations and Service
ESA Certified Senior Ecologist (CSE)
Project Management Professional (PMP)
40-hour HAZWOPER

Stephanie Hanson, PMP, CSE

Principal Scientist, Public Relations Lead

Project Manager, Various s319 Nonpoint Source Pollution Grants including Public Education & Outreach. Ms. Hanson has managed over a dozen EPA funded s319 NPS grants that have included both engineering services and a required technology transfer and public education outreach components. Outreach components have included both in-person presentations, school programs, community event activities, written fact sheets, online material and more recently, webinars and podcasts.

Project Scientist, NH DES Stormwater BMP Workshops/Pennichuck Water Works. As part of a NH DES Watershed Protection Grant, CEI produced a 2-day stormwater management workshop geared towards municipal officials and staff, developers and engineers. The workshop was initiated and funded by the NH DES and Pennichuck Water Works in an effort to provide technical outreach to the Southern New Hampshire community. The workshops focused on stormwater treatment and new methods of dealing with stormwater, that at the time were more environmentally acceptable than direct discharge to waterways. Over 100 people attended these events that also included a field component where participants had an opportunity to see successful BMPs working on various sites. Supporting organizations included the Nashua Regional Planning Commission, NH Association of Conservation Commissions, Rockingham Planning Commission, Merrimack Village District, NH Planners Association, NH Association of Regional Planning Commissions, and the NH Municipal Association.

Project Manager & Lead Author, Hobby Farm BMP Statewide Guidance, MassDEP/EPA. Funded by s319 funds, this statewide water quality guidance document was developed to assist residential hobby farmers and small agricultural operations to implement structural and nonstructural BMPs. This guidance provides detailed information for homeowners that includes soil testing, nutrient needs, fertilizer selection, alternative nutrient methods, composting, manure management, runoff site management, IPM, emergency management planning, hazardous material reduction and storage. This material was written in fact sheet format so that it could be read as one document or as 40+ separate fact sheets. This allows those using the material for public outreach to select applicable fact sheet topics for individual distribution either in hard copy or online format.

Project Manager, North & South Rivers Watershed Association, Stormwater LID Technical Outreach Grant. As part of a s319 NPS Grant, CEI worked with NSRWA to provide LID technical outreach services to the Towns of Plymouth, Pembroke, Hanover and Kingston. Elements included LID outreach workshops, a self-guided LID field tour, LID designs for later implementation, a bylaw/regulatory review making changes to promote LID and the development of a pollutant removal model for LID elements made available for public use by EPA.

Project Manager, Tree Canopy Preservation and Integration Outreach Project. U.S. EPA/MassDEP. Since design practices and regulatory programs for stormwater management often do not specifically recognize the benefits in the interception of rainfall and the consequent reduction of stormwater runoff provided by canopy trees, this project quantitatively characterized the potential role of canopy trees in achieving reductions in stormwater runoff; developed model regulatory language to encourage tree retention; and compiled guidelines for the use and retention/preservation of trees in the urban landscape. This project also included the development of a Tree Canopy website with unique logo along with fully customizable fact sheets for municipalities to encourage tree canopy preservation.

Project Manager, NPDES Phase II Regulatory Workshop, Manchester, NH. This workshop, held in Manchester, NH, was initiated and funded by CEI, in an effort to provide technical information to local and state officials on the NPDES Phase II stormwater regulations. Over 50 people attended this 1-day workshop. Supporting stakeholder organizations included: Merrimack River Watershed Council, Merrimack Village District, Nashua Regional Planning Commission, Natural Resources Conservation Service, New England Interstate Water Pollution Control Commission, New England Water Works Association, NH Association of Conservation Commissions, NH Municipal Association, NH Office of State Planning, NH Public Works Municipal Engineering Association, Pennichuck Water Works, Rockingham Planning Commission, Southern NH Planning Commission, and Strafford Regional Planning Commission.

Michael Carmasine, P.E.

Project Engineer

Mr. Carmasine is a CEI Project Engineer with experience in all aspects of design and construction of public utility systems, CAD for civil projects, and environmental sampling/mapping. Mr. Carmasine has worked on the design and construction inspection for several water supply projects which improved system hydraulics and updated aging infrastructure. He is currently working on a groundwater withdrawal study of impacts on river drawdown for the Ipswich and Parker Rivers as well as designing stormwater infiltration basins for pretreatment of impervious runoff to impaired water bodies in Cape Cod, MA. He is a sUAS Pilot (FAA Licensed) with training in drone operations and FAA code for commercial pilots.

Education
Bachelor of Science
Civil Engineering
University of Massachusetts
Amherst

Professional Registrations and Service
Registered Professional Engineer
OSHA 40 Hr HAZWOPER
FAA Remote Pilot Lic. #4019819

Selected Project Experience

Project Engineer, North Kingstown, RI, Pump Station Modifications and Chemical Feed, North Kingstown, RI. Project Engineer for the design and permitting to bring Well #10 back online after 7 years of nonuse. The project involves decommissioning the existing well and installing a new gravel packed well, extensive demo within the pump station and replacement of all chemical feed systems, providing backup power and SCADA to the site, upgrading the chemical feed systems to the town's specific need and operations.

Project Engineer, Town of Kingston, Manganese Removal Water Treatment Facility, Kingston, MA. Project engineer for the design, permitting, and construction of a manganese removal water treatment facility for two of the towns contributing wells. Primary treatment processes include pressure filtration with adsorptive media and chemical feed systems. The backwash Mn solids were pumped to on-site settling lagoons and then infiltrated. The existing lime feed building was converted to a sodium hypochlorite storage and potassium hydroxide injection point location to minimize space requirement in the new facility. The project is proceeding through the startup and testing phase Spring, 2022.

Project Engineer, West Boylston Water District, Water Treatment Facility, West Boylston, MA. Project engineer for the design, permitting, and construction of a 1 mgd water treatment facility for the Oakdale Well located along the Quinapoxet River and West Boylston's popular Rail Trail. The primary treatment process is pressure filtration with adsorptive media (GreensandPlus) to remove Iron and Mn from the contributing well. This involved a retrofit of chemical systems in the existing pump station to reuse specific chemical feed systems and relocate others to the new facility. Project included water quality analysis and sizing the chemical feed system, the analysis of filter backwash handling options, ultimately resulting in the selection of discharge of concentrated/settled solids to beneath the new facility and then decant to nearby lagoons and sewer system. The project is currently under construction and to be completed by the end of 2022.

Project Engineer, Interconnection with City of Easthampton, Southampton, MA. Project engineer for the design and construction of a water booster pump station to allow automatic transfer of water from the City to the Town and a new well pump station to provide new chemical treatment systems for chlorine and potassium hydroxide. System improvements included implementation of a radio telemetry system and SCADA, to allow remote monitoring/control of the new booster pump station and well pump station. Project funded through the Massachusetts DWSRF program.

Staff Engineer, Groundwater and Tributary Sampling, Pennichuck Brook Watershed. Collects surface water and groundwater samples from tributaries and groundwater piezometers within the Pennichuck Brook Watershed for laboratory analysis. Collected the data periodically through each year to monitor ground and tributary water quality.

Project Engineer, Construction Inspection for Water Booster Pump Stations, Merrimac, MA. Provided onsite engineering services and construction inspection for two separate booster pump stations and an associated water main required to meet the hydraulic needs in both critical areas with low pressure. Directed contractors with town employees to manage scheduling and document progress.

Project Engineer, Construction Inspection, Water Main Installation, Hatfield , MA. Provided the onsite engineering services and construction inspection for the installation of 1700 feet of 16-inch water main, including a highway crossing directional drill across Interstate I-91 and a railroad crossing.

Project Engineer, sUAS Pilot, Culvert Replacement Feasibility Study, Cummington, MA. Performed automated drone flights to analyze potential scenarios for culvert replacement. Gathered far reaching upstream and downstream features of the streambed for restoration design and related engineering analyses.

Project Engineer, sUAS Pilot, Ortho Imaging and Drone Survey by sUAS, Windsor, MA. Served as sUAS co-pilot and as a spotter during drone flights over a series of culverts discharging into the Westfield River. Performed preliminary site setup and control target site survey necessary prior to operating sUAS.

Site Surveyor, Initial survey and site analysis, Yarmouth, MA. Conducted an initial site survey collecting key features (wetland delineation, topography, road layouts) for the design phase of a retrofit stormwater BMP. Currently designing this project in CAD Civil 3D to provide treatment for impervious surface runoff.

Project Engineer, Stormwater Outfall Mapping and Sampling, New Britain, CT. Lead a field investigation for illicit discharge connection to New Britain’s storm water collection systems. Collected storm water samples for laboratory analysis under wet and dry weather conditions while mapping the discharge points for various outfalls to potentially impacted water bodies.

Staff Engineer, Sanitary Sewer System Inflow and Infiltration Study, New Britain, CT. Developed charts depicting diurnal flow variations within the town sewer system. This information was used to assess locations of high infiltration and target the critical areas to prevent sanitary sewer overflows from occurring during large storm events.

4.0 Understanding of Project Requirements

We understand that Pennichuck Water Works (PWW) shifted their primary supply for the Nashua NH Treatment Plant in 2019, from the Pennichuck Brook supply to the Merrimack River Intake. This source water change was prompted by the implementation of primary drinking water standards for PFAS compounds, which are significantly higher in the Pennichuck Brook supply compared to the Merrimack River Intake. However, the Merrimack River raw water quality has proved more challenging to treat than initially anticipated with higher (and more variable) levels of turbidity, color and total organic compounds (TOC). Although PWW has been able to successfully optimize the treatment process with its existing chemical systems for the Merrimack River supply, the effects of the variable raw water have at times stretched the capacity of certain components of the current chemical treatment systems to their limit.

The project consists of an evaluation of the Plant's existing chemical feed systems and chemical storage capacities. The evaluation will be comprehensive for all chemical feed systems and include an assessment of remaining service life of system components, assessment of chemical storage requirements versus available space, and assessment of future storage requirements based on projected maximum facility flows. Additionally, we will review current location of chemical storage/feed areas relative to injection points in an effort to minimize the potential for chemical feed system problems, increase operational efficiencies and minimize safety issues.

Background Information

PWW's Nashua NH Treatment Plant serves as the main supply for the Nashua Core System, with a capacity of approximately 32 million gallons a day. In 2016, PWW completed the first phase of improvements to allow operation of Pennichuck Brook and the Merrimack River as two completely independent sources of supply or as a blend of the two, to give PWW operators critical operational flexibility to handle known and future water quality conditions. The first phase was to make modifications to its raw water pipeline to enable water from the Merrimack River to be piped directly into the treatment facility bypassing the Pennichuck Brook reservoirs. The second phase was the completion of a new deep-water intake on the Merrimack River capable of withdrawing in excess of 35 mgd. This new intake allows for operation of the Merrimack River supply throughout the year as opposed to just the warm weather months of the year. The third phase included upgrades to the Merrimack River raw water pumping station to ensure a withdrawal of up to 22 mgd with one of its pumps out of service (firm capacity). A possible fourth phase of Merrimack River supply improvements in the future will be to add pumping capacity (firm) to achieve the current treatment facility capacity of 32 mgd including upgrades/additions to the raw water transmission main.

The original treatment facility was constructed in the 1980s. When upgrades to the plant were designed in 2005, they were done so under the assumption that the Pennichuck Brook supply would continue to be the primary source of supply with the Merrimack River supplementing flow only during the high demand periods of the summer. Due to the levels of PFAS that have been noted in the Pennichuck Brook supply and the addition of PFAS compounds as primary drinking water standards, PWW has begun to use the Merrimack River as its primary water supply more heavily and throughout the year. However, the Merrimack River raw water quality has proved more challenging to treat than initially anticipated due to higher levels of turbidity, color and organic compounds. The effects of the variable raw water have at times stretched the capacity

4.0 Understanding of Project Requirements

of certain components of the current chemical treatment system. These challenges are typical of a river intake and rely upon early detection of the water quality changes and having the proper treatment tools (i.e., chemical systems) ready to use at a moment's notice.

Chemical usage has been steadily increasing over the last 16 years as a result of these supply source changes. During high turbidity events, the chemical feed system is operating between 90-97% of its capacity. Preliminary evaluations by Pennichuck staff have determined that both chemical feed pumping capacity and storage are not adequate to treat raw water from the Merrimack River during certain climatic conditions. Undersized chemical feed pumps have made it impossible to dose at high enough levels to keep up with the Merrimack River's raw water quality during certain times of the year. Undersized chemical storage facilities force Pennichuck to rely on extremely frequent chemical deliveries; a disruption of which would leave the Plant vulnerable.

The following chemicals are used and/or stored at the Nashua Treatment Facility:

- Carbon Dioxide
- Sodium Hydroxide
- Ferric Chloride
- Non-ionic Polymer (Acrison Polymer Blending system)
- Sodium Hypochlorite
- Sodium Permanganate
- TKPP (tetrapotassium pyrophosphate)
- Zinc Orthophosphate
- Sodium Chloride
- Potassium Chloride
- Potassium Carbonate
- Calciquest

Some of these chemicals are simply stored at the Nashua Treatment Plant, for ultimate transfer and use at PWW's various remote water systems. Other chemical feed systems were installed and are ready to use, but are not used presently (carbon dioxide and sodium permanganate).

Upgrades are required to not only maintain status quo as regulations and water quality change, but also to utilize the plant at its full 32 mgd capacity in the future, possibly to serve other PFAS impacted areas as they are encountered in Southern New Hampshire.

Prior to undertaking any new capital investments in the Nashua Treatment Plant and its chemical feed systems, it is imperative that an assessment be conducted of the current condition of all chemical systems. This information will allow PWW to appropriately move forward with any proposed improvements and avoid unforeseen/surprise costs down the road. The chemical feed equipment ranges in age from the original facility (1980s) to the 2005 facility improvements. As with any capital assets, each piece of equipment has a service life that is impacted by its use and maintenance. For example, the existing polyethylene chemical storage tanks have an average service life of 20 years, after which they may start to experience small leaks due to the chemical interactions with the polyethylene. In the interest of operator safety and avoiding interruptions on the treatment operations, it is imperative that components be evaluated and replaced prior to failure.

4.0 Understanding of Project Requirements

Critical Issues for PWW

As an investor-owned public utility and one of the largest public water suppliers in Southern New Hampshire, wise capital investment and continuity of operations are critical issues to PWW. The following factors have the potential to impact these critical issues and will therefore be a focus throughout our evaluation of the chemical feed systems:

- Vulnerabilities
- Capital and Operational Efficiencies

Identification of vulnerabilities and developing mitigation measures (or system changes) to minimize these potential vulnerabilities is essential to PWW's core mission. As noted previously, the lack of sufficient chemical storage space in the existing facility creates a vulnerability, with PWW's continued operations reliant upon outside vendors (chemical suppliers) on a weekly basis, without much buffer for any disruption in this supply chain. Additionally, more frequent chemical deliveries and transfer operations increase the safety risk that is inherently associated with handling these water treatment chemicals.

Identification of efficiencies in capital investments and operations is also essential to PWW's core mission. Review and optimization of chemical storage and feed systems can enhance overall operational efficiency, such as location of injection points relative to chemical storage and feed areas. Efficient (and creative) use of existing facility space is a key consideration, given the significant investment already made in the Nashua Treatment Plant and the physical limitations (and permitting hurdles) associated with a very limited and constrained facility site.

The overriding goal of this evaluation and assessment is to identify the improvements required to ensure that the Treatment Facility is capable of producing potable water of sufficient quantity and quality meeting drinking water quality standards regardless of which source of supply (Pennichuck Brook or Merrimack River or some combination) is used to meet the demand.

Project Approach

We pride ourselves on listening to the client throughout the course of any project, in order to discern the unique needs of PWW and ensure that these issues and needs are addressed. We emphasize the participation of PWW staff during the entire process, as the ultimate long-term success of the treatment facility lies with the PWW's operators. Our approach provides an opportunity for operator input during the evaluation and conceptual design when it is fairly easy and inexpensive to make changes.

Throughout the design process, CEI will summarize the technical and financial information as required for PWW to make informed decisions on the proposed modifications. Our real-world knowledge of similar facilities and chemical feed systems and our ability to communicate this information in a format and manner that is appropriate for the particular audience is invaluable for achieving a facility that truly reflects PWW's needs and concerns.

We recognize the site constraints associated with the Nashua Treatment Plant with respect to environmental permitting, topography and vehicular/delivery traffic flow. Our initial focus will be identification of opportunities to more efficiently utilize the existing spaces, such as reconfiguration of the dry chemical storage room. This area has available headroom that could be utilized through the use of pallet storage racks accessible via forklift, thereby potentially freeing up valuable floor space for relocation of a liquid chemical feed system (i.e. Calciquest mixing/batching system and residuals pre-treatment). Another area to be considered for more efficient use of existing space is the sodium permanganate area, which is presently not used, while the adjacent ferric chloride storage is insufficient. Ideas such as these will be evaluated and presented to PWW staff for consideration.

We also recognize that PWW achieves operational efficiencies for its remote water systems through the bulk delivery and storage of treatment chemicals for these remote water systems at the Nashua Treatment Plant, which are subsequently transferred by PWW operators to the respective remote water systems as needed. Our evaluation will consider these chemical transfer operations with respect to operator safety and efficiency.

In addition to the chemical feed system infrastructure (tanks, pumps, piping), we will consider the local chemical feed control panels and associated instrumentation in our evaluation. The existing control panels are non-PLC based. Current technology has advanced to PLC based control panels for chemical feed systems, which simplify the communications between these local control panels and the facility’s main control panel. Our evaluation will focus on function (does existing panel satisfactorily perform its required functions), condition (what is the estimated remaining service life) and availability of spare parts. For example, a conversion to a PLC based control panel may seem to be a logical next step (if replacement is warranted) but recently issues within the global supply chain have created lengthy delivery times for PLC components, in comparison to non-PLC control system components. Any need to replace/upgrade the local chemical feed system control panels must also consider any planned or potential instrumentation and control system changes for the overall facility.

We are advocates for “keeping it simple” which tends to minimize costs and facilitates operation. As part of our evaluation, we will consider the possible use of an early warning system for changing water quality. For a similar surface water treatment facility with highly variable raw water quality (Pawtucket, RI), we provided an online Total Organic Carbon (TOC) analyzer which the operators have found indispensable for providing an early indication of impending water quality changes. This early warning in combination with the operator’s institutional knowledge of the treatment chemistry needed for each condition results in a pro-active operation, rather than having to react to crises. In a reactive mode, raw water quality changes can disrupt the coagulation chemistry and associated floc blanket in the Pulsator clarifier, with subsequent floc carryover onto the gravity filters that can result in “blinding” of the filters and triggering of pre-mature backwashes. Worst case, this chain reaction can effectively halt production of the treatment facility, as filters are queued for backwashing unnecessarily.

Ultimately, we will identify the various options for any of these modifications to the PWW for consideration, with a summary of the associated advantages and disadvantages for each.

5.0 Detailed Scope of Work & Budget

As noted in Section 4.0, Project Understanding, the project consists of an evaluation of the PWW Nashua Treatment Plant's existing chemical feed systems and chemical storage capacities, in light of the recent supply change from Pennichuck Brook to the Merrimack River. The evaluation will be comprehensive for all chemical feed systems and include an assessment of remaining service life of system components, assessment of chemical storage requirements versus available space, and assessment of future storage requirements based on projected maximum facility flows. Additionally, we will review current location of chemical storage/feed areas relative to injection points in an effort to minimize the potential for chemical feed system problems, increase operational efficiencies and minimize safety issues.

Our detailed scope of services is separated into the following distinct phases:

- Initial Data Review and Data Confirmation
- Condition Assessment
- Capacity Analysis
- Conceptual Design and Recommended Improvements

Initial Data Review and Data Confirmation

- Visit the facility to review and confirm the various project goals with PWW, including discussion of the water treatment chemical optimization process experienced by PWW operators, to discern any nuances in the two water supply sources based on PWW's institutional knowledge.
- Review historical raw water quality information, identifying the variability (range) for key constituents and any potential trends (i.e., storm events trigger spikes in turbidity). Conduct statistical analysis of historical water quality data in conjunction with weather conditions to be used to create a more realistic projection of "worst case" conditions and the anticipated frequency such events are expected to occur.
- Review historical chemical dosages (as optimized by PWW) and conduct independent calculations to confirm the historical chemical volumes required.
- Review peak flow projections for the treatment facility, including consideration of frequency/duration of peak flow periods, which will form the basis of chemical feed system capacity analysis.
- Obtain information on chemical use for remote sites, including anticipated future changes (additional small systems acquired/operated by PWW in the future).
- Summarize the information that was reviewed and confirmed, for discussion with PWW, to establish the data upon which our analysis will be based.

Condition Assessment

- Visit the facility to assess the field condition of each chemical feed system component including the collection of nameplate data and installation date.
- Develop summary list of chemical feed system components that will highlight the component, relative condition (good, fair, poor), age and theoretical service life per water

industry practice. Equipment list will also identify any current limitations or historical problems that PWW experiences with the equipment.

- Evaluate existing local control panels and related local instrumentation for each chemical feed system relative to function and reliability.
- Summarize our findings in tabular form for review by PWW, essentially identifying the relative condition and need for replacement/upgrade of any specific components.

Capacity Analysis

- Review and tabulate the capacities of each chemical feed system, in its current condition, based on the max volume (tanks) or rated capacity (pumps).
- Calculate the required chemical feed pump rates and chemical tank volumes for each chemical feed system, based upon the range of current and anticipated chemical dosages and treatment facility flowrates. An important consideration for high capacity treatment facilities is to ensure that the chemical feed pumps can handle the wide range of treatment conditions (low flow and low dosages up to high flows and high dosages), sometimes requiring multiple pumps to cover the full range successfully.

- Calculate the required chemical storage for PWW remote sites, where chemical storage needs to be accounted for at the Nashua Treatment facility, in conjunction with the chemicals needed directly for the Nashua Treatment Facility.
- Chemical storage volume requirements will be determined using regulatory guidelines (i.e., 30 days storage of chemical onsite), delivery volume considerations and remote site chemical requirements based on PWW chemical transfer methods.
- Identify any deficiencies in the capacity of each chemical feed system, including the current limitations (i.e., what flow and dosage can the existing equipment handle).

Conceptual Design and Recommended Improvements

- Evaluate the existing chemical feed systems and areas in terms of configuration, location with respect to ultimate injection point(s), ability to handle projected capacity requirements and operator safety.
- Evaluate the existing chemical feed systems in terms of operator flexibility (or limits), such as the current limitations of the ferric chloride system during fill operations.
- Evaluate existing dry chemical storage area (pallets of bagged chemical) to determine if additional chemical storage space can be obtained through optimization of the available vertical space (i.e., pallet racks to store vertically with access via forklift). Additional space gained in this area could be considered for relocation of the existing chemical feed systems that were added “after the fact” within the Pipe Gallery and within the Finished Water Chemical Feed Room (i.e., Calciquest).

5.0 Detailed Scope of Work & Budget

- Evaluate existing systems/practices for transfer of chemicals from the Nashua Treatment Facility to the various remote PWW water systems, with specific focus on maintaining or improving safety for operators.
- Evaluate local chemical feed control panels and associated instrumentation to identify any existing deficiencies and potential improvements. The existing control panels are non-PLC based. Current technology has advanced to PLC based control panels for chemical feed systems, which simplify the communications between these local control panels and the facility's main control panel. Our evaluation will focus on function (does existing panel satisfactorily perform its required functions), condition (what is the estimated remaining service life) and availability of spare parts. For example, a conversion to a PLC based control panel may seem to be a logical next step (if replacement is warranted) but recently issues within the global supply chain have created lengthy delivery times for PLC components, in comparison to non-PLC control system components. Any need to replace/upgrade the local chemical feed system control panels must also consider any planned or potential instrumentation and control system changes for the overall facility.

- Develop conceptual layout plans for proposed improvements, for review and consideration by PWW. Up to three (3) different conceptual layouts will be prepared.
- Summarize the evaluation and recommendations, for presentation to PWW in conjunction with the conceptual layout plans for the chemical feed systems.
- Estimate the project implementation cost for any recommended improvements, inclusive of engineering and construction costs. Cost estimates will include capital cost expenditures and life cycle cost analysis.

Assumptions

PWW shall be responsible for providing the following:

- Historical water quality;
- Chemical information and/or any requested specialty testing (i.e., organics speciation);
- Access to the facility;
- Sampling data;
- Disinfection by-product data;
- Original Plant upgrade plans (AutoCAD format) and FS&T study; and
- Project management and coordination of PWW staff and resources to assist the CEI team.

5.0 Detailed Scope of Work & Budget

Schedule

CEI understands that PWW anticipates the project to be completed by November 1, 2022 to allow any selected modifications/improvements to be designed and implemented in 2023 and 2024. CEI can meet the proposed deadline as follows:

- **July and August 2022** – Completion of the Initial Data Review, Data Confirmation and Condition Assessment (first and second tasks identified in our detailed Scope of Work).
- **September 2022** – Completion of the Capacity Analysis (third task identified in our detailed Scope of Work).
- **October and November 2022** – Completion of the Conceptual Design and summary of Recommended Improvements (fourth task identified in our detailed Scope of Work). By November 1st, a rough layout of recommended upgrades will be provided as well as a budgetary estimate for the cost of improvements.

Budget

CEI's budget, based on our detailed Scope of Work, is $87,020.

A detailed budget sheet is attached to this section.

FEE PROPOSAL FOR CONSULTING ENGINEERING SERVICES
PWW NASHUA TREATMENT PLANT - CHEMICAL FEED SYSTEM UPGRADES

June 10, 2022

Task	Description	Project Director $235.00	Project Manager $225.00	Project Scientist I $150.00	Project Scientist II $120.00	Senior Engineer $150.00	Project Engineer $125.00	I&C Electrical $225.00	Technical Review $130.00	Expenses
1	**Initial Data Review and Confirmation**									
	Initial Kickoff Meeting and Data Gathering	2	2	0	8	4	0	0	0	$500
	Review historical water quality information	2	2	4	32	0	0	0	2	$0
	Review/confirm optimized chemical dosages	2	2	4	16	0	0	0	2	$0
	Review/confirm future WTP flow projections	2	2	0	0	16	0	0	0	$0
	Obtain information on chem use for remote sites	2	2	2	8	0	0	0	0	$0
	Coordination Meeting with PWW Staff	4	4	2	4	0	0	0	2	$500
	Internal Review	2	2	0	0	0	0	0	2	$0
	SUBTOTAL (hours)	16	16	12	68	20	0	0	8	
	SUBTOTAL (cost)	$3,760	$3,600	$1,800	$8,160	$3,000	$0	$0	$1,040	$1,000
	TASK SUBTOTAL (cost)									**$22,360**
2	**Condition Assessment**									
	Site visit to assess field condition	0	4	8	0	8	0	0	0	$500
	Obtain detailed asset info (nameplate, date)	0	4	8	0	8	0	0	0	$0
	Develop summary table of equip/function/life	0	0	8	0	8	0	0	0	$0
	Instrumentation/Electrical (SAR)	0	0	0	0	4	0	0	8	$0
	Coordination Meeting with PWW Staff	4	4	0	4	4	0	0	0	$0
	Internal Review	0	0	0	0	0	0	0	4	$0
	SUBTOTAL (hours)	4	12	24	4	32	0	0	12	
	SUBTOTAL (cost)	$940	$2,700	$3,600	$480	$4,800	$0	$0	$1,560	$500
	TASK SUBTOTAL (cost)									**$14,580**
3	**Capacity Analysis**									
	Review/summarize existing system capacities	2	2	0	8	8	0	0	0	$0
	Calculate/confirm future chem feed cap req'd	2	2	0	8	8	0	0	0	$0
	Calculate/confirm chem feed for remote sites	2	2	0	8	8	0	0	0	$0
	Develop potential ranges (worst case vs best case)	2	2	0	8	8	0	0	0	$0
	Coordination Meeting with PWW Staff	4	4	0	0	0	0	0	0	$500
	Internal Review	0	0	0	0	0	0	0	4	$0
	SUBTOTAL (hours)	12	12	0	32	32	0	0	4	
	SUBTOTAL (cost)	$2,820	$2,700	$0	$3,840	$4,800	$0	$0	$520	$500
	TASK SUBTOTAL (cost)									**$15,180**
4	**Conceptual Design / Reconfiguration**									
	Evaluate configuration of chem feed spaces	4	8	0	8	8	0	0	4	$0
	Evaluate location of injection points and feed lines	0	0	4	4	0	0	0	0	$0
	Develop draft layouts (up to 3 alternatives)	0	0	0	0	24	24	0	0	$0
	Instrumentation/Electrical (SAR)	0	0	0	0	0	0	8	0	$0
	Summarize recommendations for PWW meeting	0	0	0	0	16	0	0	0	$0
	Develop cost estimates for proposed upgrades	2	2	0	4	8	0	4	0	$0
	Coordination Meeting with PWW Staff	4	4	0	4	4	0	0	0	$500
	Revise concepts per PWW Meeting	2	2	0	0	16	16	0	0	$0
	Final report	4	4	0	0	20	0	0	0	$0
	Internal Review	0	0	0	0	0	0	0	4	$0
	SUBTOTAL (hours)	16	20	4	20	96	40	12	8	
	SUBTOTAL (cost)	$3,760	$4,500	$600	$2,400	$14,400	$5,000	$2,700	$1,040	$500
	TASK SUBTOTAL (cost)									**$34,900**
TOTAL ESTIMATED PROJECT COST										**$87,020**

PENNICHUCK

Response to Request for Proposals

Nashua Treatment Plant Chemical Feed System Upgrades

June 10, 2022

Table of Contents

Hazen
Hazen and Sawyer
1750 Elm Street, Suite 402
Manchester, NH 03101 • 603.657.2581

June 10, 2022

John M. Boisvert, PE, Chief Engineer
Hannah Marshall, EIT, Project Manager
Pennichuck Water Works, Inc.
25 Walnut Street, PO Box 428
Nashua, NH 03061-0428

Re: Response to Request for Proposals - Nashua Treatment Plant Chemical Feed System Upgrades

Dear Mr. Boisvert and Ms. Marshall:

Pennichuck Water Works, Inc. (PWW) is dedicated to providing its customers with exceptional service and a high quality, reliable supply of drinking water. Hazen and Sawyer (Hazen) is eager to assist PWW with evaluating the Nashua Water Treatment Plant existing chemical feed system with the goal to meet your needs now and into the future. Hazen brings PWW a robust team of experienced advisors and engineers to deliver effective and reliable solutions to community drinking water needs. Our approach is simple, we strive for:

Technical excellence in water treatment: Hazen offers a team of unparalleled and specialized experts covering all aspects of water treatment process, design, construction, and start-up.

Collaboration: We will be your partner and a committed team member. Our approach relies heavily on close and continuous communications with you coupled with regular workshops. Our team will be led by our **Project Manager, Marc Morin, PE** and **Project Engineer, Patricia Kelliher**, interfacing directly with the PWW throughout all phases of the work.

Responsiveness: We are "right sized", offering the responsiveness of a local firm with a core team comprised of local New England resources supplemented by national experts. This staffing approach has been successfully implemented on several water treatment projects in New England and across the nation, resulting in proven on-time and on-budget delivery of high quality projects for our clients.

We are enthusiastic about the prospect of working with PWW and thank you for this opportunity. If you have any questions or require further information, please contact me by phone at (603) 219-9526, or by email at mmorin@hazenandsawyer.com.

Sincerely,

Marc Morin, PE
Senior Associate / Proposed Project Manger

Executive Summary

OUR TEAM

Our dedicated team of professionals bring the water quality and chemistry expertise needed to evaluate existing systems and develop improvement recommendations as well as design professionals capable of implementing recommended improvements through design and construction.

Project Manager
Marc Morin, PE

Water Quality
Erik Rosenfeldt, PhD, PE

Cost Estimating
Rose Jesse, CPE

Project Engineer
Patricia Kelliher

☑ **Experienced Technical Advisor**
Matthew Valade, PE, BCEE

☑ **Chemical Feed System Designer**
Alison Platt, PE

☑ **Process Mechanical**
Jacob Cantor, PE, ENV SP

☑ **Permitting Expertise**
Saya Hickey, PE
Katie Hoek, PE

☑ **Funding Lead**
Seth Robertson, PE

OUR EXPERIENCE

PWW can confidently select Hazen knowing that we have extensive experience with water quality and treatment challenges that are driving this project. This experience will help us work with PWW to deliver a solution to continue delivering safe and high quality drinking water.

Technical Excellence in Water Treatment

Collaboration

Responsiveness

Sebago Lake Water Treatment Facility
Chemical Storage Tanks CIP Development
Portland Water District, Portland, ME

MWRA Agency-Wide and Carroll WTP Technical Assistance Contracts
Massachusetts Water Resources Authority, Boston Metropolitan Area, MA

Saco River Water Treatment Facility
Maine Water Company, Biddeford, ME

Revitalization of Existing Water Supplies
City of White Plains, White Plains, NY

Rye Lake Water Filtration Plant Design
Westchester Joint Water Works (WJWW)
Westchester County, NY

OUR APPROACH

We understand the core challenges of upgrading the treatment plants chemical feed systems, and have delivered an approach to efficiently address them. **Our approach will deliver cost effective solution that will allow PWW to confidently utilize the Merrimack River as its primary raw water source, despite water quality variability and turbidity,** and position itself to address regulatory challenges.

Evaluate Existing Facilities

Develop and Screen Alternatives

Maximize Present-Day and Future Value

Hazen

Section 1:

Statement of Interest

Section No. 1

Statement of Interest

Hazen stands ready to assist PWW by bringing a unique team of highly qualified advisors and engineers to aid PWW with your near and long term goals. By leveraging this expertise, we will provide technically sound recommendations and maximize available funding.

PWW recently switched to the Merrimack River as its primary raw water source. Due to variable water quality and turbidity have resulted in existing chemical feed systems operating near capacity. As such, PWW is undertaking upgrades to its chemical feed systems at its Nashua Treatment Plant. The Hazen team has the right experience, knowledge, and expertise to help PWW complete this important project.

To ensure a successful project that will meet PWW needs not only today, but also well into the future as a changing climate continues to increase the variability and unpredictability of water resources, the selected team must possess extensive design, planning, and regulatory expertise. The team we have assembled understands the challenges of planning in the face of uncertainty, and stands ready to work with PWW develop the right solution.

Hazen will provide PWW with access to the experts identified in our proposal, and commits that the national experts on our team will actively work on the project. It is Hazen's philosophy to provide our clients with proven, local project leadership, alongside our foremost technical experts for each project, regardless of where they are located. Our project management team, located in Manchester, NH, will leverage the full depth our national resources to develop the right solution. Furthermore, though our national experts may not be local, we will not charge for travel expenses for their attendance at in-person project meetings and site visits.

Hazen's intent is to work collaboratively with PWW to develop a solution to the current chemical feed pumping and capacity concerns at the Nashua Water Treatment Plant. Hazen has the resources to successfully complete the evaluation by November 2022 to ensure funding schedule compliance. Over the past ten years, Hazen has secured and administered over $4.1B in grant and loan funding to support capital water infrastructure projects. Our experience allows us to conform with complex permitting, engineering, and contract requirements to minimize impacts to project costs and schedules.

Technical Excellence in Water Treatment

Collaboration

Responsiveness

Existing PWW sodium hydroxide chemical feed pumps. New chemical feed pumps could be replaced in the existing facility, or located in a new structure nearby.

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Section 2:

Past Experience and References for Similar Projects

Section No. 2

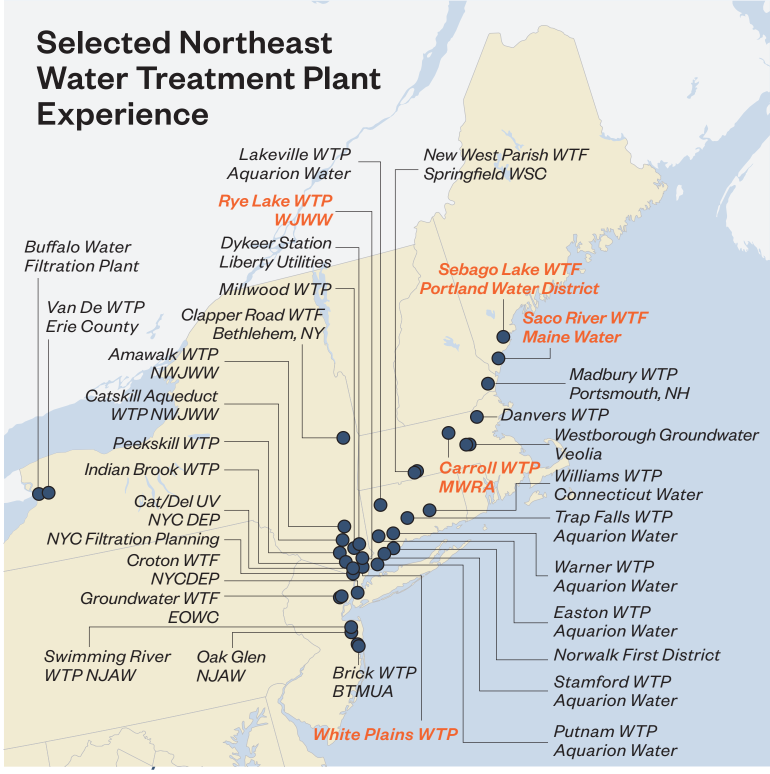
Past Experience and References for Similar Projects

Our clients rely on us to help them deliver safe, consistent, high quality drinking water with cost effective solutions. PWW can confidently select Hazen with the knowledge that we have the hands-on experience needed to deliver a cost-effective and operator friendly solution.

Water Treatment Experience

Hazen has provided a wide range of evaluation and design services for water treatment plants across the Northeast, covering the full scope anticipated under this project. Several of these water treatment projects involved accelerated schedules to meet regulatory, consent order, and/or funding deadlines. Our team brings world class drinking water experience, a detailed understanding of what it takes to meet the needs and challenges unique to the Plant, industry leading chemical feed systems and design experience, and a proven ability to navigate state and federal permitting, regulation and funding requirements.

Hazen has provided a wide range of services at water treatment plants across the Northeast. The below map shows selected northeast water treatment plant experience, ***highlighting our key projects in orange.***



Hazen's Northeast Region

Over 250 employees supported by over 1,400 additional staff nationwide

Treatment Plants

7,610 mgd

Our proposed team has a history of working together to deliver water treatment projects across the Northeast. The majority of our proposed key disciplines have supported our reference projects.

Hazen has significant experience in all chemical feed aspects needed for the proposed project. We have completed multiple projects in New England in which chemical storage and feed has been a major component of the project. **On the following pages, we have highlighted five projects, as shown in Figure 2-1, each were completed within the past five years, demonstrate our team's capabilities** and experience delivering similar solutions for clients, and also provide insight into the **creative solutions that we have developed with similar chemical facility design and construction projects.**

🟦 *Evaluation* 🟧 *Design* 🟩 *Construction*

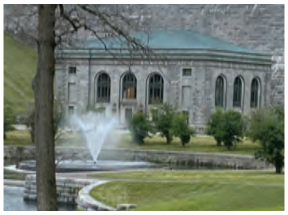
PROJECT	RELEVANCY	2017	2018	2019	2020	2021	2022
 **Sebago Lake Water Treatment Facility Chemical Storage Tanks CIP Development** Portland Water District, Portland, ME	Evaluation of chemical feed and storage equipment. An alternatives analysis with associated lifecycle costs was completed comparing the options to utilize the existing space within the treatment facility versus a new building.					🟦	🟦
 **MWRA Carroll WTP Technical Assistance Contract** Massachusetts Water Resources Authority, Boston Metropolitan Area, MA	Work collaboratively with MWRA on a variety of projects for the Carroll Water Treatment Plant, including an evaluation of the chemical feed system.			🟦 🟧	🟦 🟧	🟦 🟧	🟦 🟧
 **Saco River Water Treatment Facility** Maine Water Company, Biddeford, ME	The new water treatment facility included the design of the chemical feed system for treatment of Maine Water Company's raw water source, the Saco River.		🟦	🟧	🟩	🟩	🟩
 **Orchard Street Water Treatment Design and Chemical Systems** City of White Plains, White Plains, NY	Developed deign criteria for the design of new above ground bulk fluoride storage, evaluation of existing sodium hypochlorite storage and feed facilities, and developed site layouts for truck deliveries.	🟦	*Preliminary* 🟧		*Final* 🟧	🟧	
 **Rye Lake Water Filtration Plant Design** Westchester Joint Water Works (WJWW) Westchester County, NY	Chemical systems, including tanks and pumps, were designed for full plant flow range 3 to 30 mgd, with an average plant flow of 15 mgd.		🟦		*Preliminary* 🟧	*Final* 🟧	

Figure 2-1

Project #1

Sebago Lake Water Treatment Facility Chemical Storage Tanks Capital Improvements Plan Development

Portland Water District, Portland, ME

The evaluation included recommendation to ensure continued long-term reliability and resiliency of the chemical system at the facility. Hazen collaborated with PWD, to ensure PWD's ideas, experiences, and preferences are integrated into the final recommendations. The following key findings were determined during the study; recommendations regarding tank inspection criteria/objectives to support future inspection service procurement(s) by PWD; a prioritized plan for upgrade of the chemical storage (bulk storage and day tanks); piping and pumping facilities for continued reliable service; and budgetary cost estimates for each phase of the recommended projects.

The chemical feed system was designed during the Sebago Lake Water Treatment Facility (SLWTF) design and went into service in 1994. The chemicals stored at SLWTF include aqua ammonia (ammonium hydroxide), hydrofluosilicic acid, zinc orthophosphate, and sodium hydroxide (caustic). In 2006, sodium hypochorite replaced chlorine gas for secondary disinfection. Each chemical listed above is injected in the 60-inch finish water line in the UV Facility.

Due to the existing space constraints within the building, Hazen worked with PWD to determine the optimal components of the project. The recommendations included vertical tanks rather than horizontal tanks and to minimize the footprint of a new chemical building alternative. In addition to the style of each tank and meeting the volume requirements for each system, new bulk storage tanks included, the following features: access manways, a fill line, a draw off line, an overflow, a drain line with isolation valve, a level transmitter, a sample tap, a visual level indicator, and a vent to discharge vapors from the tanks to the outside the building. Hazen also evaluated and recommended tank materials and budgetary costs.

Project Relevancy

- Chemical feed and storage equipment
- Evaluation of existing chemical storage
- Alternatives analysis for improvements utilizing existing space vs. new building
- Lifecycle cost analysis

Project Status

Evaluation Completed: May 2022
Based on the lifecycle cost analysis, PWD plans to modify the layout of the chemical feed storage area

Key Personnel

Marc Morin, PE
Project Manager
Patricia Kelliher
Project Engineer
Rose Jesse, CPE
Cost Estimating Lead
Scott Bonett, PE
Project Director

Reference

Paul Rodriguez, PE Senior
Project Engineer
Portland Water District
(207) 774-5961
prodriguez@pwd.org

Insights

✓ **Quality of Work:**
"We really appreciate your teams efforts on this important planning project, great job." Paul Rodriguez, PE, PWD

✓ **Budget:**
20% under budget

✓ **Responsiveness:**
Regular virtual correspondence per client request
Deliverables completed on schedule

1010-644

Project #2

MWRA Carroll WTP Technical Assistance Contract

Massachusetts Water Resources Authority,

Boston Metropolitan Area, MA

MWRA utilizes two-year "As-needed (on-call) Technical Assistance Contract" as one means to engage one of the two selected engineering consultants in specific areas.

Hazen was awarded the MWRA John. J Carroll As Needed Technical Assistance Contract in 2018, and subsequently selected for a second consecutive contract in 2020. This contract involves the provision of engineering services for needs at the 405-mgd John J. Carroll WTP and associated water resources infrastructure on an on-call basis.

Under this contract, Hazen has completed evaluations of chemical systems, HVAC systems and fire suppression systems within the Carroll Treatment Plant. Hazen has provided a diverse range of services through these two consecutive contracts. Under Contract 7543, Hazen conducted an evaluation of the ozone aqua ammonia, fluoride, and soda ash storage and feed systems at the Carroll WTP. The Authority desired a review of these four chemical systems to improve redundancy, reliability, and operability. Specific areas of interest included ozone system energy savings, desired replacement of ammonia feed lines, potential corrosion within the fluoride storage and feed system and clogging within soda ash feed equipment. A critical part of the project was collaboration with Authority staff to ensure their experience, ideas and preferences were incorporated into the proposed improvements. **The evaluation included the generation of concept level capital costs and annual operations and maintenance costs for each chemical to provide the tools for an informed decision regarding specific approaches to upgrading equipment.** Findings were summarized in a Technical Memorandum.

In addition, several tasks have been associated with HVAC upgrades to specific areas of the treatment plant. Also, Hazen facilitated panel-based workshops which brought subject experts together to collaborate with MWRA on corrosion control and distribution system water quality. Hazen recently completed the design of improvements to the Wachusett Lower Gatehouse, including new large diameter piping and valves. The project also include upgrades to the building heating system and lead/asbestos abatement.

Project Relevancy

- Water Treatment Facility Planning and Design
- Chemical System Evaluation

Project Status

Contract 7453: Completed 12/2020
Contract 7456: Completed 12/2020
Contract 7713: 11/2020 - Present

Key Personnel

Scott Bonett, PE
Project Manager
Matthew Valade, PE, BCEE
Principal
Rose Jesse, CPE
Cost Estimating Lead

Reference

William Sullivan, PE
Senior Program Manager
Massachussetts Water Resources Authority
(617) 570-5435
william.sullivan@mwra.com

Insights

✓ **Quality of Work:** Quality control plan met measures and regulations

✓ **Budget:** Adherence to budgetary goals

✓ **Responsiveness:** Rapid response when needed

1010-644

Project #3

Saco River Water Treatment Facility

Maine Water Company, Biddeford, ME

The Maine Water Company selected Hazen to provide engineering, design and project administration services for a new 12-mgd drinking water treatment facility to replace its conventional surface water treatment facility in Biddeford, ME. The existing and new treatment facilities draw water from the Saco River.

The project includes construction of new raw water intake and pumping facility adjacent to the Saco River, raw water transmission main, a new water treatment facility including chemical feed and storage, inclined plate settler (IPS) clarification, dual media filtration and chlorine disinfection.

Additional processes have been provided for residuals handling. The design includes all facility disciplines including civil, architectural structural, mechanical process, HVAC/plumbing, and electrical/I&C. The project is using an alternative delivery process where Hazen is part of a collaborative team including the Owner and the Construction Manager at Risk (CMAR). Hazen assisted Maine Water in preparation of the RFQ, RFP, and selection of the CMAR during the preliminary design phase.

Hazen's scope of work included:

- Concept design phase including the selection of a water treatment process and bench scale testing.
- Preparation of a concept design report including project siting evaluation.
- Preparation of a basis of design report.
- Preparation of GC contract documents and specifications.
- Leading the Envision process and pursuit of an Envision award for the project.

Insights

✓ **Quality of Work:**
Startup is progressing smoothly and all process equipment is performing within design parameters

✓ **Budget:**
Hazen worked closely with the Owner and Contractor to pro-actively evaluate project costs and provide value engineering recommendations

✓ **Responsiveness:**
The CMAR delivery process required a high level of collaboration to meet project delivery and quality goals

Project Relevancy

- .Sized new chemical feed systems for current and future capacity needs (12 mgd - 18 mgd)
- Designed to accommodate variable water quality from river source
- Reused assets from existing treatment plant and maintained plant operations during conversion

Project Status

Scheduled to be completed June 2022

Key Personnel

Marc Morin, PE
Project Manager
Rose Jesse, CPE
Cost Estimating Lead
Jacob Cantor, PE, ENV SP
Project Engineer

Reference

Richard Knowlton
President
Maine Water Company
1 800 287-1643
Rknowlton@mainewater.com

Flocculation basin hydrostatic testing.

Project #4

Orchard Street Water Treatment Design and Chemical Systems

City of White Plains, White Plains, NY

Hazen has been providing professional engineering services to the City of White Plains for over 20 years. Assignments have included water treatment pilot testing, water quality analysis, pump station and chemical system improvements, distribution system hydraulic and water quality modeling, demand evaluation and storage tank sizing and design, membrane microfiltration and DAF design. Some of these assignments are summarized below.

Existing Chemical System Analysis and Fluoride Replacement: The City has a long term policy of removing any underground fuel or chemical storage tanks at its facilities. Thus the existing underground fluoride tanks at Orchard Street Pump Station will be removed and replaced with above-grade storage tanks. The Central Ave Pump Station fluoride system is complete and has been in operation for two years.

Hazen worked with the City to develop design criteria and design new above grade bulk fluoride storage systems. Hazen reviewed the existing sodium hypochlorite storage and feed facilities within both pump stations for compliance with current regulations and building codes, and provided recommendations for improvements. Hazen also developed site layouts and improvements for truck deliveries and spill containment for delivery trucks.

Treatment for the City's Reservoir Supply: The City is committed to diversifying its water supply and providing system redundancy to reduce its reliance on other entities. White Plains currently obtains all its drinking water from New York City's (NYC's) water system. Over 120 years old, the NYC supply pipeline is the City's sole source of water for a population of over 56,000 residents. Hazen studied solutions to provide partial redundancy and increase reliability of the City's water supply: conducting a yield analysis on the city-owned reservoirs and wells, **analyzing the raw water quality,** determining feasibility of treatment, developing a concept design and costs for treatment of the supplies, and identifying and obtaining necessary water supply permits.

The proposed 2.5-mgd WTP will provide filtration, disinfection, and removal of PFAS compounds from the In-City water supplies with unit processes that include granular activated carbon (GAC) and ultraviolet disinfection. The **chemical systems include carbon dioxide, coagulant, sodium hypochlorite, sodium hydroxide,** orthophosphoric acid, and hydrofluosilicic acid. The process must fully treat the water supply to produce water with very similar quality and pressure to combine with the NYC water at their storage tanks.

Project Relevancy

- Design future capacity needs
- Chemical systems modifications

Project Status

Design completed: 2021
Construction phase pending approval of state regulators

Key Personnel

Kristen Barrett, PE
Project Manager
Matthew Valade, PE, BCEE
Technical Advisor
Alison Platt, PE
Chemical Feed System Design Engineer
Jacob Cantor, PE, ENV SP
Process Mechanical Engineer

Reference

Udomlug (Nok) Siriphonlai, PE
Deputy Commissioner of Public Works
City of White Plains
(914) 422-1212
USiriphonlai@whiteplainsny.gov

Insights

✓ **Quality of Work:**
The study phase of the project was awarded NYS ACEC Diamond award in 2022. The submission was endorsed by the client.

✓ **Budget:**
Design completed on budget.

✓ **Responsiveness:**
Client was satisfied with project responsiveness and adjustments made throughout the duration of the project.

Project #5

Rye Lake Water Filtration Plant Design

Westchester Joint Water Works (WJWW), Westchester County, NY

WJWW is undertaking the development of a new 30-mgd water filtration plant for its Rye Lake water source to comply with disinfection byproduct regulations and USEPA's Surface Water Treatment Rule. The filtration plant will give WJWW more control over removal of disinfection byproduct precursors and better ability to routinely comply with the Stage 2 Disinfectants and Disinfection Byproducts Rule. The facility will be a 30-mgd dissolved air flotation/filtration (DAFF) plant capable of handling WJWW's current and near-future demands. The design will also integrate provisions for potential future expansion to 40 mgd.

Permitting and Environmental Review: Hazen is leading the permitting efforts for local, regional, state and federal permits, including SPDES discharge permits and wetlands permitting. Hazen is supporting development of the project Environmental Impact Statement and review process.

Chemical Systems: **Chemical systems, including tanks and pumps, were designed for the full plant flow range of 3 to 30 mgd, with an average plant flow of 15 mgd.** Each chemical room, including containment, was sized for the potential future maximum flow of 40 mgd. The chemical systems for the initial 30-mgd installation include coagulatant, sodium hypochlorite, sodium hydroxide, corrosion inhibitor, and hydrofluorosilicic acid, reserved for coagulant aid polymer and carbon dioxide in the future.

Chemical Delivery and Containment: Extensive discussion was made for chemical delivery and containment outdoors. **Hazen carefully worked within space constraints and the design team worked closely with WJWW's operations staff to design a chemical feed system that would have a belt-and-suspenders approach to preventing chemical spills during delivery.** A chemical containment area was designed next to the building to address risks associated with chemical delivery spills.

Site Assessment: This site provides proximity to WJWW's Rye Lake Pump Station, Rye Lake source water transmission main, Purchase Street Storage Tanks, and Purchase Street Booster Pump Station. Hazen performed site assessment studies including natural resources investigations (wetland delineations, endangered species, tree tagging and surveying), a Phase I Environmental Site Assessment, a Stage I Cultural Resources Survey, and a geotechnical investigation program with groundwater sampling.

Funding Support: Hazen is currently working with WJWW to obtain BIL, WIIA and SRF funding for the 30-mgd Rye Lake WFP. The rapid deadlines and specific requirements are communicated with the Hazen design team and WJWW finance team to aid in obtaining grants and loans.

Project Relevancy

- Site assessment
- Disinfection byproduct regulations
- Limited/constrained facility footprint
- Stakeholder outreach and communication

Project Status

Completion of final permitting in preparation for construction of Hazen's design

Key Personnel

Eileen Feldman, PE
Project Manager
Matthew Valade, PE, BCEE
Technical Reviewer: QA/QC
Rose Jesse, CPE
Lead Cost Estimator
Ruby Wells
Funding

Reference

Paul Kutzy, PE
Manager
Westchester Joint Water Works
(914) 698-3500
pkutzy@wjww.com

Insights

✓ **Quality of Work:**
Maintained high quality standards at each check point throughout the duration of the project

✓ **Budget:**
Project is currently within budget

✓ **Responsiveness:**
Through regular client meetings and frequent informal calls, Hazen has worked in close cooperation with WJWW to advance design, permitting, land acquisition and environmental review

The detailed design of the RLWFP has been compressed into a 12-month design period to accelerate the schedule to advance permit review and approvals from various agencies.

Section 3:

Project Team

Section No. 3

Project Team

Hazen has assembled a specialized team of water treatment plant design experts, and discipline leaders for this important project. They will work closely with PWW to successfully evaluate the Plant's existing chemical feed systems and chemical storage capacities.

The Hazen Team

Hazen is committed to providing a highly qualified, responsive team to this critical project. The Hazen team has been organized with individuals selected to address all aspects of the work required for the evaluations and possible design and construction management services. Both our proposed **Project Manager, Marc Morin, PE** and **Project Engineer, Patrica Kelliher,** live within 20 minutes, and work in our Manchester, NH office, and will be readily available when necessary.

The Nashua Treatment Plant Chemical Feed System Upgrades project and the required scope is well aligned with Hazen's experience and skillsets.

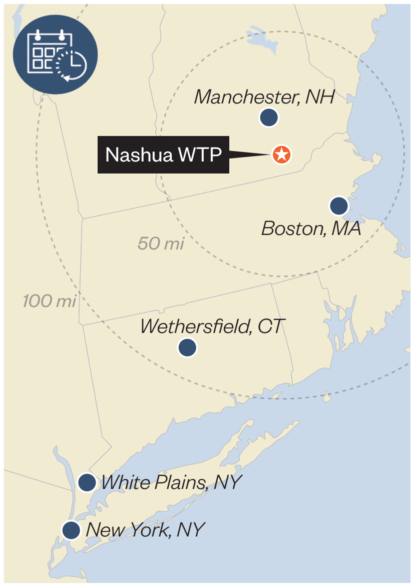
Availability and Resources

Our team will be ready to start the project and meet PWW's schedule. The We will work closely with PWW to gain valuable insight and achieve the best possible outcome for this project. We understand the overall project is approximately three years in duration and requires skillsets in evaluation and dependent on the outcome of the evaluations possibly design and construction management services.

Our organizational chart was developed with both ability and availability in mind. We affirm that our entire management and technical leadership team is committed to seeing this project through completion. The level of effort hours is addressed in Section 5 - Detailed Scope of Work and Budget, Table 5.1.

Following the organizational chart (**Figure 3-1,** shown on **page 3-13**) we provide a brief biography for our key team members. Resumes for all team members can be found in **Appendix A.**

Local Hazen Offices



Our local project management team will be responsive to PWW and present on-site throughout the project.

Multi-Disciplinary Personnel

- Environmental Scientists
- Environmental Engineers
- Civil Engineers
- Water Resource Experts
- Solid Waste Engineers
- Sanitary Engineers
- Structural Engineers
- Mechanical Engineers
- Electrical Engineers
- Chemical Engineers
- Change Order/Cost Engineers
- I&C Engineers
- Geologists
- Hydrologists
- Economists
- Architects
- CAD/Designers
- Public Relations Experts

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Marc Morin, PE I Project Manager

Mr. Morin is a Senior Associate with the firm and has 36 years of extensive experience with management, design and construction of water and wastewater engineering projects. **Mr. Morin has been involved in numerous water treatment, storage and distribution projects throughout New England.** Most recently, Mr. Morin served as the Project Manager for the design and construction of the new 12-mgd Saco River WTP for the Maine Water Company in Biddeford, Maine. This project is being constructed under a CMAR delivery model and included extensive value engineering efforts with both the Owner and Contractor. He also recently completed an evaluation of chemical storage facility upgrades for the Portland Water District's Sebago Lake Water Treatment Facility.

Given the scope and importance of this project, Mr. Morin will work closely with our proposed Project Engineer, Patricia Kelliher, to ensure comprehensive, responsive, and detail-oriented service. **Mr. Morin will be present for all required onsite work and review and coordination meetings that are necessary to aid in the success of the project.** Mr. Morin will work closely with Ms. Kelliher and support her in coordinating the design disciplines. Mr. Morin is very familiar with NHDES requirements and will ensure compliance requirements, as applicable.

36
Years of
Experience

Benefits

- ✓ Recent relevant experience with chemical system evaluations
- ✓ Extensive experience with WTP design, construction, and maintenance of operations
- ✓ Familiar with NHDES technical, funding, and permitting requirements

Project Manager's Relevant Project Experience

Saco River WTP

Mr. Morin served as the Project Manager for the design and construction of a new 12-mgd water treatment facility for the Maine Water Company in Biddeford, Maine. **The "greenfield" plant included new intake on the Saco River, Raw Water Pump Station and conveyance piping, coagulation, flocculation, filtration and disinfection facility.** The project was delivered using the CMAR project delivery method where Mr. Morin served as the primary liaison with the CMAR contractor during the design, value engineering, procurement and construction phases.

SLWTF Chemical Storage Tanks CIP Development

Mr. Morin served as the Project Manager for the evaluation of alternative approaches to upgrading and replacing chemical storage facilities at the Sebago Lake Water Treatment Facility. **The evaluation included options to replace in kind or construct a new dedicated chemical storage and feed building.** Capital and life cycle cost estimates were prepared and, working collaboratively with the District, a recommendation was made to replace in kind. In order to minimize risk and maintenance of operations impacts, Hazen worked with the District to prepare a construction phasing and packaging plan.

Tampa Electric Polk WTP

While at a previous company, Mr. Morin served as the Design Manager for a **new 8-mgd (expandable to 24-mgd) reverse osmosis water treatment facility.** The facility treated reuse water from the City of Lakeland, Florida wastewater treatment plant. Water was pumped approximately 15 miles from Lakeland to the Polk County site. **The treatment process included DenaDeg high rate clarifiers, gravity cluster filters, and reverse osmosis membranes.** Process residuals were thickened and mechanically dewatered while membrane reject was disposed through deep well injection.

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Organization Chart

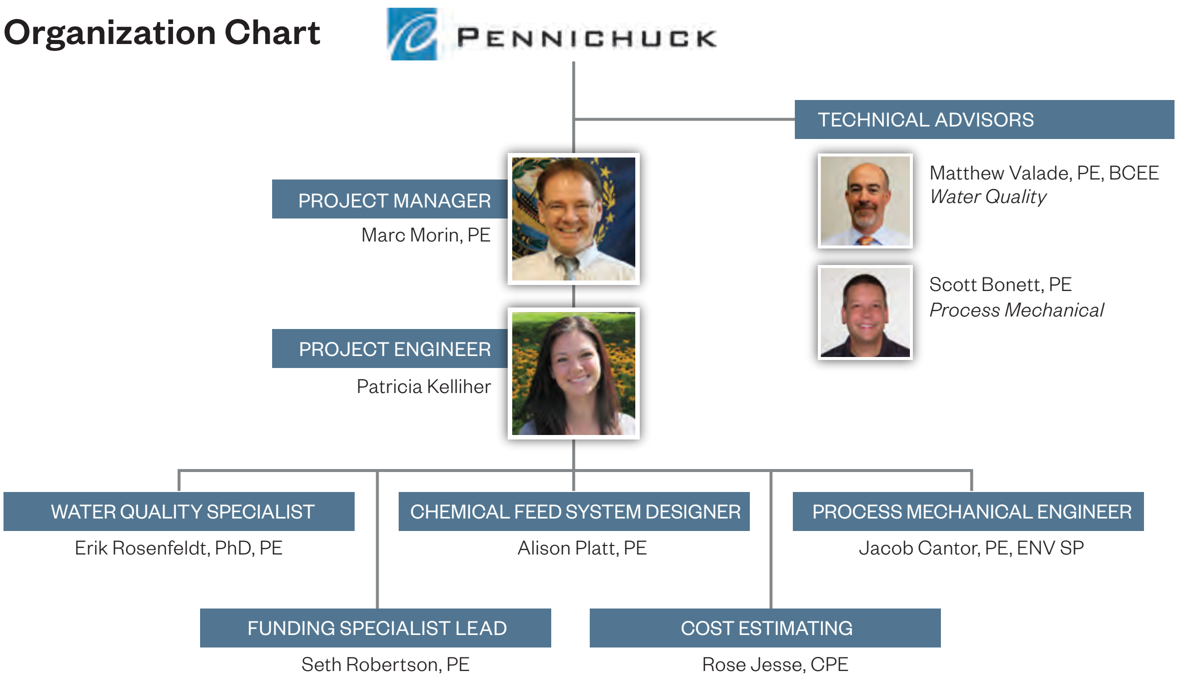

Figure 3-1

Patricia Kelliher | Project Engineer

Ms. Kelliher, located in our Manchester office, has over 12 years of experience, focused on water-related project for her clients. These projects range from hydraulic modeling, asset management, capital planning, permitting, design, and construction. **She has recently assisted Project Manager, Marc Morin to finalize the evaluation of PWD's Chemical Storage and is also assisting PWD with the design of a new water storage tank and chloramine boosting station.** Ms. Kelliher is responsible for client coordination, assisting with local, state, and national environmental permits, including permits required for funding through the State Revolving Fund, and coordinating with local vendors and Hazen's discipline's for the design. Similarly, she is the project engineer for MWRA's Tank Improvement project, which is a multi-disciplinary project for new prefabricated buildings at various tank locations to house water contaminant monitoring equipment, SCADA and security equipment, and new emergency generators.

Benefits

- ✓ Local and responsive project management
- ✓ Knowledgeable of NH regulations
- ✓ Board Member of New Hampshire Water Works Association
- ✓ Asset management and capital planning expertise

Project Engineer's Relevant Project Experience

SLWTF Chemical Storage Tanks CIP Development

Ms. Kelliher served as Project Engineer for the chemical storage facilities at the Sebago Lake Water Treatment Facility. Ms. Kelliher worked with the proposed Project Manager, Marc Morin, and internal disciplines to develop alternatives for the chemical storage. **The improvements to the chemical storage systems included recommendations to ensure continued long-term reliability and resiliency of the chemical system at the facility.**

Technical Advisors

Matthew Valade, PE, BCEE | Technical Advisor: Water Quality

Mr. Valade has 27 years of experience in the evaluation, design, construction, and operation of drinking water treatment systems and facilities, including DAF, UV disinfection, and DBPs. He is a recognized expert in dissolved air flotation, having been involved in over 20 DAF projects including piloting, design and construction. In New England, Mr. Valade served in a leadership role for the design and construction of Aquarion Water Company's 30-mgd stacked DAFF WTP, a 4-mgd DAF facility in Portsmouth, NH and is serving as Technical Director for AWC's 22-mgd Putnam WTP Stamford DAF upgrade. **In his role as a Technical Advisor, Mr. Valade will help guide the development of alternatives and review our planning and design recommendations regularly.**

Benefits

- ✓ Hazen's Northeast Regional Water Group Leader
- ✓ Participated in Peer Review of WPF Facilities Plan

Scott Bonett, PE | Technical Advisor: Process Mechanical

Mr. Bonett is currently serving as Project Director for a Task Order based Technical Assistance Contract at MWRA's John J. Carroll WTP and has executed 11 diverse Task Orders. He is also and is serving as Project Manager for an advice-based Task Order for the City of Meriden. Work has included assisting staff with an emergency conversion from sodium permanganate oxidation to pre-filter chlorine for manganese control when permanganate became unavailable due to supply-chain interruptions and also assisted the City with plant optimization after an HAA5 excursion. A raw water sampling program was developed to help inform the City as to whether permanganate use can be transitioned from year-round to seasonal application. **Mr. Bonett will bring his experience with water treatment plants and will provide technical review of all deliverables associated with the project.**

Benefits

- ✓ Experienced with many aspects of water treatment design
- ✓ 20+ years of experience, almost exclusively with New England utilities

Additional Team Members

Erik Rosenfeldt, PhD, PE | Water Quality Specialist

Dr. Rosenfeldt is Hazen's Director of Drinking Water Process Technologies, and has been involved in numerous projects nationwide focused on understanding impacts of highly variable surface water quality on treatment. Focused on developing adaptive chemical feed and optimization solutions, he's employed the approach to numerous facilities in New England facing treatment challenges associated with turbidity removal and DBPs, including Danvers, MA, Meriden, CT, and Aquarion Water, CT. He has assisted several Northeast water suppliers faced with simultaneous challenges of needing to utilize less pristine sources, long-term water quality degradation driven by climate change, and increased variability in water quality due to extreme weather. **Dr. Rosenfeldt will review raw water quality data from Pennichuck Brook and the Merrimack River and oversee development of recommendations for chemical feed system upgrades, blending, and other factors that will allow PWW to meet its water quality objectives.**

Benefits

- Has assisted water suppliers throughout the country regarding variable water quality challenges
- Direct access to industry leading expertise in treatment and regulation.

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Alison Platt, PE | Chemical Feed System Designer

Ms. Platt served as Chemical Feed System Design Engineer for the new 2.5-mgd WTP at Orchard Street Pump Station, White Plains, NY to treat the in-City water supplies to supplement the City's primary supply from NYC. She developed the chemical storage and feed system designs providing full treatment of the City's blended surface/ground water sources, and ensuring the finished water matches that of the primary supply, allowing for consistent water quality in the distribution system. Ms. Platt also served as Chemical Feed Design Engineer for the new chemical addition buildings at Hillview Reservoir, increasing the facility's redundancy and reliability into the next century. **She will leverage this extensive experience and work directly with our Project Manager and Technical Advisors as she helps guide the development of chemical feed system alternatives and lead the design process.**

Benefits

- ✓ Large WTP project experience
- ✓ Has served in similar role working with this team

Jacob Cantor, PE, ENV SP | Process Mechanical Engineer

Mr. Cantor is a process mechanical engineer with six years of experience in the evaluation and design of water treatment processes. Mr. Cantor has assisted with several chemical feed and storage projects in the Northeast area including surface water applications where considerations were needed for adapting to climate change and future regulations. Mr. Cantor served as the Process Mechanical Engineer for the Saco River WTP. **He brings a strong background in the evaluation of system hydraulics, water quality analysis, and design of mechanical equipment systems.**

Benefits

- ✓ Extensive WTP design experience
- ✓ Water quality analysis expertise

Seth Robertson, PE | Funding Specialist Lead

To help maintain compliance with WIFIA funding requirements, Hazen has proposed Mr. Robertson to lead potential funding efforts. Mr. Robertson has 24 years of experience dedicated to financial analysis, funding assistance, and capital planning. He is experienced with state and federal funding programs including Clean Water State Revolving Fund, Drinking Water State Revolving Fund, Community Development Block Grants, Economic Development Administration funding, United States Department of Agriculture Rural Development grants and loans, and many local programs. **Mr. Robertson will identify funding opportunities, deadlines, and milestones early and work with PWW to fully leverage potential funding sources.**

Benefits

- ✓ Water infrastructure and funding experience
- ✓ Specializes in funding and financial analysis, asset management and capital improvement planning

Rose Jesse, CPE | Cost Estimating

Ms. Jesse, a Certified Professional Estimator by the American Society of Professional Estimators leads Hazen's Estimating Group and will be made available to lead all estimating efforts for PWW. In 2021 alone, Ms. Jesse's estimating group has provided 154 estimates, at a total value of over $6.8B, and estimates led by her with 41% valued below $5M. She has developed cost estimates for recent WTP upgrades, including the Rye Lake WTP Upgrade, Putnam WTP Upgrade, and White Plains WTP. **She will guide the development of accurate capital and life cycle costs for project alternatives.**

Benefits

- ✓ The Hazen Cost Estimating Group was established in 2008, and is led by Ms. Jesse, Manager of Cost Estimating

Value Added Personnel

At Hazen, we take satisfaction in thinking outside the box to solve difficult challenges for our clients that may not be apparent at first glance. Our depth of technical services and talented staff with a collective breadth of knowledge and experience regarding all things water allow Hazen to offer value-added staff and services to help achieve PWW's goals and objectives. In understanding and evaluating the scope of work proposed for PWW's future objectives, we would like to suggest PWW consider the following value-added personnel that could improve the overall impact of this work.

Benefits

- ✓ Multitude of 1D and 2D hydrologic and hydraulic modeling experience
- ✓ Extensive long term planning experience

Benjamin Agrawal, PE I Climate Modeling

Mr. Agrawal has a multitude of experience conducting resilience evaluations and long-term planning projects. He recently led a Citywide multidimensional modeling project for the Boston Water and Sewer Commission that included characterizations of flooding due to sea level rise, storm surge, and a multitude of wet weather events over a 50+ year period through 2070. He also helped lead modeling efforts for several communities along the Merrimack River for CSO LTCP development (considerate of climate change influences). **Mr. Agrawal will leverage this experience to help characterize future wet weather patterns, and evaluate how these changes could impact PWW.**

Benefits

- ✓ Permitting Lead on multiple w/ww projects throughout the NE
- ✓ Experienced with Regulatory Agency Coordination and Stakeholder Facilitation

Katie Hoek, PE I Environmental Permitting

Ms. Hoek's experience in environmental review and permitting for Hazen's water infrastructure spans over a decade. She has led complex environmental review and permitting efforts through multiple types of projects, including several with funding requirements, and understands which permits to prioritize to keep projects on track. She led permitting and environmental review efforts for both the Rye Lake Water Treatment Plant and City of White Plains Water Supply projects. In New England. **Her experience working with clients, the design team and involved agencies will help in identifying permits that would be applicable for the project and aid PWW to be in compliance with all applicable regulations.**

Benefits

- ✓ A wealth of experience and knowledge to deliver an insightful and useful design and construction management services

Saya Hickey, PE I Permitting

Ms. Hickey is one of Hazen's leading regulatory and permitting experts, with extensive negotiation experience. She has provided regulatory assistance for several public and private utilities in the Northeast, and is very familiar with NPDES and EPA regional requirements and stakeholders. Ms. Hickey led the successful negotiations for Nashua's NPDES permit. **Ms. Hickey has helped clients in New Hampshire and Massachusetts with regulatory challenges related to the Merrimack River, and understands how future regulations could impact water quality.**

Benefits

- ✓ Served as task lead for developing management communication strategies

Jeff Neale I Public Relations

Mr. Neale has over 26 years of experience in managing communications and outreach programs that have shaped the narrative around environmental projects, successfully reaching diverse target audiences with succinct messages distilled from complex, technical information. Mr. Neale has applied his strategy, messaging, and information design expertise to communicating the benefits of water-related programs, projects, and technologies to utility customers, staff, and stakeholders. **If desired, Mr. Neale will work collaboratively with PWW's Corporate Communications group to develop and implement an outreach program specific to water quality topics.**

Section 4:

Understanding of the Project Requirements and Approach

Section No. 4

Understanding of the Project Requirements and Approach

Hazen has developed a thorough understanding of the project from discussions with staff, visits to the site, and experience with similar treatment processes and water quality challenges.

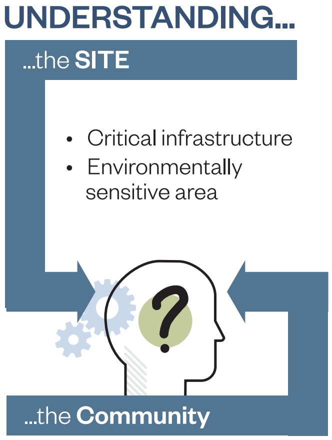
Hazen will provide thorough evaluations of the treatment plant chemical storage and feed systems and develop recommendations designed to meet your technical, schedule and budget goals. The following is a summary of our understanding of the project requirements and our approach to completing the evaluation:

Project Understanding

The Pennichuck Water Works Nashua Treatment Plant (the Plant) is the primary potable water supply for the greater Nashua, New Hampshire area. Originally designed with a capacity of 32 million gallons per day (mgd), the plant currently produces up to 25 mgd to meet the current maximum day demand of the system. The Plant was originally intended to treat water from the Pennichuck Brook, which served as the primary raw water supply prior to 2019. During periods of high demand, water from the Merrimack River could be pumped into the Pennichuck Brook supply ponds to augment raw water supply.

More recently and due to a new regulation of PFAS compounds, PWW has changed operations by focusing on the Merrimack River as its primary raw water source with Pennichuck Brook as a secondary source. Although the Merrimack River has significantly lower levels of PFAS compounds, raw water quality is highly variable, and subject to high turbidity events.

Chemical usage at the plant has significantly increased as a result of this operational change. As a result of this operational change, chemical usage has steadily increased over time. It is reported that during high turbidity events, **the chemical storage and feed systems to operate between 90% and 97% of current capacity,** even with the Plant operating well below its original design capacity. PWW has a stated goal of maintaining the ability to provide the full 32 mgd capacity of the WTP while operating entirely on either the Merrimack River, Pennichuck Brook Supply, or a blend of both sources. PWW is seeking a consultant to perform an evaluation of the chemical feed and storage improvements necessary to meet this desired goal.



...the SITE
- Critical infrastructure
- Environmentally sensitive area

...the Community
- Deliver uninterrupted drinking water supply
- Regulatory compliance

The locations of the Plant and new Merrimack River Intake and Pump Station are shown on the following **Figure 4-1.**

Nashua Water Treatment Facility

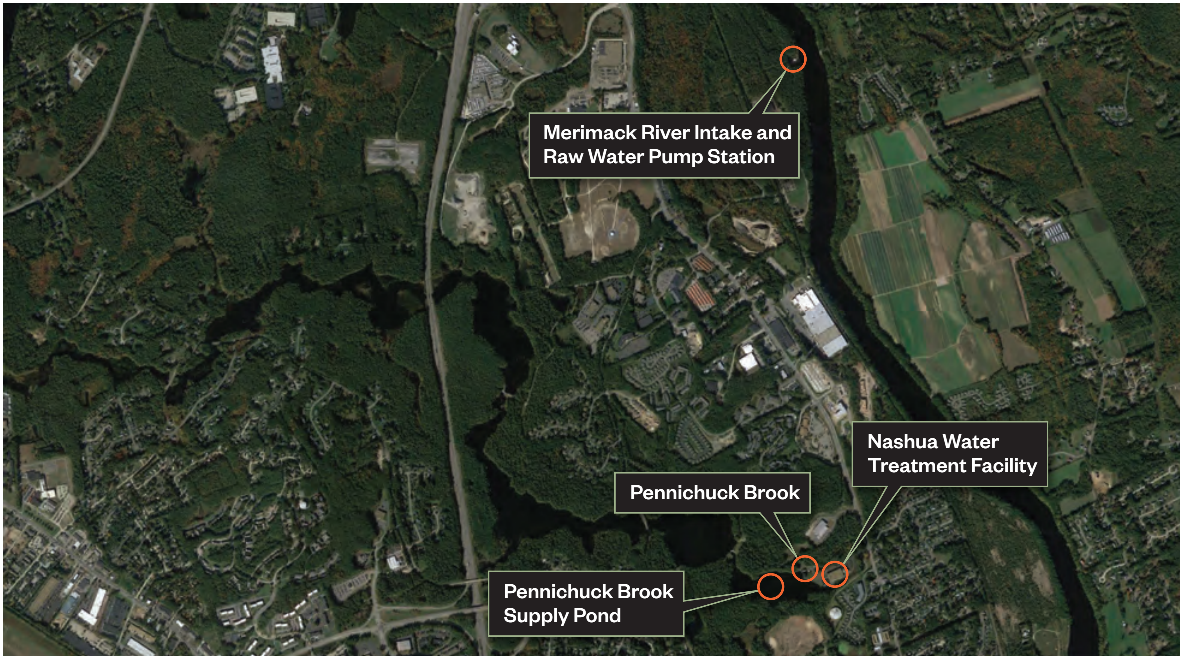


Figure 4-1

PWW has identified the need to evaluate and upgrade the chemical storage and feed systems at the Plant with the following primary goals in mind:

- Capability to operate the facility at its full 32-mgd capacity.
- Upgrade the chemical feed equipment to allow the operational flexibility to operate at full plant capacity, using either raw water supply or a blend of both.
- Upgrade chemical storage facilities to accommodate the higher feed rates needed while minimizing frequency of deliveries and providing bulk storage sufficient to weather supply chain disruptions.

Hazen's extensive experience in water treatment infrastructure will allow our team of technical experts to rapidly and effectively evaluate the following major items as soon as the Notice to Proceed is received:

- Raw water quality
- Chemical feed rates
- Chemical storage needs

Based on this evaluation, Hazen will work with PWW to progress the work, develop initial improvement alternatives and finalize recommendations through a thorough screening process. The following pages summarize Hazen's approach to completing the evaluation and developing preferred improvements designed to meet PWW's stated goals.

Project Approach

The foundation of a successful approach to this project is a well-organized program led by an experienced project team. Effective project management depends on clear communication, a culture of collaboration, and adoption of PWW's objectives for scope, schedule, budget, safety, quality. **Figure 4-2** illustrates Hazen's Project Management Approach.

Hazen's Project Approach

Improvements Approach

Workshops

- Establish PWW Goals
- Prioritize technical & non-technical challenges
- Solicit feedback in a team setting

PWW coordination throughout project

Planning

- Research & review available project documents
- Conduct Condition Assessment of existing facilities and site

Alternatives Evaluation

- Alternatives Analysis
  - Retrofit existing facility
  - Bulk Chemical Storage Building
  - New Chemical Storage & Feed Facility
- Capital & Lifecycle Cost Analysis
- Collaborative screening process to identify the preferred alternative
- Permitting Requirements Review
- Identification of Funding

Prepare and deliver final report

Project Management Approach

- Collaborative Design Approach
- Establish lines if communication
- Scope, Schedule, and Budget Management

Figure 4-2

Improvements Approach

Based on our understanding of the project, we have identified three possible alternatives for upgrading/replacing the Plant's chemical storage and feed systems. Our first order of business will be to conduct a condition assessment. Once complete, the alternatives will be refined with the assistance of PWW. Our overall approach is to identify existing facilities suitable for reuse through Hazen's Leveraging Existing Assets First (LEAF) program. We will look to leverage existing assets before building new, focusing on cost saving measures wherever possible. Next, Hazen will work together with PWW to thoroughly evaluate the alternatives and vet them using a thorough screening process that considers operations, capital and life cycle costs, schedule, regulatory requirements, and other factors. The three initial approaches are described on the following pages.

LEAF Benefits

LEAF
Leverage Existing Assets First

Hazen's goal is to Leverage Existing Assets First (LEAF). We will highlight solutions that can be implemented using existing infrastructure where long-term cost savings and continued service to customers can be achieved.

1. **Retrofit Existing Facility:** Under this scenario, each chemical feed and storage system will be evaluated in terms of remaining service life and suitability to meet future operational conditions. Recommendations will be developed detailing which, if any, systems may be replaced in kind or with modifications suitable for implementation in the current space.

   For systems not suitable for upgrade in place, alternate locations will be evaluated, including a new chemical storage and feed building. The benefit of this approach is that the space freed up by relocation of one or more systems may be reused by remaining, upgraded systems.

2. **Construction of a new Bulk Chemical Storage Building:** Under this scenario, a new structure sized to accommodate new and appropriately sized bulk storage tanks will be evaluated. As relocation of the existing bulk tanks will free up space within the existing facility, the existing spaces may be reconfigured to accommodate upgraded day storage and feed equipment. The benefit of this approach is the potential for reuse of existing feed piping. Each bulk chemical tank in the new storage building will be equipped with bulk transfer pumps designed to feed the day tanks.

3. **Construction of a new Chemical Storage and Feed Facility:** Under this scenario, a new facility dedicated to chemical storage and feed will be constructed. The facility will be sized to accommodate bulk storage, transfer pumps, day storage, feed pumps and appurtenant equipment.

Chemical Storage and Feed Considerations

In addition to providing adequate bulk/day tank storage volume and feed pump capacity, the following considerations will be incorporated into the alternatives analysis:

- Chemical and materials compatibility
- Tank types and materials
- Required secondary containment volumes
- Potential need for sprinkler systems
- Chemical delivery facilities
- Redundancy and operating flexibility
- Operator safety
- Capital and operating costs
- PWW goals institutional knowledge, ideas, and preferences

Project Proof

Sebago Lake Water Treatment Facility Chemical Storage Tanks CIP Development

Portland Water District,
Portland, ME

Mr. Marc Morin, PE efficiently managed the evaluation of chemical feed and storage equipment for the Sebago Lake Treatment Facility. An alternatives analysis with associated lifecycle costs was completed **comparing the options to utilize the existing space within the treatment facility versus a new building.**

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Design and Construction on Constrained Sites

Hazen will work with PWW to identify critical infrastructure and access points that must be maintained throughout construction, develop alternate access routes or piping bypasses, if needed, and lay out construction phasing plans that meet PWW's milestones. The benefit to this approach is the flexibility to design and construct a new facility properly sized and with the operational flexibility to accommodate future capacity and treatment needs. **Figure 4-3** identifies possible site constraints.

Nashua Water Treatment Facility Site Constraints

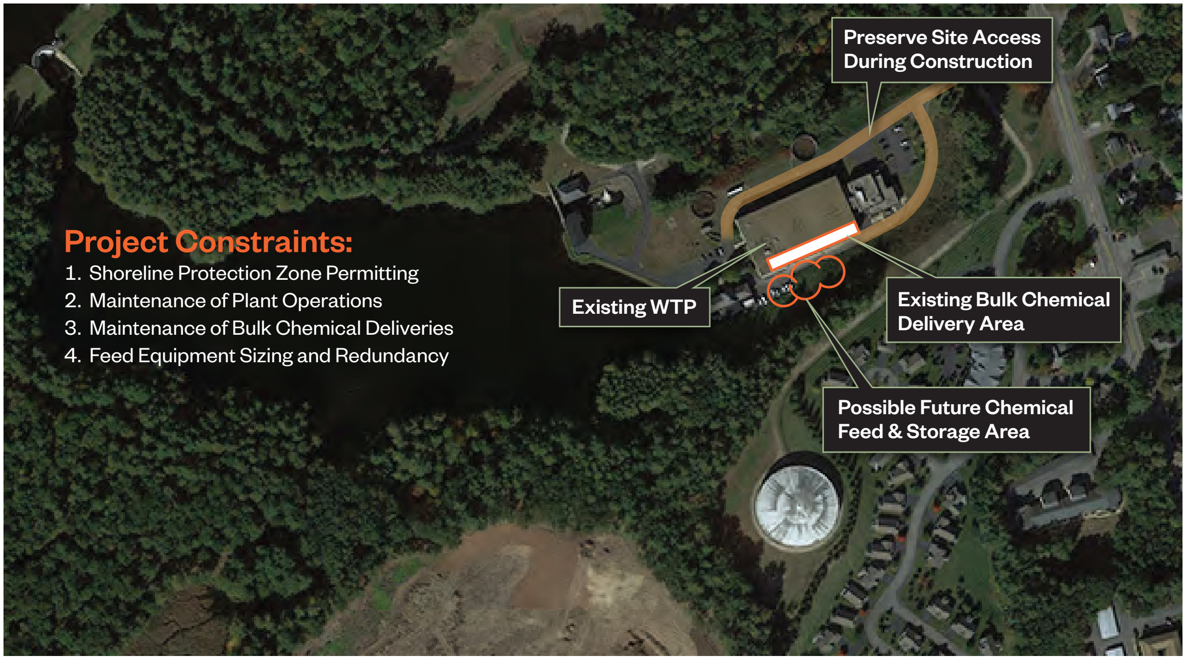

Figure 4-3

Redundancy and Reliability

Hazen will work in partnership with PWW to determine the appropriate levels of redundancy to perform recommended improvements while maintaining continuity of water supply to the public. The level of installed redundancy must be balanced with space constraints and budget. **Hazen is practiced in collaborating with clients to define where redundancy in new construction is required and where other assets can be leveraged to maintain continuity of service.**

Hazen will develop options that will incorporate the appropriate level of redundancy that will provide the flexibility to maintain equipment while reliably producing high-quality water.

Maintenance of Plant Operations and Constructability

It is critical that the Plant remain in continuous operation throughout this project. We will prepare recommendations that consider construction sequencing to minimize impacts on existing operations, particularly for any work requiring a connection to existing assets.

We have developed an operability review checklist that codifies more than 200 design features, broken into four categories:
- Operability
- Safety
- Maintenance of Plant Operations
- Startup/Commissioning/Turnover

The checklist was culled from feedback from multiple utilities that span Hazen's more than 60 domestic offices, all of which are exclusively focused on the water environment market.

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Project Management Approach

The foundation of a successful approach to this project is a well-organized program led by an experienced project team. Effective project management depends on clear communication, a culture of collaboration, and adoption of PWW's objectives for scope, schedule, budget, safety, and quality.

Hazen's Design Philosophy

Our design philosophy is to work with our clients to be their trusted advisor, to listen to their program goals and objectives and make these our goals and objectives. A cornerstone of our philosophy is to work in partnership with our clients to design efficient, high-quality facilities with a focus on operability and long-term considerations. Our approach to project delivery focuses on two primary areas, communication with PWW and key stakeholders along with technical excellence in water treatment design.

Collaborative Design Approach

We do not believe in a "one-size-fits-all" model when it comes to projects. We know that each client, as well as each project, has unique drivers, circumstances, and goals that must be considered. As such, we pride ourselves on working in close partnership with our clients every step of the way to ensure that the project not only meets but exceeds expectations.

Our collaborative approach aligns with your desire to be involved in the process and to influence outcomes. As we have learned, working together always results in a superior final product. Early involvement of our constructability and operability experts during the evaluation and preliminary design phase is another important aspect of our collaborative approach. Their input in the early phases is critical to developing a project that not only meets treatment needs but also supports ongoing operations.

We will also conduct thorough constructability reviews for each conceptual alternative. Potential construction risks, regulatory requirements, and value engineering opportunities will be considered, and detailed cost estimating and schedules will be prepared to help vet the trade offs of different approaches.

Communication/Responsiveness

In addition to regular workshops, Hazen will communicate regularly and openly with the PWW's staff. To be effective, project meetings will include procedures for accountability and timely follow-up. We will distribute meeting materials in advance to facilitate participation and inclusion of all team members. Snapshots of technical work will be prepared for review at monthly meetings. Through open communication, significant project delays will be mitigated.

Hazen's Collaborative Design Approach

Committed to Achieving PWW's Goal

A genuinely committed and experienced team means less risk, high efficiency, and lower cost to PWW

Close Proximity to the Project

Our local project staff will be available and present to facilitate communication and coordination.

Open Communication

Regular workshops and open dialogue between the Hazen team and PWW is a priority.

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Cost Estimating

Hazen's Cost Estimating Group (CEG) led by Rose Jesse, CPE will develop all cost estimates required during the evaluation phase. Our CEG has a successful track record of estimating project costs for our clients and has developed estimates that average within 10% of the low bid since 2012.

In 2020 CEG developed and compiled 143 estimates with the total value for these estimates at approximately $4.7 billion. Estimates ranged from $175,000 to the largest estimate valued at $2.1 billion for a study of planning assistance for a facility upgrade. In addition, CEG provided support and training to field staff to price and negotiate change orders.

An example of our CEG performance is the recent bid result for Aquarion's Stamford WTP Dewatering Facility. Hazen's base estimate was 15.4M, and the bids received were $15.4M, $16.0M, and $17.5M. **Our in-house cost estimating team will ensure that PWW has a strong understanding of accurate construction cost estimates early in the evaluation phase. This can lead to better cost control and designing with the budget in mind.**

Scope, Schedule and Budget Management

Working with PWW, our team will set the framework and overarching schedule to deliver the project. Project Manager, Marc Morin, PE will oversee and ensure that project tasks and deliverables contribute to the end goals and program objectives, with assistance from Project Engineer, Patricia Kelliher. Through careful project cost tracking, forecasting, and reporting our team will keep PWW appraised of project progress, budget status and any issues that may arise. Early reporting will allow the team to make adjustments efficiently and keep the project on plan.

Hazen is committed to completing the chemical system by PWW's November 2022 deadline. Opportunities to accelerate the schedule will be examined.

Permitting

Hazen will lead the development and submission of the necessary federal, state, and local permits required to advance the project including site specific environmental permits, including the NHDES Shoreland Permit, as well as those required under the SRF funding program, if funding is pursued by PWW. Site investigations will be completed to aide in the research of applicable permits. Our team will provide an anticipated project permit list with regulatory timelines specific to each alternative.

The Hazen Cost Estimating Group was established in 2008, and is led by Manager of Cost Estimating, Rose Jesse, who is a Certified Professional Estimator by the American Society of Professional Estimators.

A History of Rightsized Estimates

IN 2021 HAZEN DEVELOPED

154
estimates

TOTALING OVER
$6.8
billion

WITH 41%
VALUED BELOW
$5
million

Funding Coordination

We recognize the importance of securing funding for this project. Using our comprehensive experience with federal and NH funding programs, we will identify the most applicable, available, and achievable funding options. Our approach will include development of a comprehensive funding strategy and implementation plan to plot a course to obtaining the best funding available. To do this we will identify multiple potential funding options to provide the flexibility necessary to adapt to evolving funding programs, to leverage existing programs, and to maximize the return on PWW's capital investment while minimizing impacts to ratepayers. Funding programs that will be considered include: USEPA's Water Infrastructure and Improvement Act (WIFIA), New Hampshire Department of Environmental Services (NHDES) grants and loans including Drinking Water State Revolving Fund (DWSRF) Loans and Strategic Planning Grants, the NH Drinking Water and Groundwater Trust Fund, and Bipartisan Infrastructure Law (BIL) funding. Our approach will help identify and navigate complex permitting, engineering, and contract requirements to minimize impacts to project costs and schedules, allowing PWW and their customers to fully realize financial benefits of obtaining funding.

Quality Assurance and Quality Approach

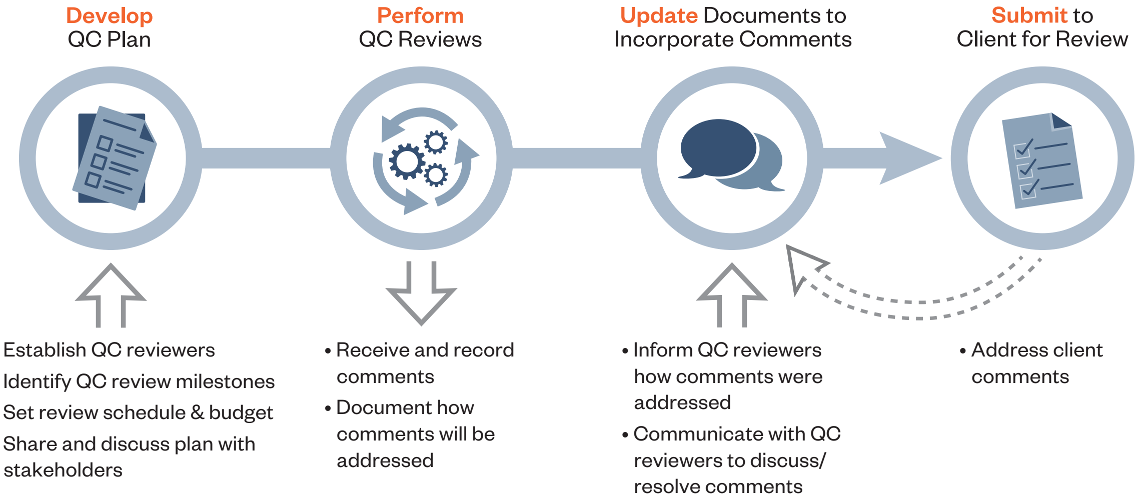
Hazen's commitment to quality is defined by our people and fostered through our formalized QA/QC process. All project submittals will follow Hazen's internal quality assurance and quality control approach. This process, shown below, is reinforced through our training programs for technical competency and QA/QC compliance and ingrained in our culture—to do the right thing when issues arise on a project. We believe quality is imperative in all that we do, from everyday email to complex design projects.

Funding Assistance Secured by Hazen over the Past 10 Years

$1.6 Billion+
Grant Funding Amount

$2.5 Billion+
Loan Funding Amount

$4.1 Billion+
Total Funding Amount



Develop QC Plan
- Establish QC reviewers
- Identify QC review milestones
- Set review schedule & budget
- Share and discuss plan with stakeholders

Perform QC Reviews
- Receive and record comments
- Document how comments will be addressed

Update Documents to Incorporate Comments
- Inform QC reviewers how comments were addressed
- Communicate with QC reviewers to discuss/resolve comments

Submit to Client for Review
- Address client comments

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Section 5:

Detailed Scope of Work and Budget

Section No. 5

Detailed Scope of Work and Budget

Hazen takes pride in the manner in which we share ownership of projects with our clients, providing technical leadership while constantly keeping the Owner's perspective and concerns in mind. This will translate to delivery of a quality and successful project.

Detailed Scope of Work

Effective project delivery depends on clear communication, collaboration, and identification of the critical path. Our experience shows that this approach facilitates informed and justifiable decision making. With this in mind, Hazen has prepared a scope of work for completing the tasks designated for 2022. Our scope of work is illustrated in **Figure 5-1.**

Our most successful projects are those in which the Owner is actively involved throughout the planning and design phases and combine Hazen's extensive water treatment knowledge with the Owner's institutional knowledge and ideas.

Detailed Scope of Work

1 Project Management

1.1 Prepare Project Work Plan

1.2 Kickoff Meeting/Data Request

1.3 Bi-Weekly Check in Calls

1.4 Monthly Reports & Invoices

1.5 QA/QC All Deliverables

Deliverables

- Project Work Plan
- Kick off Meeting Agenda/Notes
- QA/QC Plan
- Monthly Reports & Invoice

2 Alternatives Evaluation

2.1 Evaluate Existing Systems

2.2 Develop Improvement Alternatives

2.3 Prepare Preliminary Estimates

2.4 Workshop

Deliverables

- Preliminary Alternatives
- Preliminary Layouts
- Preliminary Estimates
- Workshop Agenda/Notes

3 Technical Report

3.1 Draft Technical Report

3.2 Workshop

3.3 Final Technical Report

Deliverables

- Draft Report
- Workshop Agenda/Notes
- Final Report

Figure 5-1

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Budget

In support of our scope of work and in accordance with the requirements set forth in the request for proposals, we have prepared a bottom up fee. Estimated based upon the scope of work, estimated hours by labor classification, and 2022 billing rates for each. Our budgetary fee is presented in **Table 5.1.**

Through careful project cost tracking, forecasting, and reporting our team will keep the PWW appraised of project progress, budget status and any issues that may arise.* *Early reporting will allow the team to make adjustments efficiently and keep the project on plan.

Table 5.1: Hazen's Fees

	LABOR CATEGORY							
	Technical Advisor	Project Manager	Project Engineer	Engineer	Estimator	Graphics		
TASKS	$227.20/hr	$227.20/hr	$142.00/hr	$122.12/hr	$198.80/hr	$99.40/hr	Total Hours	Total Fee ($)
1.0 Project Management								
1.1 Project Work Plan	0	0	2	4	0	0	6	772.00
1.2 Kickoff Meeting	0	3	4	6	0	0	13	1,982.00
1.3 Bi-weekly Client Calls	0	4	4	4	0	0	12	1,965.00
1.4 Monthly Reporting	0	0	8	0	0	0	8	1,136.00
1.5 QAQC	4	0	0	0	0	0	4	909.00
2.0 Alternatives Evaluation								
2.1 Evaluation Existing System	0	4	12	20	0	0	36	5,055.00
2.2 Develop Improvement Alternatives	0	4	4	28	0	8	44	5,691.00
2.3 Lifecycle Cost Analysis	0	1	1	0	0	0	2	369.00
2.4 Alternatives Analysis Workshop	0	4	8	8	0	0	20	3,022.00
3.0 Technical Report								
3.1 Draft Technical Report	0	4	5	38	8	2	57	8,049.00
3.2 Technical Report Workshop	0	4	8	12	0	0	24	3,510.00
3.3 Final Technical Report	0	0	4	0	2	2	8	1,164.00
Allowances								*100.00*
TOTAL	**4**	**28**	**60**	**120**	**10**	**12**	**234**	**$33,726.00**
							BUDGET:	**$33,700.00**
STAFF	Scott Bonett, PE Matthew Valade, PE	Marc Morin, PE Erik Rosenfeldt, PhD, PE	Patricia Kelliher Seth Robertson, PE	Jacob Cantor, PE Alison Platt, PE	Rose Jesse, CPE			

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Appendix A:

Resumes

Marc Morin, PE

Senior Associate

Mr. Morin has over 36 years of experience in the management, design, and construction of water and wastewater projects. He is an active member of both AWWA's Water Treatment Plant Design and D110 Tank Standards Committee and NEWWA's Water Treatment Plant Residuals and Filtration Committee.

Education

MS, Water Resources Engineering; University of Hampshire, 1999

BS, Civil Engineering; University of New Hampshire, 1986

Certification/License

Professional Engineer: NH, MA, FL

Areas of Expertise

- Project management
- Value engineering
- Water and wastewater conveyance, storage, pumping and treatment
- Multi-discipline design
- Construction administration
- Quality assurance/control

Experience

- 36 total years
- 5 years with Hazen

Professional Activities

American Water Works Association (AWWA)

- Water Treatment Plant Design and D110 Tank Standards Committee Member

New England Water Works Association (NEWWA)

- Water Treatment Plant Residuals and Filtration Committee Member

New Hampshire Water Pollution Control Association

Sebago Lake Water Treatment Facility Chemical Storage Tanks Capital Improvements Plan Development, Portland Water District, Windham, ME

Project Manager for the evaluation of existing chemical feed and storage facilities at the Sebago Lake Water Treatment Facility (SLWTF). The existing chemical feed and storage facilities at the SLWTF were originally constructed and placed into service in the mid 1990s. With the exception of a change from gas chlorine to sodium hypochlorite for disinfection, each system is original. Hazen evaluated the condition of the existing storage and feed systems and prepared upgrade recommendations including construction of new systems in place or construction of a new chemical storage and feed structure. Although a new, separate chemical building demonstrated the lowest risk to operations, it proved to be too costly both from a capital and life cycle cost basis. Hazen worked closely with the District to develop a plan for re-using the existing space including construction packaging into multiple contracts, temporary systems during construction, and maintenance of plant operations considerations.

Saco River Water Treatment Facility, Maine Water Company, Biddeford, ME

Project Manager for the design and construction of a new 20-mgd conventional treatment plant, to replace the existing one built in 1884. The facility will withdraw source water from the Saco River and replace an existing facility. The plant will include inclined plate settlers, dual media filtration, and appurtenant chemical feed facilities. Residuals will be processed in new sludge drying beds. Project is currently under construction.

Duck Island Wastewater Treatment Plant Improvements (Phase 2A), City of Lowell, MA

Project Manager for the Construction of the Duck Island Wastewater Treatment Plant Phase 2A improvements. The project included the rehabilitation of the existing channels for the plant's influent screw pumps, replacement of bulk sodium hypochlorite storage tanks, installation of new sodium bisulfite storage tanks, and replacement of an existing underground fuel tank for the plant's emergency generator. The total value of the construction was approximately $1.7 million.

Duck Island Wastewater Treatment Plant Improvements (Phase 2B), City of Lowell, MA
Project Manager for the final design of the Duck Island Wastewater Treatment Plant Phase 2B improvements. The project included the construction of a new locker room facility, replacement of existing sludge conveyance equipment, improvements to existing odor control systems, replacement of sodium hypochlorite and sodium bisulfite chemical feed pumps, and air handling improvements to existing plant structures and tunnel system. The total value of the construction is estimated at approximately $4.0 million.

Windham Center Elevated Storage Tank Replacement, Portland Water District, Windham, ME
Project Manager for the replacement of an elevated storage tank in Windham, Maine. The existing storage tank is undersized, and the project involves hydraulic modeling to determine whether a new tank should be built on the same site, or if a new tank at another District-owned location will be more favorable. Once a site is established, Hazen will develop construction documents for a new tank. Tank mixing and remote chloramination at the site was also incorporated into the project. The project is currently in the alternatives analysis phase.

Experience Prior to Hazen

Polk Water Treatment Facility, Tampa Electric Company, Polk County, FL
Design Manager for new 8.5-mgd reverse osmosis water treatment plant. The work included the design of new high rate clarification (DensaDeg) units, gravity cluster filters, reverse osmosis treatment skids, residuals handling and centrifuge dewatering units, associated pumping, tankage and site piping facilities.

Water Treatment Plant Value Engineering, Department of Public Works, Portsmouth, NH
*Project M*anager for value engineering of the proposed upgrade to the water treatment plant in the City of Portsmouth. Evaluated the proposed design and assisted with the development of alternative concepts for the upgrade that would minimize capital costs while meeting the treatment goals of the City's water department.

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Patricia Kelliher

Principal Scientist

Ms. Kelliher works out of Hazen's New Hampshire office providing engineering services to multiple municipalities throughout the state as well as New England, in general. This includes hydraulic modeling, asset management, and capital improvements.

Education

BS, Civil and Environmental Engineering, University of Amherst, 2010

Areas of Expertise

- Hydraulic modeling
- Asset management
- Capital improvements

Experience

- 12 total years
- 3 years with Hazen

Professional Activities

New England Water Works Association

- Young Professionals and Youth Education Committees

New Hampshire Water Works Association

- Programs Committee Member

Saco River Water Treatment Facility, Maine Water Company, Biddeford, ME

Project Engineer. Assisted with the design for approximately 2,000 linear feet of raw and finished water main and associated hydrants, valves, and appurtenances for the treatment facility from the proposed raw water intake screen to the treatment plant and to the existing distribution system. Created contract specifications for process equipment, yard piping, hydrants, valves, and appurtenances.

Asset Management Program, City of Somerville, MA

Project Engineer for development of an asset management program for the City. This program will integrate past efforts and form the basis for a unified long-term management strategy for both vertical and horizontal infrastructure. It includes an asset management maturity assessment, inventory, level of service evaluation, risk evaluation, and prioritization and implementation/communications strategy development.

Experience Prior to Hazen

Hampton Capital Improvements Plan, Aquarion Water Company, NH

Project Engineer. Prepared a Capital Improvements Plan (CIP)which included the completion of fire flow tests, hydraulic analysis, storage and supply evaluation, asset management analysis, criticality, and development of a 20-year improvement plan with associated estimated costs. Provided on-site inspection services for the construction of approximately 2,500 linear feet of 12-inch diameter HDPE water main via pipe bursting, which included coordination with New Hampshire Department of Transportation for pavement requirements on Atlantic Avenue and coordination with New Hampshire Department of Environmental Services for the removal of asbestos cement pipe.

Water Storage Tank Evaluation, City of Keene, NH

Project Engineer. Completed an evaluation of the City's existing 3 mg water storage tank to determine if it is more economical to construct a new water storage tank or to perform the necessary repairs on the existing water storage tank. Project also include water age analysis and recommendations to minimize water age due to increase in TTHM levels at sample sites in distribution system.

Above Ground Asset Management Inventory, City of Franklin, NH
Project Engineer. Utilized City record drawings and through conducting site visits, compiled an inventory of all above ground assets for the City's water treatment plant, pump stations and pressure control vaults. The inventory includes type of asset, age, condition, and estimated remaining useful life.

Below Ground Asset Management Analysis, City of Winchester, NH
Project Engineer. Conducted a conditions analysis for the below ground water infrastructure based on diameter, material, installation year, break history, corrosive soils, and static pressure. Developed a prioritized list of improvements with associated construction cost estimates.

Replacement Water Storage Tank and Booster Pump Station, Town of Winchester, NH
Project Engineer. Provided engineering services for the design of a new concrete water storage tank with new access road and water main as well as a new booster pump station to create a new pressure zone. The design project was a result of the hydraulic analysis completed for the water distribution system. Due to the storage deficit and condition of the existing tank, a new water storage tank was recommended. A new water storage tank site was evaluated for three different sites based on location to distribution system, land ownership, and style tank to maintain hydraulic grade line.

Avon CIP, City of Avon, MA
Project Engineer. Provided asset management condition analysis, critical assessment, water distribution system hydraulics analysis, and capital improvement cost development for the City.

New Storage Tank Site Evaluation, Town of Wayland, MA
Project Engineer. The addition of a secondary water storage tank was recommended to address the storage deficit and provide the Town with redundancy in the event that the existing tank is taken off line. Five potential tank sites were evaluated for the Town to determine a secondary tank location within their distribution system. Town owned sites, elevation, types of tanks, and distance from the distribution system were taken into consideration when recommending tank sites to the Town. The project involved creating and calibrating an extended period simulation model to determine effects of the secondary tank site on the distribution system and water age analysis to determine the increase in water age with the addition of the new tank.

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Matthew Valade, PE, BCEE

Vice President

Mr. Valade has 27 years of extensive experience in the evaluation, design, construction, and operation of drinking water treatment systems and facilities, including DAF, UV disinfection, and DBPs.

Education

MS, University of Massachusetts, Environmental Engineering, 1995

BS, University of Massachusetts, Civil Engineering, 1993, Mechanical Engineering, 1993

Instructor, University of Massachusetts - Water Treatment Institute

Certifications/Licenses

Professional Engineer: NH, MA, RI, CT, NY, ME, NJ, VT, Nova Scotia

Board Certified Environmental Engineer

Areas of Expertise

- Pilot studies and treatment evaluations
- Water treatment facility design and construction
- Drinking water regulations
- DAF process design
- UV disinfection system evaluation and facility design

Experience

- 27 total years
- 27 years with Hazen

Professional Activities

American Water Works Association

Water Environment Federation

Saco River Water Treatment Facility, Maine Water Company, Biddeford, ME
Technical Director. Responsible for design of a new 20-mgd new drinking water treatment plant to serve Southern Maine. This new facility will replace the existing one built in 1884. Led the treatment process evaluation to compare viable treatment options including plate settlers and dissolved air flotation (DAF). Oversaw the development of conceptual designs of both alternatives.

Walnut Hill Water Treatment Plant, MWRA, Marlborough, MA
Project Manager. Responsible for the detailed mechanical design and layout of the 405-mgd Walnut Hill Water Treatment Plant's pretreatment chemical and DAF process areas. Assisted in coordination of the mechanical design with the design firms responsible for electrical, instrumentation, HVAC, plumbing, architectural, and the mechanical/process disciplines responsible for other areas. Also assisted with the preliminary design of a new 300-mgd raw water pump station.

Finished Water Hydraulics and Chemical Feed Assessment, City of Buffalo, NY
Project Director for source to tap evaluation of the treatment process to evaluate overall corrosion control program. Included a desktop analysis of key water quality data, an evaluation of the City's water treatment plant, lead service line (LSL) scale analysis, and novel field investigations at households with LSLs. The City then extended services to perform additional services recommended by initial study to optimize flow through clearwells and chemical feeds to help assure maximum efficiency and consistency of corrosion control throughout distribution system.

Hillview Reservoir Facility Improvements, New York City Department of Environmental Protection (NYCDEP), Yonkers, NY
Project Manager for this multi-phased project to provide chemical facilities, flow control improvements and facility refurbishment at New York City's 2-bgd Hillview Reservoir. Leading the evaluation of existing systems and design of new chemical addition facilities to consolidate and

Hazen

improve chemical storage and provide flow-paced chemical feed systems. Design of the new chemical addition facilities includes bulk chemical storage, chemical feed systems, process equipment sizing, and operations space programming. Design of facility improvements also includes the rehabilitation of existing 100-year-old facilities and improvements to provide hydraulic redundancy.

Putnam Water Treatment Plant DAF and Filter Upgrade, Aquarion Water Company, Greenwich, CT
Lead Technical Advisor of a comprehensive, phased upgrade of Aquarion's 23-mgd Putnam Water Treatment Plant. The first phase includes demolition of one sedimentation basin, placement of support of excavation (SOE), upgrade and expansion of the plant's electrical service entrance, and DAF construction, startup, and commissioning. The second phase encompasses demolition of another sedimentation basin, more SOE, and filter construction, startup, and commissioning.

Orchard Street Pump Station and Treatment Plant, City of White Plains, NY
Technical Advisor for the planning and design of a new water treatment facility and associated systems, including chemical feed and pumping systems. The new treatment plant will supplement the City's water supply system and reduce reliance on purchasing water from an outside community.

New Design Road Water Treatment Plant Upgrade, Frederick County, MD
UV Process Leader. Responsible for Hazen's portion of the 25-mgd upgrade project, which included design of a new residuals handling facility, consisting of backwash equalization, gravity thickening and belt filter presses, 10 new chemical feed systems ranging from powdered activated carbon to sulfuric acid, and UV disinfection.

West Parish Water Treatment Facility Peer Review, Springfield Water and Sewer Commission, Westfield, MA
Technical Director. Participated in the Peer Review of a Facilities Plan for the Springfield (MA) Water and Sewer Commission. The Facilities Plan (generated by another consultant) was associated with a new 80-mgd DAF/flotation facility encompassing approximately $200M of capital improvements. The peer review consisted of a comprehensive review of the Facilities Plan document and background information, and evaluation of key areas. Findings and recommendations were discussed in a workshop setting and documented in a Technical Memorandum.

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Scott Bonett, PE

Associate Vice President

Mr. Bonett has 22 years of experience in the planning, design, and construction of water and wastewater treatment facilities. His projects have spanned throughout New England.

Education

MS, Environmental Engineering, University of Massachusetts, 1998

BS, Environmental Science, University of Massachusetts, 1993

Certification/License

Professional Engineer: MA, CT, NY

Areas of Expertise

- Project management
- Design and construction of water and wastewater treatment facilities
- Design and construction of pumping stations
- Facilities planning
- Bench and pilot scale treatability studies

Experience

- 22 total years
- 15 years with Hazen

Professional Activities

Water Environment Federation

American Water Works Association

- Connecticut Section Education and Program Committee Member
- Connecticut Section Chair

Sebago Lake Water Treatment Facility Chemical Storage Tanks Capital Improvements Plan Development, Portland Water District, Windham, ME

Project Director for the evaluation of existing chemical feed and storage facilities at the Sebago Lake Water Treatment Facility (SLWTF). The existing chemical feed and storage facilities at the SLWTF were originally constructed and placed into service in the mid-1990s. With the exception of a change from gas chlorine to sodium hypochlorite for disinfection, each system is original. Hazen evaluated the condition of the existing storage and feed systems and prepared upgrade recommendations including construction of new systems in place or construction of a new chemical storage and feed structure.

MWRA Agency-Wide and Carroll WTP Technical Assistance Contracts, Massachusetts Water Resources Authority, Boston Metropolitan Area, MA

Project Manager for this two-year task-order based (on call) Technical Services Contract which started in December 2020. This contract (Contract 7713) involves as needed study, design, and engineering during construction for projects at the 405-mgd Carroll Water Treatment Plant and water supply infrastructure. Current projects include the installation of a dehumidification unit within the plant's UV disinfection room and replacement of a 42- and 48-inch raw water valves and the Wachusett Lower Gatehouse. Responsible for project budget, scope, and schedule, as well as technical oversight and overall client satisfaction with deliverables.

Putnam Water Treatment Plant DAF and Filter Upgrade, Aquarion Water Company, Greenwich, CT

Project Manager for the design to replace the sedimentation process with dissolved air flotation (DAF) at Aquarion's 22-mgd Putnam Water Treatment Plant. Project includes a new filter building as a replacement for the existing filter facilities; new electrical service; extensive yard piping changes; and modifications to the residuals' clarifiers. Project also involves a detailed sequence of construction to ensure plant operations are maintained throughout construction.

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On-Call Engineering Services, Aquarion Water Company, CT
Project Director (2019-present) for a task order-based contract for Aquarion Water Company; served as Project Manager for five years (2014-2019 for this same contract. Over this time, involved in over 35 task orders which have included alternatives analyses, design, and construction of a variety of water infrastructure projects. Responsibilities have included oversight of design, maintaining adherence to schedule and budget, quality review, and ensuring client satisfaction with deliverables.

Water Treatment Plant Optimization Advice, City of Meriden, CT
Project Manager for an advice-based task order for the City of Meriden. Work included assisting the Broad Brook Reservoir treatment staff with an emergency conversion from sodium permanganate oxidation to pre-filter chlorine for manganese control when permanganate became unavailable due to supply-chain interruptions. Developed a raw water sampling program which will help inform the City as to whether permanganate use can be transitioned from year-round to seasonal application.

On-Call Engineering Services, Connecticut Water Company, CT
Project Manager for an ongoing on-call services agreement with Connecticut Water Company. Task orders have included a DAF pilot study at the Williams Water Treatment Plant, a desktop study of options for manganese removal from existing wells in Southbury, and optimization of corrosion control chemicals for a small groundwater supply in Coventry. Task order work has included alternatives analysis, concept layouts, and construction cost estimates.

General Engineering Services, Springfield Water and Sewer Commission, MA
Program Director for this task order-based (on-all) contract. Task orders include a peer review of the Facilities Plan for the West Parish Water Treatment Facility plant upgrade, which is comprised of an 80-mgd DAF/filtration facility encompassing approximately $200M of capital improvements.

Agency Wide Technical Assistance (Contracts 7546. 7497 and 7498, and 7691), MWRA, Boston, MA
Project Manager in four consecutive terms for this two-year, task order-based (on call) Technical Services Contract, the first term of which started in July 2014. Over the past seven years, have overseen 100 task orders of varying size and complexity, which have included water resources, wastewater collection, water distribution, and general infrastructure projects. Responsible for project budget, scope, and schedule, as well as technical oversight and overall client satisfaction with deliverables.

Erik Rosenfeldt, PhD, PE

Associate Vice President

Dr. Rosenfeldt is Hazen's Director of Drinking Water Process Technology and a senior member of the firm's Drinking Water Process and Applied Research Groups. His work focuses on drinking water and reuse technology, evaluating, implementing, and optimizing conventional and advanced treatment processes for a variety of water quality concerns.

Education

PhD, Civil and Environmental Engineering, Duke University 2007

MS, Civil and Environmental Engineering, Duke University, 2003

BS, Chemical Engineering, Washington University, 1999

Certification/License

Professional Engineer: MA,MI, NY, VA

Areas of Expertise

- Emerging contaminants
- Physical/chemical processes
- Water process technology
- Bench / pilot testing
- Water chemistry
- Advanced oxidation

Experience

- 23 total years
- 12 years with Hazen

Professional Activities

American Water Works Association

- Organic Contaminants Research Committee

International Ozone Association

International Ultraviolet Association

Drinking Water Process Optimization and Regulatory Support, Hanover County, VA

Project Manager and Technical Advisor for on-going process support related to managing treatment challenges and regulatory compliance in the Hanover County drinking water system. Projects have included understanding causes and developing strategies to reduce elevated levels of disinfection byproducts in the Doswell (VA)-supplied portion of the system, designing chlorination process changes and chemical feed upgrades, and developing nitrification control strategies for distribution system optimization. Additional tasks performed under the on-call contract include AWIA support tasks, bench testing, and emergency response and operations support.

Process Optimization Study, Beaufort Jasper Water and Sewer Authority, Okatee, SC

Technical Lead for process optimization and source water quality assurance. Provided technical oversight and planning to address treatment optimization for the Authority's two drinking water treatment plants. Plant-match jar testing procedures were developed for each facility and training provided to assist operations in reacting to rapid water quality changes and pursue optimization strategies. By suggesting optimization, the Authority expects to save over $150,000 per year in chemical costs associated with treatment modifications at one facility

Optimizing Selection of Filtration Pretreatment and Chemical Oxidant for UV Advanced Oxidation of Potable Reuse Waters, WateReuse Texas/City of Wichita Falls, TX/OK

Co-Principal Investigator for the on-site pilot testing at Wichita Falls, TX and Lawton, OK, which was combined with modeling approaches utilizing advanced OH radical background scavenging evaluation to assess the feasibility of implementing UV advanced oxidation for oxidation of emerging contaminants in direct potable reuse as part of non-membrane technology based process schemes

Reducing DBPs through process changes, City of Winchester, VA
Technical Advisor supporting process optimization investigations for the City's water treatment plant related to understanding water quality impacts of coagulant changes. The project involved developing and implementing a bench-to-full scale testing plant for evaluating performance of alternate coagulants. Through tasks under the on-call services contract, Hazen performed initial jar tests to verify vendor claims about impacts on turbidity, organics removal, DBP formation, and corrosion control and continued assistance through full-scale implementation support and water quality monitoring, to help the City meet the goals of reducing costs, optimizing treatment performance, and maintaining high water quality as they moved from ferric chloride to PACl based coagulation.

Advanced Water Treatment for Reuse Applications, City of Franklin, TN
Technical Advisor for development of a comprehensive technology evaluation for assessing and proving performance for regulatory approval for the first potential indirect potable reuse application in Tennessee. The evaluation includes process selection, piloting, and research and development of sustainable approaches to "right-size" treatment for achieving a variety of water quality goals, from advanced nutrient control to indirect or direct potable reuse.

EDC/PPCP Benchmarking and Monitoring Strategies for Drinking Water Utilities, University of Massachusetts, Amherst, MA
Co-Principal Investigator and Project Manager. Endocrine-disrupting chemicals (EDCs), pharmaceuticals, and personal care products (PCPs) encompass hundreds of trace contaminants that have been detected in raw and treated drinking waters. As it is impossible to monitor for all the compounds all the time, the project aims to develop a watershed-level protocol for addressing EDCs/PCPs monitoring needs, utilizing a combination of statistical tools, GIS and spatial analysis, and analytical sampling of indicator and surrogate compounds. The project was funded by the Water Research Foundation.

Alison Platt, PE

Senior Principal Engineer

Ms. Platt specializes in the evaluation of water treatment processes and plant design, with expertise in water treatment chemical systems.

Education

MS, Environmental Engineering, Manhattan College, 2015

BS, Civil Engineering, Manhattan College, 2013

Certification/License

Professional Engineer: NY

Areas of Expertise

- Chemical feed systems design
- Process/mechanical design
- Water/wastewater treatment process design
- Water/wastewater distribution system design and construction

Experience

- 9 total years
- 5 years with Hazen

Professional Activities

American Water Works Association

New York Water Environment Association

Hillview Reservoir Chemical Addition Facilities and Flow-Control Improvements, New York City Department of Environmental Protection, Yonkers, NY
Chemical Feed System Design Engineer. Responsible for development of the basis of design criteria for the new chemical systems located at an active reservoir which serves New York City 1 billion gallons per day of potable water. The project includes the construction of two new chemical storage and feed buildings on an active dam. Developed the process/mechanical design criteria for the storage and feed buildings for new chlorine gas, phosphoric acid, and sodium hydroxide systems. Responsible for the development of technical memoranda, technical specifications, and Engineers Report. This project is currently under design.

Also serving as *Project Controls Engineer*, responsible for developing, implementing, and managing project controls, which includes scope management, schedule management and forecasting, budget management and forecasting, progress and performance measurement, and management of a team of over 60-70 active technical staff, including more than a dozen subconsultant firms. Also responsible for coordinating field inspections/investigations, including mechanical equipment inspections, structural monitoring programs, geotechnical subsurface investigations, soil and groundwater investigations, and evaluations of critical power infrastructure.

Orchard Street Water Treatment Plant, City of White Plains, NY
Chemical Feed System Design Engineer. Responsible for the design of a new green-field 2.5 mgd stacked dissolved air flotation/filtration (DAF/F) plant with advanced granular activated carbon (GAC) treatment for the removal of per- and polyfluoroalkyl substances (PFAS) to improve redundancy, maximize use of in-City water supplies, and reduce reliance on the New York City system. Developed the chemical storage and feed systems design for new carbon dioxide, sodium hypochlorite, coagulant, phosphoric acid, sodium hydroxide, and fluoride systems. Involved in the design of the DAF/F, GAC, and UV treatment systems and residual management systems.

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Experience Prior to Hazen

Hydraulic Capacity Analysis and Design of Yard Piping within 28.9 MGD Wastewater Treatment Plant, Rockland County Sewer District No. 1, Orangeburg, NY

Design Engineer. Assisted in the evaluation and replacement of aging pipes throughout the plant. Evaluated existing conditions to determine locations of corroded pipe in need of replacement, conducted a hydraulic capacity analysis based on the existing piping material, condition, and design flow. Assisted in the design of new pipe systems to reduce future corrosion by implementing proper installation methods and incorporating adequate maintenance access points.

Design of Sewer and Manhole Repairs and Replacement, Rockland County Sewer District No. 1, Orangeburg, NY

Design Engineer. Responsible for the evaluation of gravity sewers and manholes for inflow and infiltration (I&I) and design of rehabilitation measures. Developed sewer rehabilitation design of both full span replacement and section replacement, including piping material, size, slope, alignment, and joint assembly to allow for optimal conveyance of sewage during peak hourly flow and wet weather situation while preventing future I&I or root entrance. Developed manhole rehabilitation design of both full replacement and section replacement, including manhole location, drop pipe inverts, manhole diameters, benches, lifts and rings, and cover types. Developed other design repairs, including frame grouting, frame replacement, waterproof lining installation, and cement repair.

Analysis and Design of Building Envelope Restoration Design, Parkchester South, Bronx, NY

Project Manager/Engineer. Responsible for the physical evaluation and restoration design of building envelopes for 15 individual high-rise buildings ranging from 10 to 12 stories. Physical evaluation of existing conditions included facades, windows/wall openings, building cornices/projections, railings/fire escapes, cladding/fascia, all appurtenances, structural steel members, steel lintels, and reinforced concrete. Designed repair and replacement elements including new structural steel members and concrete covers, steel member waterproofing, construction of new parapets and water tower walls, steel lintel replacement, brick replacement, mortar repointing, fire scape steel supports, and steel anchoring of gargoyles.

Jacob Cantor, PE, ENV SP

Principal Engineer

Mr. Cantor specializes in the inspection, planning, design, and construction of water treatment facilities, pump stations, and wastewater conveyance systems.

Education

MS, Biological Systems Engineering, Virginia Tech, 2016

BS, Biological Systems Engineering, Virginia Tech, 2015

Certification/License

Professional Engineer: MA, CT, NY

Envision Sustainability Professional

Pipeline Assessment Certification Program

Enclosed Space Entry

CPR and AED

Areas of Expertise

- Drinking water treatment
- Pump stations
- Drainage and sewage collection systems
- Field engineering
- ArcGIS

Experience

- 6 total years
- 6 years with Hazen

Saco River Water Treatment Facility, Maine Water Company, Biddeford, ME

Mechanical Engineer. The project included the design and construction of a 12-mgd greenfield water treatment plant and raw water intake for the Saco/Biddeford area in Maine. Responsible for the mechanical design of the treatment plant including four facility pump stations, clarification, filtration, disinfection processes as well as the residual disposal and waste recycle systems, and facility control systems. Performed shop drawing review, quality control and quality assurance, using the Envision framework as a sustainable guideline for the design, and coordination between overall design team, client, and construction contractor.

Orchard Street Pump Station and Treatment Plant, City of White Plains, NY

Mechanical Engineer. Prepared design and specifications for a 2.5 mgd dissolved air flotation (DAF) facility in White Plains, NY. Responsible for the mechanical design of six facility pump stations, intake screen and air sparging system, piping, and valving.

PFAS Treatment Evaluation and Preliminary Engineering Design, City of Danvers, MA

Mechanical Engineer. Prepared preliminary design for a 2-mgd, greensand and GAC filtration facility. Responsible for the evaluation and design of six facility pump stations.

Clapper Road Water Treatment Plant Improvements, Town of Bethlehem, NY

Mechanical Engineer. Designed a DAF clarification step within the existing 8-mgd Clapper Road filtration plant. Responsible for the design of the raw water pump station and residual disposal systems; also assisted with hydraulic and control systems.

Water Residuals Disposal, Town of Acton, MA

Project Engineer. Assisted the Town with drying and removal of 120,000 gallons of water residuals from a water treatment plant waste lagoon in Acton, MA. Responsible for recommending improvements to the residuals disposal system.

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Sewer Rehabilitation and Repair, Town of Haverhill, NH
Mechanical Engineer. Designed sewer lining and excavated repair for 1,600 linear ft. of 8-in combined sewer in Haverhill, NH. Responsible for drafting and resident engineering services.

Stormwater Permitting Assistance, City of Nashua, NH
Project Engineer. Assisted the City of Nashua with compliance to the New Hampshire MS4 permit. This included writing stormwater management and illicit discharge detection and elimination plans, as well as conducting an outfall prioritization exercise for wet weather sampling. Lead a field inspection of stormwater best management practices, and recommended rehabilitation and maintenance for these systems.

Sewer Rehabilitation and Repair Project, City of Manchester, NH
Mechanical Engineer. Designed sewer lining and excavated repair for 30,000 linear ft. of combined sewer (varying sizes from 8-in to 24-in) in the City of Manchester, NH. Responsible for design, drafting, and resident engineering services.

Seth Robertson, PE

Associate Vice President

Mr. Robertson serves as Hazen's Corporate Infrastructure Funding Leader. His project experience includes development of asset management programs, capital improvement planning, utility development, financial modeling and rate studies, and funding strategy development and implementation.

Education

BS, Environmental Engineering, North Carolina State University, 1997

Certification/License

Professional Engineer: NC

Areas of Expertise

- Funding assistance
- Financial analysis
- Asset management
- Capital planning

Experience

- 24 total years
- 1 year with Hazen

Professional Activities

Water Environment Federation

Island Water Reclamation Facility Relocation, Fort Pierce Utility Authority, FL

Funding Strategy Development. The Island Water Reclamation Facility has a history of damage from coastal events and presents a substantial ongoing risk due to its current location on South Hutchinson Island. Responsible for developing a funding strategy and implementation plan that evaluates feasible funding options including the use of State Revolving Funds (SRF), Florida Resiliency Grants, Water Infrastructure Finance and Innovation Act Funds, and emerging funding sources through the American Rescue Plan and Infrastructure Investment and Jobs Act to fund the approximately $100 million project. This strategy includes timelines, estimated chance of funding, and true cost of each funding alternative to provide a comprehensive evaluation that maximizes the best funding available.

Experience Prior to Hazen

North Carolina Division of Water Infrastructure, NC

SRF Section Chief. Responsible for the management of over $2 billion in critical need water and wastewater infrastructure funds. Also served as the co-chair of the national EPA and SRF workgroup.

Neuse River Water Reclamation Facility, Town of Clayton, NC

Funding Assistance. The Town of Clayton has a critical need for expansion of their current wastewater treatment capabilities due to a combination of residential and industrial growth. Responsible for developing the funding strategy for the new Neuse River Water Reclamation Facility and managed the preparation of applications to the North Carolina Division of Water Infrastructure for the Clean Water SRF. A total of $110 million in funding was secured over three application rounds which represents a savings of approximately $40 million in interest costs over the revenue bond alternative. This is the largest funding award for a single project through the North Carolina SRF program to date.

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Asset Condition Assessment, Financial Modeling, Sewer Rehabilitation and Replacement, Town of Selma, NC

Funding Assistance. The Town of Selma has been experiencing significant infiltration and inflow since Hurricanes Florence and Michael. The resulting I/I created system overflows and excessive treatment costs. Two projects were identified as priorities for reducing flows in addition to the need for system condition assessment and financial modeling. Responsible for managing the securing of a total of $5.5 million (including $3 million in grants) through the Clean Water SRF Additional Supplemental Appropriations for Disaster Relief Act of 2009, Community Development Block Grant-Infrastructure program, and the North Carolina Asset Inventory and Assessment grant program to fund the identified needs.

Water and Wastewater Rehabilitation and Planning, City of Dunn, NC

Funding Assistance. The City of Dunn has significant expected growth while experiencing capacity restrictions in the existing water and wastewater systems. Responsible for developing and implementing a comprehensive funding plan for both the water and wastewater systems which consisted of water line replacements, sewer rehabilitation, and the study of regional partnerships for a new drinking water treatment plant. A total of $8.3 million was secured through this process including $2.4 million in grants. A combination of funding was acquired through the Clean Water SRF, Drinking Water State Revolving Fund, Community Development Block Grant-Infrastructure fund, and the North Carolina Merger Regionalization Feasibility grant program to help the City address immediate issues and plan for the future.

Rose Jesse, CPE

Senior Associate

Ms. Jesse oversees Hazen's Northeast Estimating Team utilizing the recommended practices of the AACE, real data on cost, and construction knowledge. In 2021 alone, her team provided 119 construction estimates at a total value of over $5.3B - all within 6% of construction bid.

Education

BS, Civil Engineering Technology
Rochester Institute of Technology, 1996

Certification/License

Certified Professional Estimator

OSHA 10 & 30 hour Construction Outreach

AACE: Risk Management, Cost and Schedule Control, and Earned Value Management

Areas of Expertise

- Construction cost estimating
- Constructability review
- Project management
- Risk assessment
- Construction sequencing/scheduling

Experience

- 25 total years
- 7 years with Hazen

Professional Affiliations

Project Management Institute

Association for the Advancement of Cost Engineering International

National Association of Women in Construction

New York Water Environment Association

Rye Lake Water Filtration Plant Design, Westchester Joint Water Works, Westchester County, NY
Cost Estimating Lead. Provided oversight to the cost estimating team for the process evaluation and conceptual and preliminary design of the 30-mgd stacked dissolved air flotation/filtration (DAF/F) facility.

MWRA Agency-Wide and Carroll WTP Technical Assistance Contracts, Massachusetts Water Resources Authority, Boston Metropolitan Area, MA
Cost Estimating Lead for this two-year task-order based (on call) Technical Services Contract which started in December 2020. This contract (Contract 7713) involves as needed study, design, and engineering during construction for projects at the 405-mgd Carroll Water Treatment Plant and water supply infrastructure. Current projects include the installation of a dehumidification unit within the plant's UV disinfection room and replacement of a 42- and 48-inch raw water valves and the Wachusett Lower Gatehouse.

Saco River Water Treatment Facility, Maine Water Company, Biddeford, ME
Cost Estimating Lead. Provided an initial cost evaluation for the project that includes the design and construction of a new 20-mgd conventional treatment plant, to replace the existing one built in 1884. The facility will withdraw source water from the Saco River and replace an existing facility. The plant will include inclined plate settlers, dual media filtration, and appurtenant chemical feed facilities. Residuals will be processed in new sludge drying beds. Project is currently under construction.

Madbury Backwash Tank and Pump Station, City of Portsmouth, NH
Cost Estimator. This project was a multidisciplinary design initiative. In addition to the pump station, the entire plant was constructed under the City's sustainability program. LEED silver certification was received in 2011.

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West Parish Water Treatment Facility, Springfield Water and Sewer Commission, Westfield, MA
Cost Reviewer/Advisor. Participated in the Peer Review of a Facilities Plan for the Springfield Water and Sewer Commission. The Facilities Plan (generated by another consultant) was associated with a new 80-mgd DAF/F facility encompassing approximately $200M of capital improvements. The review consisted of a comprehensive review of the Facilities Plan document and background information, and evaluation of key areas. Findings and recommendations were discussed in a workshop setting and documented in a Technical Memorandum.

Putnam Water Treatment Plant DAF and Filter Upgrade, Aquarion Water Company, Greenwich, CT
Cost Estimator. The project included the replacement of the sedimentation process with DAF at Aquarion's 22-mgd Putnam Water Treatment Plant. Project includes a new filter building as a replacement for the existing filter facilities; new electrical service; extensive yard piping changes; and modifications to the residuals' clarifiers. Project also involves a detailed sequence of construction to ensure plant operations are maintained throughout construction.

Broad Run Water Reclamation Facility, Loudoun Water, Ashburn, VA
Cost Estimator. Provided oversight and estimating to the team for the 16.5 MGD Design Flow Expansion project. Project included both new facilities and rehabilitation of existing facilities including bioreactor basins, membrane facilities, screening facilities, odor control, UV treatment and chemical buildings, thickening and dewatering facilities, GAC, clarifiers, and large EQ tanks.

Indian Brook Water Treatment Plant, Village of Ossining, NY
Cost Estimating Manager. Providing oversight and estimating for the new water treatment plant. Scope of work includes substantial earthwork, retaining walls, buildings, equipment, electrical and instrumentation. Project value approximately $34 million.

Stamford Water Treatment Plant Residual Alternative Analysis, Aquarion Water Company, CT
Cost Estimator/Reviewer. Provided support and review of estimates for the installation of new lagoons in a greenfield location. The project involved excavation and removal of over 30,000 cy of earth and rock and the installation of pumps and pipe to support dewatering of the facility.

Benjamin Agrawal, PE

Principal Engineer

Mr. Agrawal specializes in conveyance systems, condition assessment, 1D and 2D modeling, and long term planning. He has worked on multiple projects throughout New England.

Education

BS, Civil Engineering,
Northeastern University, 2016

Certification/License

Professional Engineer: NH

OSHA 8-HR: Confined Space Entry

Areas of Expertise

- 1D and 2D modeling
- Water quality
- HoloBuilder (construction progress management platform)
- Stormwater treatment and conveyance
- Green infrastructure

Experience

- 8 total years
- 6 years with Hazen

Sewer and Watershed Delineation, City of Portsmouth, NH

Modeling Engineer. Delineated water and sewersheds in the City of Portsmouth using ArcGIS Pro. Using GIS data provided by the City, which contained shapefiles for the City's storm and sewer infrastructure as well as elevation contours, comprehensive mapping of drainage patterns and the collection system were developed to support future capital work and regulatory requirements.

Inundation Model, Boston Water and Sewer Commission, MA

Modeling Engineer. Hazen is currently developing a multi-dimensional inundation model for the Boston Water and Sewer Commission. This model will be used to predict citywide inundation resulting from rain events concurrently with differing coastal conditions. Model results will be used to inform storm preparation planning, including evacuations, operations procedures, and other flood protection measures. Hazen will utilize state of the art visualization tools such as ArcGIS StoryMaps and Microsoft Power BI to enhance the accessibility of model results and ensure that the Commission can easily share relevant mapping and information with the public and other agencies.

Integrated Plan, City of Lowell, MA

Modeling Engineer. Supported development of water quality monitoring/modeling and sewer system characterization/modeling using PCSWMM advanced modeling software. Developed a plan for the deployment of sixteen flow meters for model calibration. The model will be used to assess sewer system performance and CSO capture, then to assess the effectiveness of additional CSO control measures and system improvement to support updating the previous CSO long-term control plan.

Experience Prior to Hazen

Water Advice, Town of Avon, MA

Project Engineer. Developed a spreadsheet to calculate flow in parallel pipes based on length, diameter, and friction factor. The spreadsheet calculated the overall CT value of up to 6 sections of parallel pipes to ensure adequate disinfection. Simulated 4-log system improvements in WaterCAD and developed yearly CCR and MassDEP compliant distribution list.

Katie Hoek, PE

Senior Associate

Ms. Hoek's work focuses on identifying potential environmental impacts and working with the design team to minimize or mitigate these impacts. She has led complex permitting efforts and understands which permits to prioritize to keep projects on track.

Education

MS, Civil/Environmental Engineering, Stanford University, 2005

BS, Physics, St. Lawrence University, 2002

Certification/License

Professional Engineer: NH, NY

Areas of Expertise

- Permitting
- Environmental impact statements and assessments
- Water quality studies/reports
- Environmental project management
- Stakeholder facilitation and coordination

Experience

- 17 total years
- 15 years with Hazen

Professional Activities

National Association of Environmental Professionals

American Water Works Association

Revitalization of Existing Water Supplies, City of White Plains, NY
Permitting Lead Led development of the environmental assessment and preparing and obtaining all permits for installation of a new water storage tank and construction of a new water treatment plant, including revitalization of a prior supply and the installation of associated treatment systems.

Rye Lake Water Filtration Plant Design, Westchester Joint Water Works, Westchester County, NY
Regulatory Liaison. Provided technical regulatory guidance for preparation of an environmental impact statement and federal, state and local permits to support construction of a new dissolved air flotation (DAF) water treatment facility including land transfer between the project sponsor and County.

MWRA Agency-Wide and Carroll WTP Technical Assistance Contracts, Massachusetts Water Resources Authority, Boston Metropolitan Area, MA
Permitting Lead for a variety of task order projects, including environmental monitoring, stormwater/CSO work, facilities planning, and cost estimating.

Saco River Water Treatment Facility, Maine Water Company, Biddeford, ME
Regulatory Liaison. Provided technical regulatory guidance for the Saco River Water Treatment Facility project including evaluation of permitting needs for a new water intake structure.

Sea Street Pump Station Upgrade, Town of Nantucket, MA
Permitting Lead. Responsible for identifying, tracking and helping to secure permits to support design upgrades to the 5.6-mgd pump station.

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Hazen

Saya Hickey, PE

Associate Vice President

Ms. Hickey is one of Hazen's leading regulatory and permitting experts, with skills is NPDES permitting and negotiation, water quality, sustainability, and watershed planning. This includes projects related to the Merrimack River.

Education

BS, Chemical Engineering, University of Kentucky, 1985

Certification/License

Professional Engineer: TN, NY, KY, MN

Areas of Expertise

- Regulatory compliance and permitting
- Water quality/watershed planning
- Collection system correction
- MS4 compliance

Experience

- 34 total years
- 9 years with Hazen

Professional Activities

Water Environment Federation

New England Water Environment Association

Regulatory Assistance – POTW NPDES Permit, City of Lowell, MA

Permitting. Began negotiations with Massachusetts DEP and EPA Region 1 prior to issuance of the draft permit focusing on appropriate nutrient limits. Provided comments on the draft permit and the technical basis for the appeal of the final permit.

Regulatory Assistance, City of Nashua, NH

Permitting. Reviewed the City's draft permit in detail, checked reasonable potential calculations and basis for new permit requirements. Compared the permit requirements with applicable state and federal rules, statute and protocols. Prepared technical memo that outlined several deficiencies with the draft permit as well as recommending corrections to permit requirements. Reviewed the 2015 final permit and provided the technical basis for the permit appeal. Successfully negotiated with EPA Region 1 to achieve a very favorable total phosphorus permit limit and to delete unnecessary monitoring requirements.

Long-Term Control Plan and MS4 Assistance, City of Nashua, NH

Permitting. Assisting Nashua in negotiations with EPA R1 regarding proposed consent decree modifications to require additional CSO controls and inclusion of MS4 compliance. As a result of this work, EPA has agreed to table any consideration of revising the CD to include MS4 requirements. Ongoing negotiations will focus on post-construction monitoring and additional CSO controls

Regulatory Assistance – MS4, City of Lowell, MA

Permitting. Reviewed both the draft and final EPA Region 1 General Permit for Discharges of Stormwater from Small MS4s. Reviewed applicable provisions of the CWA and 40 CFR, as well as Massachusetts Water Quality Standards, to determine the full impact of the draft permit on the City. Prepared comments on the draft permit and assisted Lowell in its appeal of the final permit. Also assisted the City in an application for an individual MS4 permit to resolve the appeal.

Hazen

Jeff Neale

Director of Communications

For more than 25 years, Mr. Neale has managed communications and outreach programs that have shaped the narrative around environmental projects, successfully reaching diverse target audiences with succinct messages distilled from complex, technical information.

Education

BA, Literature, American University, 1994

Areas of Expertise

- Communication and public outreach strategy
- Messaging and materials development
- Project management

Experience

- 26 total years
- 13 years with Hazen

Lead and Copper Rule Revision Compliance Program, WSSC, Laurel, MD

Public Relations/Outreach. This programmatic evaluation assisted WSSC in developing a comprehensive Lead and Copper Rule Revision Compliance Program. Working collaboratively with numerous WSSC departments, an action plan was developed to provide a road map for the lead service line inventory and replacement plan, corrosion control treatment, and public outreach. A detailed program schedule and management approach were developed to ensure that tasks are completed in a timely manner and compliance requirements are met well in advance of the US EPA October 16, 2024 deadline.

Integrated Water Management Planning, New York City Department of Environmental Protection, New York, NY

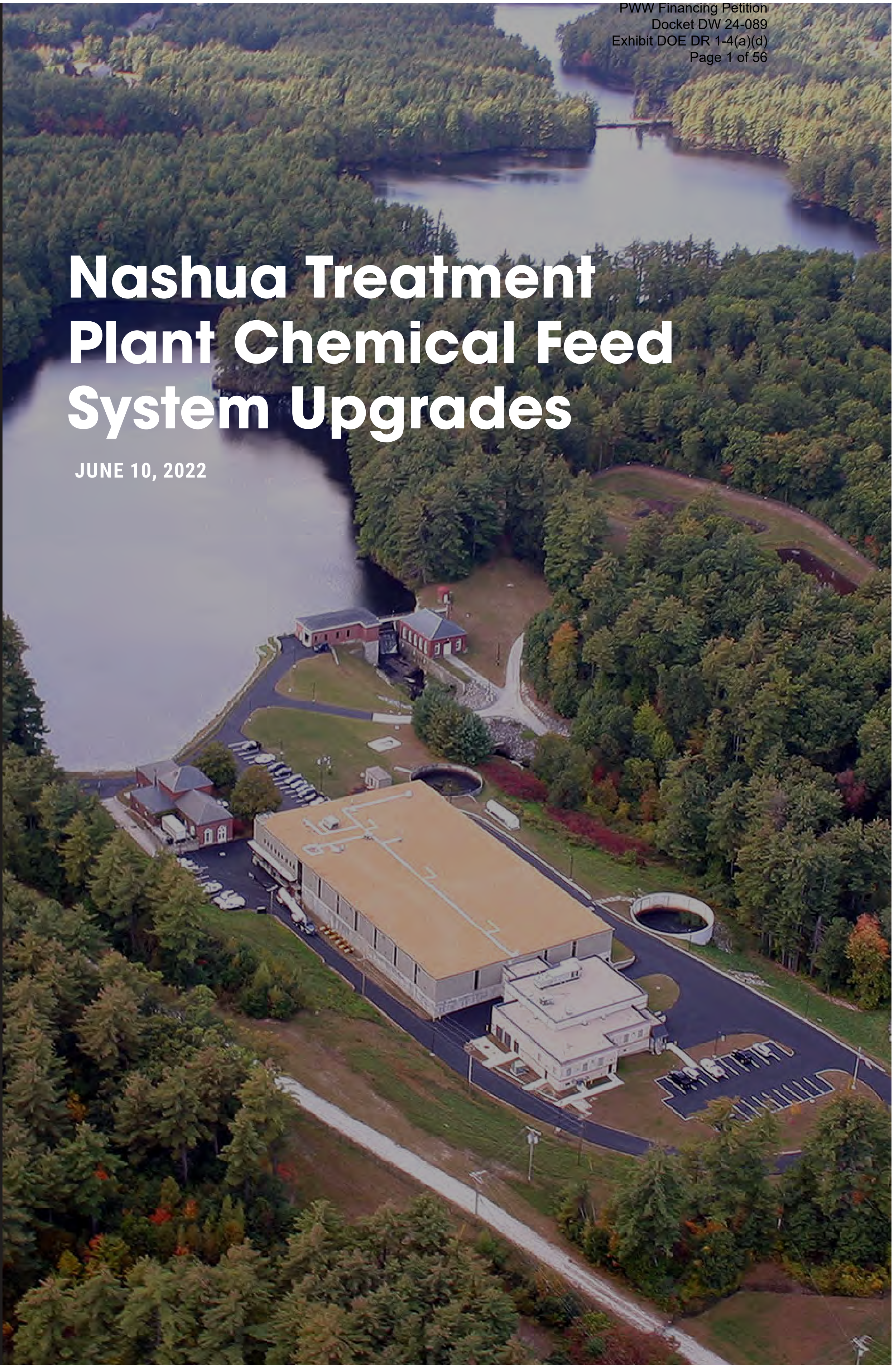
Public Relations/Outreach. Led all outreach and communications efforts to affected communities and the general public as well as other institutional, governmental, and environmental stakeholders. Outreach efforts include working with technical teams to develop planning and messaging and with graphic designers to develop electronic and print materials intended to communicate value and win support for the paradigm shift to integrated water management.

Water Resources Planning, City of Santa Fe, NM

Public Relations Creative Director. Led development of two sets of printed materials explaining a range of projected water supply/demand scenarios, the history of water infrastructure investments the City has made to meet growing demand over time, and a project intended to provide additional supply and resiliency to the Santa Fe system. Both sets communicate complex information visually (using infographics and photos) to two different target audiences, one being residents, the other City Council members, the Mayor's office, and other stakeholders.

Hazen

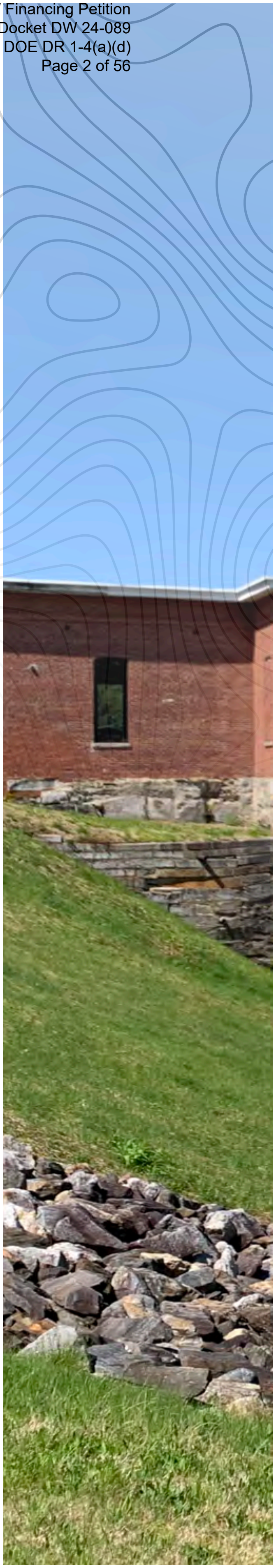
Hazen and Sawyer
1750 Elm Street, Suite 402 • Manchester, NH 03104



Nashua Treatment Plant Chemical Feed System Upgrades

JUNE 10, 2022

PREPARED FOR: PENNICHUCK WATER WORKS INC. // PREPARED BY: STANTEC CONSULTING SERVICES INC



Contents

Stantec

STATEMENT OF INTEREST

June 10, 2022

Pennichuck Water Works Inc.
Attn: John J. Boisvert, PE, Chief Engineer, and Hannah Marshall, EIT
25 Walnut Street
PO Box 428
Nashua, NH 03061-0428

RE:
Nashua Treatment Plant Chemical Feed System Upgrades

Dear Mr. Boisvert, Ms. Marshall and Members of the Selection Committee:

Pennichuck Water Works (PWW) is recognized as a premier supplier of water in New Hampshire providing reliable, high quality, and affordable water in sufficient quantities. The addition of PFAS compounds as primary drinking water standards has challenged many water suppliers in New England over the last several years and has resulted in suppliers seeking new sources of supply and/or the addition of treatment. PWW's foresight in putting infrastructure in-place to by pass the Pennichuck Brook System and pump water directly from the Merrimack River to the plant, has allowed it to maintain compliance with this new contaminant. This supply source change has resulted in coagulant use that exceeds guidelines for available monthly chemical storage volume and chemical feed pumps operating close to their rated capacity. These changes in chemical feed rates require updates to the existing equipment to meet storage and pumping requirements.

We are excited to have the opportunity to assist you in meeting this new challenge and build upon the previous work that we achieved together as part of the $35 million ACEC Award Winning plant upgrade that was completed in 2009 and resulted in increasing the redundancy, flexibility, and reliability of the plant.

To ensure this project is successful and meets the needs of PWW both now and in the future, we have assembled a team that brings:

Excellence in Design. Chris Yannoni has spent his career in the field of water treatment helping clients throughout New England address their most critical treatment and chemical handling challenges. Stantec's philosophy of designing flexible and reliable systems that go beyond primary and secondary drinking water standards at a reasonable cost mirrors PWW's overarching mission of providing reliable, high quality, and affordable water in sufficient quantities to its customers.

Experienced Management and Technical Team Members. To provide the range of services needed for this project, we have selected Stantec Team members that we know and trust from experience on other projects and who have direct relevant experience at the Nashua Treatment Plant, several of which we have listed in our qualifications section:

- Katie Chamberlain, our process evaluation lead, has 20 years of experience and is Stantec's US North Regional Sector Lead in Drinking Water Treatment. She has worked closely with Chris Yannoni on water treatment process studies and start-up of treatment facilities. She works with other water treatment sector leaders across Stantec, sharing technical information and project lessons learned related to drinking water treatment topics and collaborating with the wider Stantec water treatment community throughout the world.
- Mike Bartley, our concept design lead, has 20 years of experience and is Stantec's US North Regional Sector Lead in the Process Mechanical engineering discipline providing similar benefits stated for Katie. He has completed many similar treatment plant process and chemical feed system upgrades including the previous major plant upgrades for PWW.
- Jeff Cohen will lead the architectural design, as he has done for most of our treatment and chemical feed system layouts over the past 35 years including the previous major plant upgrades for PWW.

Stantec Consulting Services Inc.
65 Network Drive 2nd Floor
Burlington, MA 01803

Our knowledge and expertise individually, combined with our familiarity and experience working together, and collaboratively with PWW as part of the previous major plant upgrade, creates the ideal team for this project.

A Team Culture and Approach Focused on Collaboration. During this Concept Design effort, our approach gives you the key information needed to understand the issues and visualize alternatives, supported by thorough analysis; we will share this information with collaborative workshops aimed to promote discussion and ultimately select the alternative that best fits PWW needs.

Cost Effective Design and Construction. Our team's experience brings more than an outstanding design. We know how to create a cost-effective design without sacrificing quality and operability. Our experience brings the added value of understanding where major cost implications occur during design. We know the key items to pay attention to during each phase of design, bidding, and construction to maximize the value of each dollar PWW is spending.

Our team has a demonstrated history of successful collaborative delivery, and this proposal presents our continued commitment to deliver affordable, safe and reliable treatment solutions to water providers like PWW.

We look forward to the opportunity to work with you. Please contact me if you have any questions about our proposal or require additional information.

Erica Lotz **INC.**

Erica Lotz PE
Principal in Charge
erica.lotz@stantec.com

Christopher Yannoni PE
Project Manager, Senior Principal
christopher.yannoni@stantec.com

Past Experiences & References

About Stantec

Communities are fundamental. Whether around the corner or across the globe, they provide a foundation, a sense of place and of belonging. That's why at Stantec, we always design with community in mind.

The Stantec community unites approximately 22,000 employees working in over 350 locations across 6 continents. We care about the communities we serve—because they're our communities too. We're designers, engineers, scientists, and project managers, innovating together at the intersection of community, creativity, and client relationships. Balancing these priorities results in projects that advance the quality of life in communities across the globe.

#1

Ranked most sustainable corporation in North America

2021 Corporate Knights Global 100

#2

Design Firm in Water International Design

2021 Engineering News-Record (ENR)

At Stantec, we approach every water and natural resource project we undertake thoughtfully, and execute it with excellence. We partner with our clients to design fit-for-purpose solutions that address their communities' unique needs throughout the water infrastructure life-cycle. We proactively manage the schedule and scope of every client's project, which means that you can be confident that we'll deliver on target, within budget, and on time, every time.

Our Experience

Stantec will draw upon our experience with medium and large regional water supply and delivery projects, broad range of technical expertise, and strong local knowledge and resources to support and advise Pennichuck Water Works. Leveraging a 100-year legacy in New England, having completed over seventy (70) water treatment plants in New England, we bring a global portfolio of expertise in water supply planning/ management, water treatment including chemical systems, pumping, and transmission system expertise, as well as experience applying this knowledge for communities throughout New England.

On the following page, the table demonstrates Stantec's water engineering experience over the past fifteen years, with a particular focus on water treatment. Details on New England water treatment projects and select medium to larger capacity water treatment projects throughout North America are presented, including new chemical storage and feed systems as a critical process component.

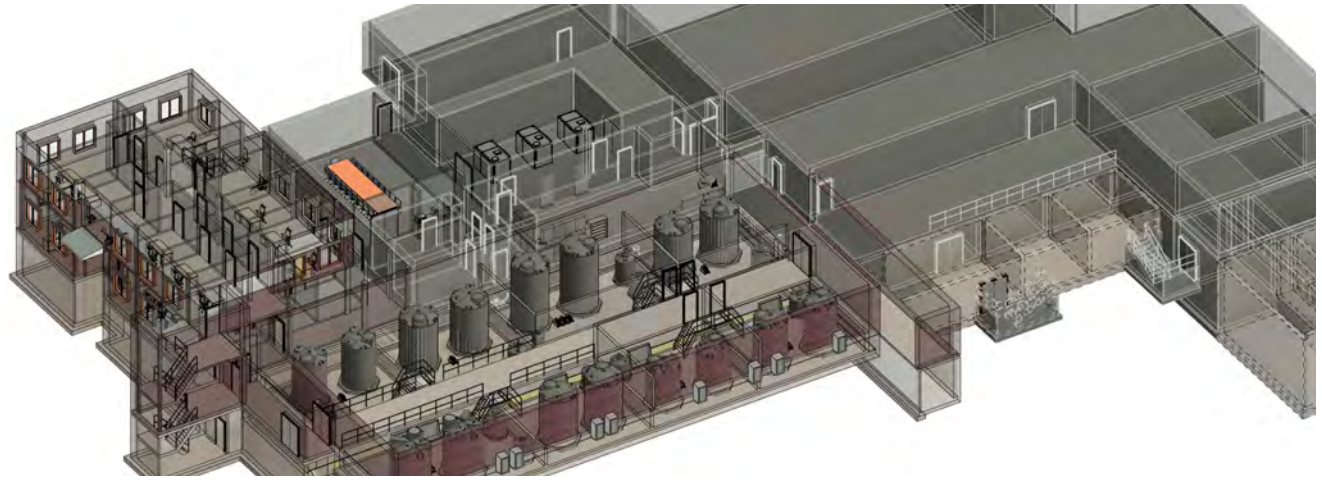
Presented following the table are five projects for major regional suppliers in Connecticut, Massachusetts, and Vermont that demonstrate our team's recent experience on similar projects.

WATER TREATMENT EXPERIENCE

Water Treatment Plant Name	Address	Capacity	General Process Rehab	General Process Redund.	DBP Reduction	Ozone	Chlorine Dioxide	Direct Filtration	MIEX	Conventional Clarification	Incl. PS.	DAF	Upflow Floc Blank.	Ballasted Sand Flocculation	Membrane	Media Filter	GAC Filter	GAC Contactor	PAC	Nano Filtration	Res. Man. NPDES	Enhanced Coagulation	Minim. Pre-Chlor.	pH Relocation	CW Baffle	FW Storage	Chloramination	Boost Clor.	Tank Operations	In-Tank Mixing	In-Tank Aeration
Regional																															
John J. Carroll WTP	Weston and Marlborough, MA	400	🟧	🟧	🟧	🟣🟢																					🟣🟢				
West Hartford WTP	West Hartford, CT	90	🟧	🟧												🔵🟣🟢										🔵				🔵🟣🟢	
Worcester WTP	Worcester, MA	50	🟧	🟧																	🔵🟣🟢										
Bloomfield WTP	Bloomfield, CT	40	🟧	🟧						🔵						🔵										🔵				🔵🟣🟢	
Pennichuck Water	Nashua, NH	30	🟧	🟧	🟧		🔵🟡					🔵🟡	🔵🟡	🔵	🔵		🔵🟡🟣🟢				🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢		🔵🟣🟢					
City of Fall River	Fall River, MA	24	🟧	🟧	🟧	🔵	🔵		🔵						🔵	🔵🟣🟢	🔵		🔵	🔵	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢
City of Taunton	Taunton, MA	14	🟧	🟧	🟧	🔵										🔵	🔵	🔵		🔵				🔵🟣🟢			🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	🔵🟣🟢	
City of Groton	Groton, CT	12	🟧	🟧	🟧		🔵🟡🟣🟢			🔵🟣🟢	🔵	🔵🟡🟣🟢			🔵	🔵	🔵🟡🟣🟢				🔵🟣🟢	🔵🟣🟢		🔵🟣🟢		🔵🟣🟢					🔵🟣🟢
City of Gloucester	Gloucester, MA	10	🟧	🟧	🟧	🔵	🔵								🔵	🔵	🔵			🔵		🔵🟡🟣🟢	🔵🟡🟣🟢	🔵🟡🟣🟢	🔵🟣🟢		🔵🟣🟢		🔵🟣🟢	🔵🟣🟢	
Madbury WTP	Madbury, NH	8	🟧	🟧	🟧	🔵🟡						🔵🟡	🔵	🔵	🔵🟡	🔵🟡	🔵🟡		🔵🟡			🔵🟡				🔵🟣🟢	🔵🟡	🔵🟣🟢			🔵🟣🟢
North America																															
Quartz Hill WTP	Palmdale, CA	90	🟧	🟧	🟧	🔵🟡🟣🟢	🔵		🔵	🔵🟡🟣🟢	🔵🟡🟣🟢				🔵	🔵	🔵🟡🟣🟢	🔵	🔵	🔵	🔵🟣🟢	🔵🟡🟣🟢	🔵🟡🟣🟢	🔵🟡🟣🟢	🔵🟡🟣🟢		🔵🟡🟣🟢	🔵	🔵		
Harry Tracy WTP	San Bruno, CA	180	🟧	🟧		🟢		🔵🟡🟣🟢								🔵🟡🟣🟢					🔵		🔵	🔵	🔵	🔵	🔵	🟣🟢	🔵	🔵🟣🟢	
Hap Cremean Water Plant	Columbus, OH	120	🟧	🟧	🟧	🔵🟡🟣🟢									🔵🟡		🔵🟡🟣🟢	🔵🟡	🔵🟡	🔵🟡		🔵🟡🟣🟢									
Vineyard Surface WTP	Sacramento, CA	50		🟧						🔵🟡🟣🟢					🔵🟡🟣🟢																
Seymour Capilano	North Vancouver, BC	475		🟧	🟧	🔵🟡🟣🟢	🔵	🔵🟡🟣🟢			🔵🟡					🔵🟡🟣🟢	🔵🟡				🔵🟡🟣🟢		🔵	🔵	🔵🟡🟣🟢		🔵🟡	🔵🟡🟣🟢			
South Fork Treatment Plant	Nanaimo, BC	30		🟧				🔵🟡				🔵🟡			🔵🟡🟣🟢	🔵🟡					🔵🟡🟣🟢										
Green River Filtration Facility	Tacoma, WA	150						🔵🟡🟣🟢			🔵🟡🟣🟢			🔵🟡		🔵🟡🟣🟢					🔵🟡🟣🟢										

LEGEND

- 🔵 Treatability Study Planning
- 🟡 Pilot Study
- 🟣 30% Preliminary Design
- 🟢 Final Design



Rendering Proposed Chemical and Administration Office Building Addition

Champlain Water Treatment Plant - Chemical Building Addition

South Burlington, Vermont

Champlain Water District (CWD), the state's largest regional public water supplier, operates a 20 million gallon per day (MGD) Water Treatment Facility (WTF) in South Burlington, VT. CWD is responsible for the treatment and transmission of wholesale water to 83,000 customers in twelve (12) water systems throughout Chittenden County. Since the original facility was constructed in 1974 there have been many process additions and changes that have increased the plant capacity from 12 to 20 MGD. As is typical with a facility that has expanded in stages over many years, the functional layout of the facility is not as efficient as it would have been if the facility were built new. The existing size, space, and location of the chemical storage and process areas are inadequate to comply with existing codes and needs of the facility and administration office areas have expanded into areas originally designed for process equipment and laboratory space.

Stantec is nearing completion of a chemical storage and feed evaluation preliminary engineering report (PER) to centralize the eight (8) major process chemicals including conversion of potassium permanganate to sodium permanganate. The conceptual design includes a 60-foot by 100-foot chemical building addition that houses two bulk storage tanks, day tanks and feed systems for each chemical ranging in size from 2,500 to 5,000 gallons or a total of 60,000 gallons of bulk storage. The concept also includes a new two story 50-foot by 70-foot administration office building addition that allows for repurposing the existing administration office space for a properly sized laboratory, new blower room for process flushing and backwash, and a larger size conference room area. The completion of the PER followed VT Department of Environmental Conservation (DEC) requirements for receiving Drinking Water State Revolving Funds for this estimated $20 million project.

Preliminary Engineering Report
All New Chemical Storage and Feed Systems
New Standby-Power
New Blower Equipment
New Administrative Office Addition
DWSRF Funding
Maintain Continuity of Supply
Utility, Drain and Process Pipe Relocation
Life Cycle Cost Estimating

Reference:	**Joe Duncan, 802-861-4808 joe.duncan@champlainwater.org**
Client Decisions/Actions:	**Presenting recommendations to Board**
Project Budget:	**$20 million**
Project Start:	**December 2021**
Project Completion:	**June 2022**
Team Members Involved:	**Chris Yannoni, Project Manager Mike Bartley Chris Nichols Phil Relf Trey Dykstra Don Polla Jeff Cohen Mike Price Paul Paone Kevin Bucher Jeff Cota**

Phosphate Chemical System

DAF/GAC Building Addition (on left) to Existing WTP

Groton Utilities, Water Filtration Plant Improvements

Groton, Connecticut

Through expert investigation, testing, and engineering efforts, Groton Utilities (GU), a regional supplier, was successfully granted $54M through the Drinking Water State Revolving Fund (DWSRF) program—marking this WTP upgrade as the largest project in the program's history.

Conventional water treatment processes at GU's plant historically produced a good finished water quality, however, as water quality regulations have become ever more stringent, meeting treatment goals has become increasingly difficult.

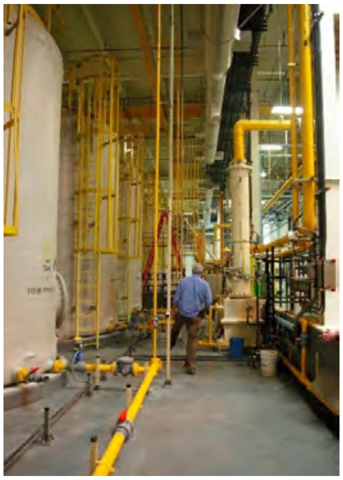
With upgrade needs at a critical high, our team provided a comprehensive process evaluation of existing sedimentation and filtration processes. Complexity was added to the equation with GU's wish to enhance its overall ability to control manganese levels more effectively in its finished water. Our team's conceptual design report compared possible solutions for improved water treatment. The result was the implementation of a pilot process that utilized a Dissolved Air Flotation (DAF) method followed by deep bed GAC filtration. This replacement for GU's existing sedimentation and filtration process offered the flexibility of being fully implemented as either a new build solution or a retrofit option, should funding become a challenge.

The pilot study showed that the combined processes of DAF followed by deep bed GAC and post manganese contactor adsorption met all of GU's treatment goals. Our team completed the preliminary and final design over a 36-month period working closely with Groton Utilities operations staff.

In July 2017, the federal-state DWSRF program granted GU and our team a notice to proceed on the 3-year, $54M build out of an improved facility. The new DAF/GAC filtration facility has been in service since November 2020. The project included rehabilitation and repurposing of the existing facility and included all new chemical storage and feed systems, new standby power, and new administrative office areas located in the old Unit 2 flocculation area as part of a complete building renovation. The last phase of the project —the manganese contactor process —went on-line in April 2022 and the project was completed in May 2022.

Preliminary Engineering Report
All New Chemical Storage and Treatment
Maintain Continuity of Supply
DWSRF Funded Project $15 Million Grant, $39 Million Loan
Process Evaluation
Condition Survey
Utility, Drain and Process Pipe Relocation
Life Cycle Cost Estimating

Reference:	**Ron Gaudent, 806-446-4091, gaudetr@grotonutilties.com**
Clients Decisions/Actions:	**Most Recommendations Implemented**
Project Budget:	**$54 million**
Project Start:	**January 2008 (concept design and piloting)**
Project Completion:	**May 2022**
Team Members Involved:	**Chris Yannoni, Project Manager Mike Bartley Chris Nichols Katie Chamberlain Phil Relf Trey Dykstra David Glennon George Bagdasarian Jeff Cohen**



Hypo system upgrade at CWTP

Wachusett Aqueduct Emergency (WAPS) Raw Water Pump Station

John J. Carroll Water Treatment Plant, Technical Consulting Services

Marlborough, Massachusetts

Stantec has been providing technical consulting services since 2006 at the 405 MGD John J. Carroll Water Treatment Plant (CWTP). Stantec has provided technical consulting and design services on approximately 100 task orders ranging from developing a fast plant restart to upgrades of major chemical feed systems. During the construction of these task orders we were able to keep the CWTP on-line with only minor shutdowns to make final connections and test the installed equipment. The following are several examples of the chemical feed task orders:

- Prepared plans and specifications for the installation of a new sodium hypochlorite feed system at the William Brutsch Water Treatment Facility.
- Developed plans and specifications and construction phase services for the upgrade of the sodium hypochlorite feed systems at the CWTP.
- Developed plans and purchase specifications for the installation of new ozone gas flow meters, and chlorine residuals analyzers.
- Prepared plans and specifications for Aqueous Ammonia system piping and metering pump replacement.
- Prepared plans, specifications and construction phase services for the replacement of the fluoride weigh feeder, piping and control system.
- Prepared plans and specifications for the replacement of the weigh feeders and control systems for the soda ash system.
- Prepared plans and specifications, provided construction phase services for the installation of a 2nd gaseous oxygen line.
- Prepared plans and specifications for the installation of closed loop cooling water system for the ozone generators.

These and many other task orders required multidiscipline services and close interaction with MWRA design and operations staff to meet aggressive schedules and maintain supply to the 47 cities and towns in Massachusetts with a total service population of approximately 2 million people. The task orders are part of projects that constitute close to $30 million of construction. Stantec also recently completed the 240 MGD Wachusett Aqueduct emergency pump station for raw water redundancy.

Gold ACEC Engineering Excellence Award Winner
BSCE Large Project Sustainability Award Winner
240 MGD Emergency Pump Station (raw water redundancy)
Over 100 Task Orders $25K to $200K
Preliminary Engineering and Basis of Design Reports
Chemical Feed System Improvements
New Standby Power

Reference:	**Bill Sullivan, 617-570-5435, william.sullivan@mwra.com**
Client Decisions/Actions:	**Recommendations Implemented**
Task Order Budget:	**$35 million**
WAPS Budget:	**$50 million**
Project Start:	**July 2006**
Project Completion:	**November 2022**
Team Members Involved:	**Chris Nichols, Project Manager** **Chirs Yannoni** **Mike Bartley** **Chris Nichols** **Katie Chamberlain** **Phil Relf** **Trey Dykstra** **Jeff Cota** **George Bagdasarian** **Jeff Cohen**

Water Treatment Plant at North Watuppa Pond

New Caustic Soda Feed System

Fall River Water Treatment Plant Upgrade

Fall River, MA

Stantec completed a 20-year $150 million Water System Master Plan that included a comprehensive evaluation of Fall River's 24 MGD conventional water treatment plant. As part of the study, FST evaluated raw and treated water quality data; evaluated the physical capacity of the unit processes; collected filter cores of the sand media in the shallow bed ABW filter units; evaluated the structural, mechanical, electrical, and HVAC systems; and developed cost estimates for potential upgrade to the facilities which are over 27 years old.

Based on FST's evaluations and recommendations, FST completed design and services during construction of a $9.5 million SRF project which included the addition of a carbon dioxide feed system for alkalinity adjustment and corrosion control; baffling the clearwell and relocating chemical feed injection equipment; rehabilitating the 11" deep ABW filters with 16" deep dual media ABW filters complete with filter to waste; installing an aqua ammonia storage and feed system for chloramination; replacing gas chlorinators; installing a new chemical feed control panel; installing a complete SCADA system for plant monitoring and control; replacing the emergency generator, replacement of the settling basin sludge collectors; replacement of the Operations Building roof including addition of HVAC equipment and replacing the constant speed low lift pumps with VFDs. The addition of VFD's to the 14, 8 and (2) 5.3 MGD low lift pumps will result in a significant reduction in energy costs. All work was completed while the WTP remained online. Other improvements in the CIP include:

- Ozonation including three (3) ,5000 pound per day ozone generators and two (2) LOX tanks sited on south side of plant
- Secondary GAC deep bed filtration with intermediate pumping
- Replacement of the flocculation drives
- New ventilation system in chemical feed room
- Convert from gas chlorine to liquid chlorine
- UV disinfection

The City has implemented over $100 million of capital improvements recommended in the Master Plan (updated in 2014) funded by MADEP DWSRF program including settling basin residuals pump station upgrades and a planning for redundant 36-inch finished water line at the water treatment plant.

Preliminary Engineering Report
All New Chemical Storage and Feed Systems
New Standby-Power
DWSRF Funding
Maintain Continuity of Supply
Condition Survey
Process Evaluation

Reference:	**Paul Ferland, 508-324-2320, pferland@fallriverma.org**
Client Decisions/Actions:	**Most Recommendations Implemented**
Project Budget:	**$100 million**
Project Start:	**March 200**
Project Completion:	**June 2022**
Team Members Involved:	**Chris Yannoni, Project Manager** **Chris Nichols** **Jeff Cohen**

Babson Water Treatment Plant

New Bicarbonate Feed System

Gloucester Water Treatment Plant Upgrade

Gloucester, MA

In 2003 Stantec completed a comprehensive performance evaluation of the 1960 conventional Babson Water Treatment Plant as a result of a previous MADEP Notice of Non-compliance (NON) for THM exceedance. The comprehensive performance evaluation included SDWA assessment, identified plant performance limiting factors, replacement of equipment and alternative treatment methodologies with recommendations and cost estimates.

During August of 2009, the City experienced a 20-day boil water order as a result of aging infrastructure at the Babson and West Gloucester Water Treatment Facilities. Under an administrative consent order issued by the MADEP, the City undertook an aggressive fast- tracked program of system improvements to improve water quality and increase reliability.

Stantec was retained by the City to perform bench-scale testing to improve WTP performance. Specifically, the goals of the testing were to:

- Evaluate alternative coagulants to improve organics removal and minimize THM formation in the distribution system.
- Evaluate a coagulation strategy to minimize solids formation.
- Evaluate the use of sodium hydroxide as an alternative to lime

Following bench-scale testing, Stantec developed the design for improvements to both the Babson and West Gloucester WTPs over a 12-week period and bid in mid-March. The design included new treatment technologies as well as improvements to existing processes and building systems. Under Stantec direction, all improvements were completed on time and within budget prior to the ACO deadline of July 1.

Stantec functioned as the overall program manager for the City to report to the City managers and the MADEP on all construction contracts, preparation of SRF and ARRA paperwork for all construction contracts amounting to $30 million and coordinated all start up activities.

Preliminary Engineering Reports
Fast-Track Project (ACO)
All New Chemical Storage and Feed Systems
New Standby-Power
DWSRF Funding
Maintain Continuity of Supply
Condition Survey
Process Evaluation
MA DEP Regional Drinking Water Award

Reference:	**Larry Durkin, Former Environmental Engineer, 978-578-1326 ldurkin@cityofmalden.org**
Client Decisions/Actions:	**Recommendations were implemented once funding was received.**
Project Budget:	**$30 million**
Project Start:	**September 2002**
Project Completion:	**January 2020**
Team Members Involved:	**Chris Yannoni, Project Manager Chris Nichols Jeff Cota**

Project Team

Team Structure

Whether at the local, regional, or watershed level, we bring together sector-specific expertise from across Stantec's global network. Our holistic approach balances creative vision and technological innovations with environmental, social, regulatory, and economic needs across all project phases.

Our Northeast Water team unites 120+ employees in 16 locations working on a variety of water treatment treatment projects, including chemical feed system upgrades, process evaluations, upgrades to filtration treatment trains, optimization of coagulation, among many other types of projects. Leading this project is our Burlington, Massachusetts, office which houses our core team of water engineers, architects, and civil engineers. In support of our core team are civil, geotechnical, and permitting professionals who regularly work together from our Hyannis and Auburn, New Hampshire, offices to provide the resources and special capabilities required to perform this work to Stantec's high standard. The project team assigned to this project are diverse and skilled at the successful delivery of drinking water treatment projects that require a combination of water chemistry, drinking water engineering including climate change and resiliency considerations, and public education/presentations.

The key team members identified on the organization chart have, in some cases, worked together for more than 20 years, designing hundreds of chemical systems. Over the last 10 years this team has completed preliminary and final designs for more than 50 chemical storage and feed systems in New England.

Managing Your Project

How your project is developed is just as important as how it's engineered. Our **Project Manager, Chris Yannoni**, will lead our technical team to maintain the standard of excellence of design and execution our clients have come to expect. Chris is a Senior Principal at Stantec with 37 years of drinking water related experience and is well known across New England, having managed a multitude of projects for various municipal clients. Chris brings exceptional familiarity with the nuts-and-bolts of all elements of waterworks facilities with a focus on water treatment facilities, making him a prime candidate to serve in this role. Chris is committed to this project and will focus on execution and ensuring your schedule and budget are met.

Serving as our **Project Technical Leads, Katie Chamberlain (Process Evaluation)** and **Mike Bartley (Design Manager)** will focus on the technical aspects of the chemical feed system project, digging into the details of your specific needs and integrating the input of our design support disciplines.

Mike Price **David Pernitksy**

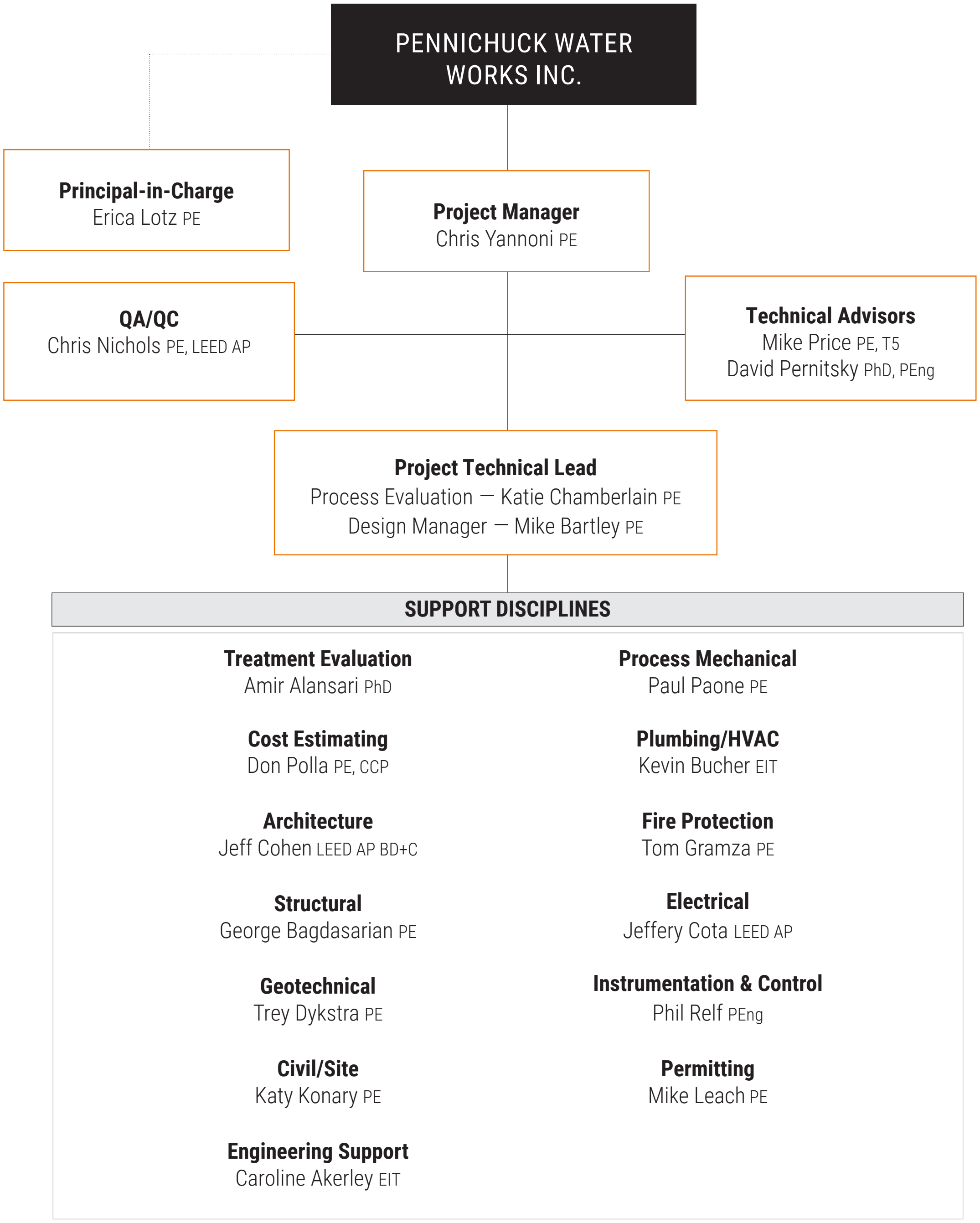
Technical Advisors Who Can See the Big Picture

We have selected water treatment plant design and operations experts as technical advisors to be part of our team. These technical experts have established a national reputation as leaders in the water sector. Mike is skilled at upgrading water treatment plants, having managed the design of upgrades to more than 20 water treatment plants in the past 25 years. With 30 years of experience, David is Stantec's global water treatment subject matter expert - having led many international drinking water projects involving state-of-the-art technological solutions.

Mike and David will offer lessons from similar water treatment design projects to the Nashua Treatment Plant Chemical Feed Systems Upgrade.

Team Organization

Our fully integrated team is organized with clear lines of responsibility and accountability starting from the top. Key persons and their roles are identified in our Organization Chart. Resumes for each key person follow this section. The level of effort for each individual can be found within the budget table on page 55.



PENNICHUCK WATER WORKS INC.

Principal-in-Charge
Erica Lotz PE

Project Manager
Chris Yannoni PE

QA/QC
Chris Nichols PE, LEED AP

Technical Advisors
Mike Price PE, T5
David Pernitsky PhD, PEng

Project Technical Lead
Process Evaluation — Katie Chamberlain PE
Design Manager — Mike Bartley PE

SUPPORT DISCIPLINES

Treatment Evaluation
Amir Alansari PhD

Cost Estimating
Don Polla PE, CCP

Architecture
Jeff Cohen LEED AP BD+C

Structural
George Bagdasarian PE

Geotechnical
Trey Dykstra PE

Civil/Site
Katy Konary PE

Engineering Support
Caroline Akerley EIT

Process Mechanical
Paul Paone PE

Plumbing/HVAC
Kevin Bucher EIT

Fire Protection
Tom Gramza PE

Electrical
Jeffery Cota LEED AP

Instrumentation & Control
Phil Relf PEng

Permitting
Mike Leach PE

Christopher Yannoni PE

Project Manager

Office Location

Burlington, Massachusetts

Education

M.S., Civil Engineering (Water Resources Planning), Northeastern University, Boston, 1988

B.S., Civil Engineering, University of Massachusetts, Amherst, 1983

Water Treatment Plant Operation I Certificate, California State University, Sacramento, 2015

Registrations

Professional Engineer - NH, MA, VT, CT, RI

Chris is a Senior Principal with 37 years of experience planning, designing, managing and value engineering municipal surface water treatment plants. Chris has completed pilot studies, preliminary engineering reports, final designs, construction phase services including start-up plans, and O&M manuals, and/or post construction phase operations assistance for more than 25 surface water treatment facilities across the US to keep City's and Town's in compliance with current and future Safe Drinking Water Act regulations. These facilities range in size from 50 gpm for a small community in Arizona to 400 MGD for MWRA in Massachusetts. Other surface water plants in the 10 to 30 MGD range that Chris has provided engineering services include Groton, CT, Fort Knox, KY, Fall River, MA, Taunton, MA, Max, ND, Nashua, NH, Wadsworth, OH, and Pawtucket, RI.

PROJECT EXPERIENCE

Pennichuck Water Works, Water Treatment Plant, Nashua, NH | Project Manager

Project Manager, Comprehensive evaluation of raw water supply and water treatment facilities, and development of $52 million CIP; pilot plant studies; engineering services for $35 million upgrade including multiple permit filings, new aeration building and in-reservoir water quality management structures, replacement of all chemical storage and feed systems, new carbon dioxide system, headworks and clarifier improvements, major filter rehabilitation, new boilers, new generators, building modifications including new roof and expanded laboratory/ operations/ training area, new 60 MGD finished water pumping station including 4,000 ft of 30- to 48-inch pipe at WTP to new 6.5 MG finished water reservoir and new SCADA system.

Chemical Building Addition, Champlain Water District, South Burlington, VT | Project Manager

Project Manager, development of $20 million concept design report for VTDEC DWSRF including new 6,000 sf chemical and 3,500 sf administration office building additions to replace all eight chemical storage and feed sytems in a new centralized building for 20 MGD WTP.

Groton Water Treatment Plant, Groton, CT | Project Manager

Project Manager for $54 Million DWSRF funded improvement program at 12 MGD water treatment plant including concept design, piloting, and design of new DAF/GAC filtration facility, retrofitting existing filters to manganese contactors, as well as major upgrades to the existing facility HVAC, plumbing, electrical and I & C systems.

Water Treatment Plant Improvements, Fall River, MA | Project Manager

Project Manager, development of $150 million CIP and engineering services for installation of new filters, chemical storage and feed systems, carbon dioxide system, chloramination system, generator, field instruments, and SCADA at 24 MGD capacity facility.

John J. Carroll Water Treatment Plant, Marlborough, MA | Principal in Charge

Principal-in-Charge, completion of nearly 100 task orders over last 14 years at 400 MGD ozone facility including design of redundant gaseous oxygen feed PRV and pipeline and closed loop cooling system for ozone generators, chemical feed system upgrades, 30-inch blow-off for high service area; development of hydraulic and water quality models of WTP, and detailed plant re-start procedures; instrumentation and control modifications; development of SOP for emergency activation of the Wachusett Aqueduct, ultraviolet (UV) sleeve fouling study plant and UV conceptual design for 10 MGD Cedar Hill pump station.

Water Treatment Plant Improvements, Taunton, MA | Project Manager

Project Manager, development of $60 million CIP, design and services during construction for upgrade of 20 MGD transfer station, replacement of all chemical storage and feed systems, new carbon dioxide system, new chloramination system, new ultraviolet (UV) disinfection facility, new high lift pumps with VFDs, new field instruments and new SCADA system.

Improvements to 144 MGD Water Treatment Plant, Providence, RI | Project Manager/Engineer

Project Manager/Engineer, planning studies, pipe loop, bench and pilot scale studies, and design and construction services for rehabilitation of nearly every unit process as part of a $12 million upgrade of the largest water treatment plant in New England.

Water Treatment Process Evaluations, Newburyport, Gloucester, Fall River, Somerset and Taunton, MA | Project Manager

Project Manager, responsible for comprehensive performance evaluations, water quality analysis, and alternative treatment methodology evaluations.

Treatment Plant Improvements, Gloucester, MA | Principal in Charge

Principal In Charge, emergency improvements to 10 MGD capacity Babson, West Gloucester and Klondike water treatment plants. Work include the renovation and replacement of chemical feed systems, installation of SCADA system and acting as Owners Project Manager for multiple construction contracts required under consent order with the MA-DEP in response to a 20-day boil order.

Madbury Water Treatment Plant Upgrade, Portsmouth, NH | Project Manager

Project Manager, engineering services for plant condition survey, pilot scale evaluation of ozone, dissolved-air flotation (DAF) and membrane processes along with chloramination to reduce elevated DBPs as part of $20 million upgrade to 8 MGD facility.

New Membrane Plant, Jamestown, RI | Project Manager

Project Manager, engineering services for raw water quality management study, pilot studies of reverse osmosis and ultra-filtration and design of 350 gpm membrane filtration facility for highly colored, flashy raw water quality, water storage tank and pipeline as part of $12 million improvement program.

Katie Chamberlain PE

Project Technical Lead, Process Evaluation

Office Location

Burlington, Massachusetts

Education

M.S., Environmental Science and Engineering, Colorado School of Mines, 2006

B.S., Chemical Engineering, Rensselaer Polytechnic Institute, 2002

Registrations

Professional Engineer, MA

With 20 years of experience, Katie is a registered professional engineer with a focus on providing water treatment process solutions for municipalities. She serves as Stantec's Regional Practice Lead for drinking water treatment in the Northeast. Katie's areas of specialty include iron and manganese treatment, water treatment alternatives analysis, water treatment plant optimization, and water treatment plant basis of design planning. Additionally, she is a technical expert in asset management and helps clients implement programs and utilization of risk-based decision-making principles for long-term capital planning.

PROJECT EXPERIENCE

Petty Harbor Water Treatment Plant Manganese Removal Emergency Response Services, St Johns, Newfoundland and Labrador, Canada | Technical Support

Provided technical support to the Petty Harbour surface water treatment plant operators and laboratory staff during a manganese peak event that was occurring in their source water (Long Pond). The municipality was experiencing hundreds of dirty water complaints during this time, requiring the need to determine a quick and efficient solution to reduce manganese entering the distribution system. Provided jar testing support to determine most preferred oxidant, oxidant dose and ideal pH conditions. Based on jar test results, assisted with installation and startup of a pre-filtration potassium permanganate chemical feed system to achieve manganese removal at the filtration plant.

Southbridge Water Treatment Plant Filter Optimization Pilot Testing, Southbridge, MA | Project Engineer

Performed full-scale pilot studies at the Southbridge Water Treatment Plant to optimize clarification and filtration processes. The goal of the pilot was to increase the filter run times by optimizing the coagulation/flocculation process at the WTP. The impacts of various coagulants, polymers, and filter aids were observed during this study, leading to a recommendation to implement filter aid and polyamine polymer for future operations, which was shown to increase filter run times by several hours.

High Street Water Treatment Plant Design and Construction Services, Bridgewater, MA | Design Manager

As the treatment process lead engineer, led the preliminary design, permitting and final design tasks for the greenfield 2 MGD filtration plant. High Street Water Treatment Plant is designed to remove iron and manganese from four groundwater wells, adjust pH for corrosion control, and to provide disinfection of treated water. Design includes work at three sites: the new water treatment plant site upgrades to the existing maintenance garage, and upgrades to the existing three wellhouses.

Old Marlboro Road Water Treatment Plant Upgrades, Maynard, MA | Design Manager

Performed a full-scale pilot study at the Old Marlboro Road Water Treatment Plant (WTP), which utilizes greensand plus pressure filtration for iron and manganese removal, to evaluate treatment alternatives and determine the best path forward for reducing disinfection byproducts (DBP) in the finished water. The pilot study evaluated (1) the addition of coagulant prior to greensand filters for TOC removal and (2) the use of potassium permanganate for oxidation as a replacement for sodium hypochlorite, to reduce the potential of DBP formation. Based on the Pilot Study results, final design of WTP upgrades were completed to include a potassium permanganate feed system, a Parshall flume for backwash waste monitoring, filter media replacement, and miscellaneous plant upgrades.

Adams Fire District Well Stations Chemical Feed System Design, Adams, MA | Design Engineer

Designed upgrades at the Town's three groundwater well stations to include permanent sodium hypochlorite chemical feed systems to meet Consent Order requirements to disinfect all drinking water sources.

Barnstable Fire District PFAS Removal Water Treatment Plant, Barnstable, MA | Treatment Process Lead

Treatment Process Lead for the permitting, design and construction of a new 1.6 MGD PFAS removal water treatment facility. Project includes new water treatment facility which includes greensand filtration along with granular activated carbon for the removal of PFAS from two ground water sources..

Tilton Northfield Water District, Iron and Manganese Treatment Evaluation & Pilot Testing, NH | Project Engineer

Evaluated treatment alternatives for the Tilton Northfield Water District well supply, to address changing manganese regulations in NH, developed pilot test plan, and preliminary design.

Kent County Water Authority, RI Greenwich Well Iron and Manganese Treatment, RI | Senior Technical Consultant

Provided technical expertise during the conceptual design and detailed design phases for retrofit of an existing well station to include iron and manganese oxidation/filtration treatment.

Region of Waterloo, Erb Street Environmental Assessment & Enhanced Conceptual Design | Project Engineer

Evaluated treatment options for manganese removal at the Erb Street treatment plant to meet new Ontario manganese aesthetic objective of 0.02 mg/L and developed enhanced conceptual design based on a greensand filtration treatment system.

Region of Waterloo, East Cambridge Filter Backwash Recycle Evaluation | Project Technical Lead

Project Technical Lead for a study to evaluate feasibility and cost effectiveness of implementing backwash waste recycling at several of the Region's iron and manganese groundwater treatment facilities.

Mike Bartley PE

Project Technical Lead, Design Manager

Office Location

Burlington, Massachusetts

Education

M.S.C.E., University of Massachusetts Lowell, 2012

B.S.C.E., Worcester Polytechnic Institute, Worcester, 2002

Registrations

Professional Engineer, MA

Mike has almost 20 years of experience in civil and process engineering. Mike serves as Stantec's Northeast Engineering Discipline Lead for Process engineering and has worked on some of the largest and most complex water and wastewater treatment and pumping facilities throughout New England. He brings strong technical expertise and organization to our team for this project.

PROJECT EXPERIENCE

Pennichuck Water Works, Water Treatment Plant, Nashua, NH | Assistant Engineer

Assisted in the design of chemical feed system and instrumentation systems for the construction of a new pumping station addition to the plant, and water treatment plant upgrades. Assisted in the coordination of instrumentation and chemical feed equipment with electrical and systems integration personnel. Assisted with Construction Administration Activities including shop drawing review.

Groton Water Treatment Plant, Groton, CT | Project Engineer

As Project Engineer designed pumping systems for treatment plant upgrades. Designed backwash supply system for GAC filters and manganese contactors that can utilize either on site stored water in a gravity-fed arrangement, pump water from treatment process, or distribution water.

John J. Carroll Water Treatment Plant, Marlborough, MA | Project Engineer

Project Engineer for design and construction phase services for upgrades to the cooling water system for the ozone generators at the 405 MGD water treatment plant. Conducted hydraulic analysis of new closed and open loop systems, assisted in selection of equipment for the project and responsible for piping and equipment layout. Provided engineering services during construction of the facility including shop drawing review and development of Standard Operating Procedures.

Membrane Water Filtration Plant, Jamestown, RI | Project Engineer

New membrane water treatment plant for highly colored water in the Town of Jamestown, RI. Designed chemical feed system, instrumentation systems and treatment process systems for the plant. Assisted in the plant layout coordination with multi-disciplined team and outside architect. Provided engineering services during construction of the facility.

Norwell Water Treatment Facility, Norwell, MA | Assistant Engineer

Design services for a 1.5 MGD state-of-the-art membrane treatment plant. Assisted in general arrangement and selection of mechanical, chemical feed and instrumentation.

Pawtucket Tunnel Dewatering Pump Station, Pawtucket, RI | Assistant to Project Technical Lead

Assisted the project technical lead with coordinating and checking progress among the various disciplines as well as assisting with coordination efforts. The pump station is one component of a multi-phase CSO control program. Coordination efforts are required within the pump station structure and the tunnel design contract. The pump station and tunnel design are being pursued by different teams, and require detailed coordination at preliminary stages of design to ensure different future contractors working on different future construction packages fit together properly in a sub grade pump station.

Water System Improvements, Fall River, MA | Project Engineer

As Project Engineer assisted in multiple projects in Fall River including, water main replacement, pump station upgrade, and storage tank replacement. Prepared SRF funding documentation including preliminary plans and specifications. Performed hydraulic modeling to aid in the selection of pumps and storage tank overflow elevation for the creation of a new high service area.

Wachusett Aqueduct Pumping Station, Marlbourough, MA | Project Engineer

Involved in design and construction of the 240 MGD, Wachusett Aqueduct Pumping Station. Activities included hydraulic analyses and determination of pumping requirements; selection of pumps, valves and metering; overseeing development of a physical model of the pumping system; design of 84- and 120-inch diameter site piping; day-to-day coordination with various design disciplines. Conducted analyses and prepared designs for improvements to the John J. Carroll Water Treatment Plant ozone treatment system to implement changes required from changing influent conditions when the pump station is online.

Northern Intermediate High (NIH) Assessment and Concept Plan, MA | Project Engineer

As Project Engineer identified various pipeline routes and feasible storage tank sites to address lack of redundancy within the NIH service area. Collected field information including pipe lengths, existing utilities, and ease of construction for feasible pipeline routes. Completed related GIS mapping to both analyze constructability and present preferred alternatives. Assisted in preparation of reports for short and long term improvements to provide redundancy and reliability to the service area. Conducted hydraulic modeling to analyze feasibility of improvements.

Mike **Price** PE, T5

Technical Advisor

Office Location

Walnut Creek, California

Education

M.S., Environmental Engineering, University of Illinois, 1976

B.S., Civil Engineering, University of Illinois, 1975

Registrations

Professional Engineer, CA, OH

Grade 5 Water Treatment Operator #14149, State of California

Mike is a senior water engineer with 45 years of experience specializing in the planning, design, construction, and operation of potable water supply, treatment, storage, and distribution facilities. His projects have utilized a variety of water treatment technologies, including conventional flocculation and filtration, high-rate sedimentation/clarification, ozonation, membrane filtration, granular activated carbon (GAC) filtration, ultraviolet (UV) disinfection, and many different chemical feed systems. Mike is especially skilled at upgrading existing water treatment plants, having managed the design of upgrades to more than 20 water treatment plants in the past 25 years and serving in a technical role on many others.

PROJECT EXPERIENCE

Chemical Building Addition, Champlain Water District, South Burlington, VT | Technical Advisor

Technical advisor for preliminary engineering report for $20 million chemical building addition project at 20 MGD facility.

Chemical Systems Safety Improvement Project, Oakland, CA |Project Manager

Currently leading a $53 million project to design upgrades to the chemical storage and feed systems at five of East Bay Municipal Utility District Water Treatment Plants and one disinfection facility. The goal is to bring all the systems into compliance with current safety codes and industry practices, as well as provide consistency among all the facilities. The improvements include replacement of all chemical feed pumps with standardized arrangements, separation of hazardous chemicals currently in the same air space with non-hazardous chemicals, replacement of all chemical piping from the storage and feed areas to the injection points, HVAC improvements and separate power supplies to comply with code requirements for standby power, containment improvements in chemical delivery areas, and related access and control improvements.

Sacramento River Water Treatment Plant, Sacramento, CA | Technical Advisor

Served as Technical advisor for all process upgrades at the 160 MGD Sacramento River Water Treatment Plant (WTP) and residuals handling process upgrades at the 200 MGD E.A. Fairbairn WTP. The upgrades at the Sacramento River WTP included adding a new 80 MGD flocculation/sedimentation/filtration train to match an existing train of the same size. The upgrades also included modifications to the plant's solids handling system by replacing existing sludge drying beds with mechanical dewatering. Two thickeners, four sludge blending tanks and three centrifuges were added to the plant. At the E.A. Fairbairn WTP, new mechanical dewatering facilities were added to replace existing sludge drying beds. The upgrades included addition two thickeners, three sludge blending tanks and two centrifuges for mechanical dewatering.

Waterman Water Treatment Plant, Fairfield, CA | Optimization Engineer

Stantec was retained by the City to design and provide construction management for this $67 million expansion and modernization of the Plant. Through the project, the plant's capacity was increased from 15 to 30 MGD with the addition of an advanced Actiflo ballasted flocculation clarification process, a new electrical distribution system, an upgraded operations building, and six rehabilitated dual media (anthracite/sand) filters. Mike oversaw plant optimization testing for more than a year at this 30 MGD plant. The majority of the optimization work involved minimizing chemical doses for coagulants, flocculant aids, and filter aids in connection with Actiflo and filter performance. Mike's adjustments to optimize the new processes saved $200,000 annually for the City of Fairfield, while still producing water that exceeds regulatory requirements consistently.

Lake Oswego-Tigard Water Treatment Plant Expansion, West Linn, OR | Technical Advisor

Provided expert review for this upgrade project, doubling the Lake Oswego Water Treatment Plant's capacity from 15 to 38 MGD. Following a detailed evaluation of the existing processes and water quality requirements, Mike oversaw detailed designs for the upgraded processes, which included intermediate ozonation, biologically active carbon filtration, sludge thickening, and mechanical dewatering equipment.

Vineyard Surface Water Treatment Plant, Sacramento County, CA | Water Treatment Technology Lead

To meet new water supply demands for decades to come, the Sacramento County Water Agency constructed its first surface water treatment plant. Stantec provided preliminary and final design and construction management services for the Vineyard Surface Water Treatment Plant, which treats water from the Sacramento River, pumped from the Freeport intake facility. The plant was designed to treat up to 50 MG of water per day in a concerted effort to limit groundwater pumping and to verify the long-term sustainability of the groundwater basin. The solids handling facilities for the plant includes 3,600-GPM horizontal flow wash water clarifiers, two 1,000-GPM gravity thickeners, a sludge storage tank, and three, 2,000 lb/hr centrifuges. All decant and centrate water are discharged to the sanitary sewer and all centrifuge solids cake is disposed of at a local landfill. Mike successfully guided the project through regulatory requirements and optimized plant controls for ease of operation. During the startup phase of this new 100-MGD surface water treatment plant, Mike worked with agency staff and developed operational procedures and control logic to allow the plant to be operated remotely up to 16 hours per day, making the plant the largest surface water treatment plant in California with remote operations.

Green River Filtration Facility Project, Ravensdale, WA | Design Manager

Served as Design Manager for an alternative delivery project to comply with the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). Tacoma Water was required to either increase disinfection capability or install filtration. Based on several factors, including supply reliability, Tacoma Water decided to construct a new water treatment plant and incorporate an existing ozonation system. Raw water is delivered through two 72-inch pipelines to this innovative hybrid facility, which has a capacity of 90-MGD when operating in conventional treatment mode and 168-MGD when operating in direct filtration mode. The facilities included new flash mix, flocculation, sedimentation enhanced by plate settlers, high rate filtration, and mechanical dewatering with screw presses. The project also included construction of two treated water reservoirs and existing ozonation facilities remained in use as pre-ozonation upstream of coagulation. The design was completed in 11 months, and the plant went into service ahead of Washington State's regulatory deadline. At $30 million below budget, the final construction cost was over $144 million.

David Pernitsky PhD, PEng

Technical Advisor

Office Location

Calgary, Alberta

Education

PhD, Environmental Engineering, University of Massachusetts at Amherst, 2001

M.S., Environmental Engineering, University of Alberta, 1992

B.S., Civil Engineering, University of Alberta, 1990

Registrations

Professional Engineer, Alberta

David is a subject matter expert and lead water treatment resource for Stantec's municipal and industrial water treatment projects. He has 30 years of environmental engineering experience in drinking water treatment, groundwater remediation, wastewater reuse, wastewater treatment, and water resource management. David has led many projects involving state-of-the-art technological solutions such as dissolved air flotation (DAF), ozonation, granular activated carbon (GAC), ion exchange, membrane filtration, reverse osmosis (RO), and high rate granular media filtration systems.

PROJECT EXPERIENCE

Griswold Water Purification Facility Chemical Feed Study, Aurora, CO | Technical Advisor

In his role as Technical Advisor, performed onsite bench scale zeta potential testing to evaluate the performance of various coagulants on the raw water sources used by the facility. He also provided insight for the evaluation of the conversion of the existing chlorine gas system to onsite sodium hypochlorite generation and the associated impacts the chlorine dioxide generation and looked at alternatives for taste and odor removal and pretreatment of the Quincy Reservoir raw water supply to address high algae and total organic carbon.

Yan Yean Water Treatment Plant Upgrade, Melbourne, Australia | Senior Reviewer

Senior Reviewer of process design for improvements to the 40 MGD direct filtration plant to renew the asset and provide taste and odor control. Improvements include the addition of GAC filter-adsorbers to provide T&O control downstream of the existing direct filtration filters, the addition of UV disinfection, new sodium hypochlorite addition facilities, renewal of lime and polymer dosing facilities, and provisions for future installation of ozone for additional T&O control.

Buffalo Pound Water Treatment Plant Renewal, Regina, SK, Canada | Process Lead

Served as Process Lead for a progressive design-build project to upgrade a 66 MGD treatment plant. The project consisted of converting the existing conventional sedimentation plant with GAC adsorbers to a DAF-ozone-BAC process. The design includes conversion of existing square clarifiers to DAF basins, addition of a new ozone contactor, conversion of existing GAC contactors to 3-meter-deep BAC filter adsorbers, conversion of four existing circular clarifiers to backwash equalization tanks, backwash water storage tanks, and backwash waste thickeners. Chemical systems will receive a complete overhaul, and freeze-thaw residuals treatment ponds will be improved and expanded.

Water Treatment Program, St. John's, Canada | Lead Process Engineer

Worked as Process Lead for upgrades to the Bay Bulls Big Pond Water Treatment Plant and the Petty Harbor Long Pond Water Treatment Plant as part of the City's overall water treatment program. Later, as an employee of Stantec, David helped the City respond to a colored water incident. For the 31 MGD Bay Bulls direct filtration plant, David was involved in this project from the initial pilot testing to the detailed design. For Petty Harbor Long Pond, David was the process lead for treatability testing, process selection, and design of a greenfield 7 MGD DAF filtration plant.

Portage La Prairie Water Treatment Plant Expansion | Project Advisor

Work included process selection, pilot testing, preliminary and functional design of a 8 MGD expansion to the Portage La Prairie Water Treatment Plant (WTP). David is providing oversight of process selection and design and providing overall QA/QC. The existing WTP uses Actiflo, lime softening, ozonation, dual-media filtration and GAC adsorption to treat water from the Assiniboine River. In spite of the advanced processes used, disinfection byproduct (DBP) concentrations can exceed regulatory limits due to the high organic carbon concentrations in the river, relatively poor organics removal through the plant and a long retention time in the regional distribution system. Rather than expand the plant using the existing, complex process configuration, our team recommended a membrane-based process that uses ultrafiltration (UF) for pre-treatment followed by nanofiltration or reverse osmosis for organics removal. Bench-scale membrane tests and bench-scale Simulated Distribution System DBP tests were conducted prior to piloting to streamline the pilot testing effort, resulting in significant savings. The preliminary design of the membrane expansion is currently being developed with functional design to follow.

Goldbar Wastewater Treatment Plant, Advanced Water Treatment Facility, Edmonton, Canada | Project Technical Lead

Technical Lead for Conceptual Design of an advanced water treatment facility at the Goldbar Wastewater Treatment Plant (WWTP) to provide treated municipal wastewater effluent for industrial cooling and process water for an external Hydrogen production facility. Scope included review of applicable regulations, design of immersed UF filtration and chlorine disinfection systems, and integration of new facility into the existing secondary WWTP.

Chris Nichols PE, LEED AP

QA/QC

Office Location

Burlington, Massachusetts

Education

MBA, Southern New Hampshire University, Manchester, 2006

Registrations

Professional Engineer, MA

LEED Accredited Professional #8B38A9AF6F, U.S. Green Building Council

Chris has 36 years of civil, environmental, and construction experience in a wide variety of settings. He is thoroughly conversant with water/wastewater operations and management, managing construction projects, and structural engineering.

PROJECT EXPERIENCE

Pennichuck Water Works, Water Treatment Plant Improvements and Finished Water Pumping Station, Nashua, NH | Deputy Project Manager

Deputy Project Manager for the design and construction phase of a $35 million upgrade including the construction of a 30-MGD finished water pumping station and water treatment plant improvements. The pumping station included a new building, five intermediate pumps, a 6.5-MG storage tank, five high-lift pumps, new chemical feed systems, new electrical systems, and an emergency generator. The water treatment plant improvements included complete rehabilitation of the headworks and clarifiers, conversion from six filters to 12 filters, chemical feed systems, electrical and HVAC, and the installation of new offices and bathrooms within the existing building footprint.

John J. Carroll Water Treatment Plant, Marlborough, MA | Project Manager

Project Manager for an on-call consulting contract with MWRA since 2007. In this capacity, he has overseen more than 100 task orders. He has also managed tasks outside of the water treatment campus including replacement of a flow control valve in the transmission system, evaluation of energy dissipating valves at a dam facility, and evaluation of a water turbine at a water transfer facility.

Groton Water Treatment Plant, Groton, CT | Assistant Project Engineer

Assistant Project Manager for the design and construction of a 12-MGD dissolved air floatation (DAF) and GAC filtration plant that included polishing contactors to remove manganese. The project replaced existing sedimentation basins and gravity filters with three new DAF basins and four new GAC filters in a new building. The project also included the conversion of three existing filters to manganese contactors, construction of two new 1-MG ground storage tanks, new high-lift pumping, a backwash system, and intermediate pumping systems. Additionally, the existing water filtration plant was upgraded to provide more administrative space, locker rooms, HVAC and plumbing systems, and a new electrical system.

Gloucester Water Treatment Plant, Gloucester, MA | Deputy Project Manager

Deputy Project Manager for the design and construction phase service for emergency improvements to Babson, West Gloucester, and Klondike water treatment plants. Work included the renovation and replacement of chemical feed systems, installation of the SCADA system, and other miscellaneous improvements required under a consent order with the MA-DEP in response to a 20-day boil order. Design phase services were completed in 6 weeks, and critical construction components were completed within three months from the notice to proceed. Two other construction contracts were co-occurring at the Babson plant, which we coordinated.

Water Treatment Plant Improvements, Fall River, MA | Project Engineer

Project Engineer development of $150 million CIP and engineering services for installation of new filters, chemical storage and feed systems, carbon dioxide system, chloramination system, generator, field instruments, and SCADA at 24 MGD capacity facility.

Manchaug Water District Water System Improvements, Sutton MA | Project Manager

Project Manager for design and construction phase services for the construction of a new iron and manganese filtration facilities and appurtenant equipment. Project included a new building, aeration system, high lift pumping; installation of SCADA system and chemical feed systems.

DAF Pilot Study, Portsmouth, NH | Deputy Project Manager

Deputy Project Manager for a dissolved air floatation, membrane filtration, and carbon filtration pilot study for 6-MGD treatment facility. The study investigated the use of pre-filtration ozone and included a review of residuals waste handling and disposal options.

Membrane Water Filtration Plant, Jamestown, RI | Project Manager

Project Manager responsible for the review of design and cost estimates for 1 MGD Zenon membrane water filtration facility to treat high color surface water supply.

Pumping Station Improvements, Taunton, MA | Project Manager

Project Manager for the design and construction of renovations to main pumping station. Included upgrade of electrical system, removal of underground storage tanks, SCADA and instrumentation improvements.

Taunton Water Treatment Plant, Taunton, MA| Project Manager

Project Manager for construction phase services, rehabilitation of 12 MGD water filtration plant. Upgrades to pumping systems, chemical feed systems, SCADA system.

Tauton Water Treatment Plant - Ultraviolet Disinfection System, Taunton, MA | Project Manager

Project Manager for the design and construction of 14 MGD UV disinfection system at the Taunton Water Filtration Plant. This is the largest and first surface water UV disinfection system in New England at the time of construction.

Residuals Handling System, Worcester, MA | Project Manager

Project Manager, design and construction for installation of automated residuals removal system from spent backwash holding tank of 50 MGD water filtration facility.

Amir Alansari PhD

Treatment Evaluation

Office Location

Winston-Salem, North Carolina

Education

PhD, Civil Engineering, University of North Carolina, 2021

M.S., Civil Engineering, University of North Carolina, 2013

B.S., Civil Engineering, University of North Carolina, 2010

Amir is an environmental engineer who has extensively researched various areas of water treatment. His experience includes drinking water (treatment processes, plant design, pilot plant design, control systems, and process optimization), coagulation chemistry and flocculation, low-pressure membrane filtration processes, membrane fouling control strategies, computational fluid dynamics applications in water treatment, conventional filtration optimization, supervised machine learning and deep neural networks, and data visualization, dashboards and GUI design.

PROJECT EXPERIENCE

Mulraugh Water Treatment Plant, Fort Knox, KY | Water Treatment Specialist

Performed chemical dosing calculations and developed a dosing guide for plant start-up. Amir also reviewed chemical storage tank capacities.

Automated Drinking Water Treatment Pilot System | Water Treatment Specialist

Created a 3D-scale model of the pilot system that includes all the parts, equipment, and plumbing - Assist in the construction and assembly of the pilot system (e.g., plumbing, electrical, etc.). Created a LabVIEW program that automates the entire process (from coagulation to disinfection).

Wateropolis Pilot-Scale Filtration System | Water Treatment Specialist

Built a pilot-scale filtration system to test the performance of a ceramic filter media in removing Cryptosporidium-sized particles. Identified suitable operating conditions (e.g., backwash rates). Designed and performed experiments and analyzed data.

Goulston Technologies | Water Treatment Specialist

Performed weekly particle size analyses on lubricant samples - Analyzed data and prepared weekly progress reports.

Antibiotic Resistance Study | Water Treatment Specialist

Designed and built digestors; purchased online DO and pH probes; created a LabVIEW program to log experimental data.

Saint-Gobain Ceramic Membrane Pilot Study | Water Treatment Specialist

Assembled the membrane element and connect it to an existing pilot system - Install inline pressure transducers and conductivity sensors. Created a LabVIEW program to log experimental data. Performed a membrane challenge test and analyzed results.

Don Polla PE, CCP

Cost Estimating

Office Location

Denver, Colorado

Education

M.S., Environmental Engineering, Colorado School of Mines, 1995

B.S., Mechanical Engineering, University of Idaho, 1986

Registrations

Professional Engineer, CA

Certified Cost Professional #399985, AACE International, Inc.

Don is a certified cost estimator and works for Stantec's construction cost estimating division that prepares engineer's estimates and hard-dollar bid construction cost estimates for major pipelines, treatment plants and other heavy civil facilities. His project experience includes new pipe installation by open cut, bore & jack, horizontal directional drilling, and tunneling. He has experience with pipe diameters up to eight feet, and with pipe materials including steel, ductile iron, PVC, HDPE, pressure concrete, RCCP, copper, RCP, Hobas, Vylon, FRP, clay, and polycrete.

PROJECT EXPERIENCE

Water Treatment Plant Upgrades Champlain Water District, Champlain, VT | Cost Estimator

Provided cost estimates on this water treatment plant upgraded project. Stantec is nearing completion of a chemical storage and feed evaluation preliminary engineering report (PER) to centralize the eight (8) major process chemicals including conversion of potassium permanganate to sodium permanganate. The conceptual design includes a 60-foot by 100-foot chemical building addition that houses two bulk storage tanks, day tanks and feed systems for each chemical ranging in size from 2,500 to 5,000 gallons or a total of 60,000 gallons of bulk storage.

West Lynn Sewer Separation, Lynn, MA | Lead Cost Estimator

Provided cost estimates for new storm drain piping, manholes, catchbasins; 114 MGD pump station; 54" force main; relocation/improvements to sanitary sewers, relocation/improvements to water mains. Work included open cut installation, trenchless installation, CIPP pipe lining, soil remediation. Estimated civil, mechanical, and utility portions of improvements. Organized and combined supporting estimates including structural, architectural, electrical, and I&C. Produced opinion of probable cost reports. Responded to comments and questions. Developed local labor and equipment rate tables.

Southern Delivery System (SDS) Program, Colorado Springs, CO | Cost Estimator

Stantec served as the program manager for the SDS Program. In this role, Stantec provided overall program management services; design and construction project oversight services; project schedule, budget and scope monitoring; procurement support; and document control management services, Environmental Impact Statement and Planning, Program Management, Design Management, and Construction Management. The program managed the design and construction of 62 miles of underground raw and treated water pipelines, a 50-MGD water treatment plant and three water pump stations. Don provided baseline cost estimates for the pipelines and is responsible for providing independent estimating services for claims and potential change orders.

Miami-Dade Wastewater Improvement Program, Miami, FL | Lead Cost Estimator

Don provided cost estimates for capital improvement projects for Miami Dade treatment and collection components. Estimated civil, mechanical, and utility portions of improvements. Organized and combined supporting estimates including structural, architectural, electrical, and I&C. Produced opinion of probable cost reports. Responded to comments and questions. Developed local labor and equipment rate tables.

Jeff Cohen LEED AP BD+C

Architecture

Office Location

Burlington, Massachusetts

Education

B.S., Architectural Engineering Technology, Wentworth Institute of Technology, 1984

A.S., Architectural Engineering Technology, Roger Williams College, 1981

Jeff has served as Project Manager, and Project and Architectural Engineer on numerous building renovation and new building construction projects. In his role as Project Administrator for several LEED projects, Jeff was responsible for leading, reviewing and overseeing the LEED certification process. He has managed the integration of multiple design disciplines to pursue LEED certification; identified credit synergies for integrated design to support LEED certification; identified conditions under which LEED prerequisites are met; and verified that credit documentation meets LEED requirements. He has contributed architectural design of new and renovated buildings and industrial facilities, with responsibilities including preparation of plans, specifications, and cost estimates, field investigations, and conducting building condition and code assessments.

PROJECT EXPERIENCE

Pennichuck Water Works, Water Pumping Station, Nashua, NH | Architectural Engineer

Responsible for architectural design of new 8,250 square foot finished water pumping station addition to the existing water treatment plant. Special attention was given to complimenting the appearance of the existing facility and providing durable, low-maintenance materials and finishes. Exterior wall treatments include the use of split-face and ground-face CMU, along with glass block units for providing natural light in the facility.

Pennichuck Water Works, Water Treatment Plant, Nashua, NH | Architectural Engineer

Responsible for architectural design of alterations, repairs and additions to 39,000 square foot water treatment plant. Alterations included providing additional floor space on the second floor for administrative activities and a new training room; a new locker room for female staff; modifications to laboratory cabinetry and window treatments; new interior finishes; and upgrading the fire separation assemblies between mixed uses. Repairs to architectural components included masonry crack and exterior envelope repair and replacement of ballasted EPDM roofing.

Groton Water Treatment Plant, Groton, CT | Architectural Engineer

Responsible for architectural design of treatment plant renovation involving building envelope upgrade (roofing replacement, rainscreen assembly installation, door and window replacement, masonry repairs), reconfiguration of interior spaces including new administrative wing, restrooms, locker rooms, and staff break room and new interior finishes.

Water Treatment Plant Improvements, Fall River, MA | Architectural Engineer

Responsible for architectural engineering services for installation of new filters, chemical storage and feed systems, carbon dioxide system, chloramination system, generator, field instruments, and SCADA at 24 MGD capacity facility.

Chemical Building Addition, Champlain Water District, South Burlington, VT | Architectural Engineer

Architectural Engineer for the development of $20 million concept design report for VTDEC DWSRF including new 6,000 sf chemical and 3,500 sf administration office building additions to replace all eight chemical storage and feed sytems in a new centralized building for 20 MGD WTP.

George Bagdasarian PE

Structural

Office Location

Burlington, Massachusetts

Education

M.S., Structural Engineering, Tehran University, 1970

B.S., Civil Engineering, Tehran University, 1969

Registrations

Professional Engineer, MA

George has 51 years of consulting engineering experience in the field of structural engineering. He has extensive experience with design of parking garages, pedestrian bridges, evaluating of existing structures, wastewater treatment plant buildings, industrial and commercial buildings, airport facilities, power plant buildings and petrochemical facilities.

PROJECT EXPERIENCE

Pennichuck Water Works, Water Treatment Plant, Nashua, NH | Structural Engineer

Responsible for structural coordination, site investigation, and structural design for modifications to the Pennichuck Water Treatment Plant. Developed drawings and calculations for new filter system.

Groton Water Treatment Plant, Groton, CT | Structural Engineer

Structural design of new tanks for DAF filter and new building on top of the tanks.

John J. Carroll Water Treatment Plant - Wachusett Aqueduct Pumping Station, Marlborough, MA | Structural Engineer

Structural design for new 250 MGD water pumping station in Marlborough, MA. Project included guardhouse and canopy building, covered storage building, surge tank structure.

Water Treatment Facility - UV Building, Taunton, MA | Structural Engineer

As Structural Engineer, worked on structural calculations and provided inspection of structural components during construction.

Barnstable Fire District Well No. 5, Barnstable, MA | Project Design Engineer

Designed a new pump station building foundation, walls and prefabricated roof planks. The utilitarian design provides a facility with sustainable, durable, low-maintenance materials and finishes.

Clinton Wastewater Treatment Plant, Phosphorus Reduction Facility, Clinton, MA | Project Engineer

Prepared structural calculations for new building, concrete tanks and equipment support foundations.

Deer Island Wastewater Treatment Plant, MA | Project Engineer

Prepared demolition drawings for existing DSL pump pads and designed support pads for new DSL pumps.

Alewife Brook Pumping Station Rehabilitation, MA | Project Engineer

Provided structural design for the rehabilitation of the wastewater pumping station. Work included roof design and modifications, a concrete floor opening, covers, influent junction chamber restoration, and bypass discharge. Also included in the design was a structural steel framing to protect the pumping station walls during flooding.

Trey Dykstra PE

Geotechnical

Office Location

Auburn, New Hampshire

Education

M.S., Civil Engineering,
Syracuse University, 1996

B.S., Civil Engineering,
Syracuse University, 1993

Registrations

Professional Engineer, NH, MA, PA

Always willing to help out, Trey is one of Stantec's "go-to" geotechnical engineers in the New England area. He brings over 27 years of broad geotechnical engineering experience to our team that includes below grade utilities, roadways, bridges, commercial, developments, industrial development and landfills. Responsibilities include project management, planning subsurface investigation programs, performing geotechnical engineering studies, preparing design reports, preparing project specifications, conducting construction inspections, and managing field staff.

PROJECT EXPERIENCE

Groton Water Treatment Plant, Groton, CT | Geotechnical Engineer

Geotechnical Engineer for the design and construction of a 12-MGD dissolved air floatation (DAF) and GAC filtration plant that included polishing contactors to remove manganese. The project replaced existing sedimentation basins and gravity filters with three new DAF basins and four new GAC filters in a new building. The project also included the conversion of three existing filters to manganese contactors, construction of two new 1-MG ground storage tanks, new high-lift pumping, a backwash system, and intermediate pumping systems.

Chemical Building Addition, Champlain Water District, South Burlington, VT | Geotechnical Engineer

Geotechnical Engineer for development of $20 million concept design report for VTDEC DWSRF including new 6,000 sf chemical and 3,500 sf administration office building additions to replace all eight chemical storage and feed sytems in a new centralized building for 20 MGD WTP.

Town Forest Water Tank, Groveland, MA | Project Engineer

Project Engineer responsible for providing geotechnical design recommendations for a 0.8 million gallon municipal water storage tank. The project involved drilling four test borings and providing a report in accordance with the manufacturer's requirements and AWWA standards.

Woodsville Water Treatment Plant, Woodsville, NH | Project Manager

Project Manager responsible for providing geotechnical design recommendations and construction bid package to remedy floor and wall settlement of a water treatment plant located adjacent to a sluiceway for a small hydroelectric generating station. Recommended grouting to support the structure and limit future settlement based on the presence of loose sand below the existing structure and the potential for migration of soil below the structure. Reviewed proposed grouting program developed by the contractor for suitability for the site.

Quinapoxet Transfer Pipeline, Holden, MA | Geotechnical Engineer

Geotechnical Engineer responsible for providing recommendations for a new utility 40-foot long utility bridge over the Asnebumskit River. The bridge will carry a 30-inch diameter restrained joint pipe of the river channel. The geotechnical design parameters were provided based on the AASHTO LRFD and MassDOT Bridge Design Manual. Both abutments will be supported on spread footings bearing on soil.

Katy Konary PE

Civil/Site

Office Location

Hyannis, Massachusetts

Education

M.S.,Environmental Engineering, University of Massachusetts, 2003

B.S., Civil Engineering, University of Massachusetts, 2001

Registrations

Professional Engineer, MA

Katy’s work at Stantec has involved peer reviews, feasibility studies, permitting, grant applications, site development, wetlands protection, design and inspection of sewage disposal systems, wastewater treatment facility design and construction oversight, stormwater control and drainage designs, and water supply development. She also brings extensive experience with preparation of environmental permitting documentation at the local, state and federal level.

PROJECT EXPERIENCE

High Street Water Treatment Plant Design and Construction Services, Bridgewater, MA | Civil/Site Engineer

Civil/Site Engineer for the preliminary design, permitting and final design tasks for the greenfield 2 MGD filtration plant. High Street Water Treatment Plant is designed to remove iron and manganese from four groundwater wells, adjust pH for corrosion control, and to provide disinfection of treated water. Design includes work at three sites: the new water treatment plant site upgrades to the existing maintenance garage, and upgrades to the existing three wellhouses.

Water Supply Development, Carver, MA | Project Engineer

Involved with the water resource planning and municipal water supply investigations for the Town of Carver, MA. Work included identifying and assessing potential municipal water supply well sites, researching needs assessments, assisting with various grant and loan opportunities and funding options to assist the Town in the development of a regional water supply network, and preparing state and local permits.

Wastewater Treatment Facility, Boxborough, MA | Project Engineer

Project Engineer involved with investigating performance issues at an existing wastewater treatment facility serving an office park in Boxborough, MA and negotiation of an Administrative Consent Order (ACO) with the MassDEP that provided short-term remedies to assist performance, and development of a long-term upgrade plan that led to the design and construction of a new membrane bioreactor wastewater treatment plant. Responsible for preparing the Wastewater Treatment Design Report and Operations and Maintenance Manual, assisted with the facility evaluation, design and construction phase services including a public bid process, contractor selection, Contract Administration and periodic inspections performed throughout the construction period and during facility start-up and operation. The ACO has been resolved and the treatment facility has been operating effectively meeting all permit discharge limitations.

Wastewater Treatment Facility Design, Mashpee, MA | Project Engineer

Assisted in the design and oversaw construction activity for the 40,000 GPD Rotating Biological Contactor (RBC) wastewater treatment facility and effluent disposal system to serve a 52-unit rental housing community to be developed by the Mashpee Wampanoag Tribe. Responsible for preparing the Hydrogeological Assessment and Mounding Analysis Report, Wastewater Treatment Design Report, and the Wastewater Treatment Facilities Operations and Maintenance Manual. The residential development is located within the recharge area for a nitrogen sensitive embayment requiring that the RBC WWTF provide tertiary treatment levels with denitrification and ultraviolet disinfection to produce a high quality effluent suitable for subsurface disposal with strict total nitrogen effluent requirements.

Paul Paone PE

Process Mechanical

Office Location

Burlington, Massachusetts

Education

B.S., Civil Engineering, Wentworth Institute of Technology, 2010

Registrations

Professional Engineer, MA

Paul is a civil engineer whose work at Stantec has focused on inspection and design for sewer collection systems, wastewater treatment facilities and pumping stations, water distribution systems and water treatment facilities projects.

PROJECT EXPERIENCE

Chemical Building Addition, Champlain Water District, South Burlington, VT | Project Engineer

Project Engineer for development of $20 million concept design report for VTDEC DWSRF including new 6,000 sf chemical and 3,500 sf administration office building additions to replace all eight chemical storage and feed sytems in a new centralized building for 20 MGD WTP.

Deep River Water Treatment Plant, Sodium Hypochlorite Feed System, Norwich, CT | Project Engineer

Project included the design of upgrading the existing chlorine gas feed system to a sodium hypochlorite feed system. Responsibilities included reviewing existing conditions via field investigation and record plans, designing the new feed system and then preparing the contract drawings, specifications and cost estimate for the related work.

Newington Booster Pump Station Upgrades, Newington, MA | Project Engineer

Project included the design of upgrading and modifying an existing booster pump station. Upgrades involved designing an addition onto the existing booster pump station as well as designing the modifications to the existing booster pump station pumps and piping. Designed upgrades to the sodium hypochlorite feed system as well. Responsibilities included reviewing existing conditions via photos and record plans, coordinating drawings/Revit model, and then preparing the contract drawings and specifications for the related work.

Parker Colorado Water Resource Centralization Project, Parker, CO | Project Engineer

Project was a progressive design build which included the design of two water purification facilities, upgrades and modifications to remote peaking wells, and conveyance piping to and from the new water purification facilities. The water purification facilities were designed to centralize water sources from local wells while providing iron and manganese removal through filtration and provide chemical treatment to the water. Responsibilities included reviewing existing conditions via record plans, site visits and photos, designing the water purification facilities, designing the peaking wells upgrades, attending weekly progress meetings, coordinating drawings/Revit model, coordinating and corresponding with the client, contractor and other teams in charge of designing other elements of the project, and then preparing the contract drawings, specifications and cost estimate for the related work

Water System Improvements, Stoneham, MA | Project Engineer

Project included the evaluation of the existing water system and designing/choosing the best method for upgrades. Responsibilities included reviewing and evaluating existing conditions via field investigation and record plans, developing the plan for upgrading the system and then preparing the contract drawings, specifications and cost estimate for the related work.

Kevin **Bucher** EIT

Plumbing/HVAC

Office Location

Burlington, Massachusetts

Education

B.S., Mechanical Engineering, University of New Hampshire, 2018

Kevin is a Mechanical Designer with two years of design experience. He has aided in the design of fire suppression, plumbing and HVAC systems for a wide range of project types including commercial office, water treatment facility, airport and industrial facilities. Kevin has assisted in managing projects and wishes to better himself while working within a respectable business environment.

PROJECT EXPERIENCE

Chemical Building Addition, Champlain Water District, South Burlington, VT | Mechanical/ HVAC Designer

Mechanical/HVAC Designer for development of $20 million concept design report for VTDEC DWSRF including new 6,000 sf chemical and 3,500 sf administration office building additions to replace all eight chemical storage and feed sytems in a new centralized building for 20 MGD WTP.

High Street Water Treatment Plant Upgrade, Bridgewater, MA | Mechanical Designer

Mechanical Designer responsible for the design of plumbing and fire protection systems for a new 1.62 MGD water treatment plant.

Kings Bay Naval Submarine Base Routine Waterfront Facility Inspection and Assessment and Refit Wharf 3 Repair Designs, Kings Bay, GA | Mechanical Designer

Mechanical Designer responsible for HVAC systems in the steel caisson, which provides movement of water in and out of the dry docks. Design included an AHU chilled water de-humidification system at sensitive dew point parameters.

Logan Express Garage, Framingham, MA | HVAC Designer

HVAC Designer responsible for the design of HVAC systems in an existing parking garage and the new additional three (3) levels.

Pfizer G3 Office Renovation, Andover, MA | Mechanical Designer

Mechanical Designer responsible for the full renovation of fire protection and plumbing systems.

Replace SSN Berthing Pier 32, Groton, CT | Mechanical Designer

Mechanical Designer responsible for the design of a compressed air system located on the pier. The design included dual rotary screw compressors rated at 141 CFM each and a desiccant air dryer serving compressed air hand tools.

Yonkers Distribution Facility for UPS 555 Tuckahoe Road, Yonkers, NY | Mechanical Designer

Designed a new fire suppression system for a renovated UPS distribution facility. The design included wet and dry systems protecting complex conveyor, office and industrial areas.

Pfizer G2 Office Renovation, Andover, MA | Mechanical Designer

Mechanical Designer responsible for the full renovation of fire protection and plumbing systems.

Tom Gramza PE

Fire Protection

Office Location

Burlington, Massachusetts

Education

B.S., Mechanical Engineering, University of Massachusetts - Lowell, 1998

Registrations

Professional Engineer MA, NY, CT, TX, WY, UT

Tom has designed plumbing, fire suppression and fire detection/alarm systems for a wide range of project types including commercial office, residential, visitor attraction, laboratory, educational, airport, nuclear and industrial facilities. His experience includes FERC/FEED designs for several new LNG facilities located throughout the U.S. Gulf Coast region and was responsible for the design and Federal Energy Regulatory Commission permitting of the fire protection/ process safety systems for those facilities.

PROJECT EXPERIENCE

High Street Water Treatment Plant, Bridgewater, MA | Senior Fire Protection Engineer

Senior Fire Protection engineer, responsible for the assessment of hazardous chemicals to be stored onsite and design of the fire suppression systems for the new water treatment plant.

Millipore Sigma - Carbon Production Plant, Bellefonte, PA | Plumbing/Fire Protection Engineer

Lead fire and plumbing engineer responsible for the design of the plumbing infrastructure to support the carbon processing facility, including domestic water, lab waste & vent, compressed air, nitrogen generation, RODI and pH neutralization.

Canadian Solar Photovoltaic (PV) + Battery Storage Facility, CA | Lead Fire Protection Engineer

Lead Fire Protection Engineer responsible for developing a fire safety plan several planned Solar PV + BESS facilities in California. Scope of work included evaluation of proposed battery storage vendor equipment and the integral fire safety features, as well as recommendations to enhance fire safety throughout the planned facilities.

Driftwood Liquefied Natural Gas (LNG) – Export Terminal, Calcasieu Parish, LA | Fire Protection Engineer

Fire Protection Engineer responsible for the FERC/FEED design of fire protection system deliverables (fire water, fire & gas, passive fire protection, hazardous area classification, etc.); as well as process safety (facility siting, hazard analyses). Also responsible for preparing permitting reports (Resource Report 11 & 13) for Federal Energy Regulatory Commission.

National Grid - LNG Storage Facility, Lynn, MA | Fire Protection Engineer

Lead Fire Protection engineer, responsible for the design of new high expansion foam suppression system for LNG vapor mitigation. Responsible for fire protection and fire alarm design, as well as project construction cost estimating.

Gulf LNG – Export Terminal, Jackson County, MS | Fire Protection Engineer

Lead Fire Protection Engineer responsible for the FERC/FEED design of fire protection system deliverables (fire water P&ID's, fire water layout, fire & gas detection drawings, high expansion foam design, passive fire protection drawings, hazardous area classification, etc.). Also responsible for preparing the fire protection portion of permitting documentation (Resource Report 11 & 13) for Federal Energy Regulatory Commission.

Phil Relf

Instrumentation & Control

Office Location

Burlington, Massachusetts

Education

M.S., Electrical Power Engineering, University of Greenwich, 2015

B.S., Electrical and Electronic Engineering, University of Greenwich, 2014

As an I&C engineer, Phil has produced and reviewed process and instrumentation diagrams (P&IDs), PLC panel layouts, loop diagrams, system architecture diagrams and graphical display layouts. He has produced specifications for items such as field instrumentation, control panels, control philosophies, PLC hardware/software and security systems. He has also been responsible for construction phase services including review of shop drawings and submittals, assisting in the development of control system software for PLC's and HMI's and responding to requests for information.

PROJECT EXPERIENCE

Groton Water Treatment Plant, Groton, CT | Electrical/Instrumentation & Controls Engineer and Startup and Commissioning Coordinator

Served as the Electrical/I&C Engineer and Startup and Commissioning Coordinator for the Groton Utilities (GU) Water Treatment Plant upgrade project. He supported the GU upgrade through submittal review, responding to RFIs, and Electrical inspection. He served as Stantec's startup and commissioning coordinator, overseeing the startup of pumping systems, dissolved air flotation units (DAF), GAC filters, Manganese contactors, SCADA/control systems and chemical systems.

John J. Carroll Water Treatment Plant, Wachusett Aqueduct Pumping Station, Marlborough, MA | Instrumentation & Controls Engineer

Supported the final stages of the Wachusett Aqueduct Pumping Station, including but not limited to onsite PLC (Allen Bradley) and SCADA (GE iFIX) workstation programming adjustments, production of record drawings and the training of MWRA's staff on the pumping stations Instrumentation and SCADA system.

Chemical Building Addition, Champlain Water District, South Burlington, VT | Instrumentation & Controls Engineer

Instrumentation & Controls Engineer or development of $20 million concept design report for VTDEC DWSRF including new 6,000 sf chemical and 3,500 sf administration office building additions to replace all eight chemical storage and feed sytems in a new centralized building for 20 MGD WTP.

High Street Water Treatment Plant, Bridgewater, MA | Instrumentation & Controls Engineer

Provided Instrumentation and control design for the Bridgewater High Street Water Treatment Plant along with the SCADA and control upgrades to the Town of Bridgewater's remote wells storage tanks, and Carvers Pond Treatment Plant.

Chemical Feed and SCADA Upgrades, Adams, MA | Instrumentation & Controls Engineer / Construction Support

Responsible for the construction support, technical queries and modifications to design and instrumentation changes during construction for the remote Well sites and main SCADA system for the town. He is also providing commissioning support along with startup services and inspection.

Jeffery Cota LEED AP

Electrical

Office Location

Burlington, Massachusetts

Education

B.S., Electrical Engineering, University of Vermont, 1988

Registrations

LEED Accredited Professional

Jeffrey has 33 years of electrical engineering experience in design of commercial, industrial, healthcare, laboratory, academic, high-tech institutional, military and manufacturing type projects. As Project Engineer, he is responsible for organizing Division 16 specifications, determining incoming electrical service sizes and preparing service calculations, the design of normal and emergency power, indoor and outdoor lighting design and calculations, site utility design, fire alarm design, and telecommunications/data or specialized system design. He is experienced in project management from conceptual design and project cost estimating through final construction documentation and construction administration for owner acceptance.

PROJECT EXPERIENCE

Pennichuck Water Works, Water Treatment Plant Improvements, Nashua, NH | Electrical Designer

Designer for the electrical systems for the expansion of the existing plant that kept the plant operational during construction. Work included providing a 750 kVA transformer, 1000 ampere, 480volt distribution switchboard, 1100 kW emergency generator with an emergency switchboard, motor control centers, lighting system, fire alarm system and telephone system.

Finished Water Pumping Station, Pennichuck Water Works, Nashua, NH | Electrical Designer

Designer for the electrical systems for the replacement of the existing pump station with a new station. Work included providing a 2500 kVA transformer, a 3000 ampere, 480volt main distribution switchboard to power 3 - 400 HP and 2 - 250 HP soft started motors and 3 - 200 and 2 - 150 VFD driven motors, a 1250 kW emergency generator, a motor control center, a lighting system, a fire alarm system and a telephone system.

John J. Carroll Water Treatment Plant - Wachusett Aqueduct Pumping Station, Marlborough, MA | Project Electrical Engineer

Electrical design of a new water pumping station, including 480v power distribution. motor control and branch circuit wiring, 208/120V distribution and branch circuit wiring, branch circuit and instrumentation wiring for meter and valve vaults and domestic waste systems, fire alarm system consisting of pump station main fire alarm control panel networked via fire optic cable to main plant fire alarm system, and miscellaneous buildings systems.

Groton Water Treatment Plant, Groton, CT | Electrical Engineer

Electrical engineer, provided design assistance for water treatment facility modifications and expansion. Electrical design work included preliminary site and treatment plant investigations, assessments, and generator analysis.

Water Treatment Plant Improvements, Jamestown, RI | Electrical Engineer

Electrical Engineer, responsible for the design of a new water treatment facility utilizing a Zenon membrane system and interconnection to the existing water treatment facility. Work included providing a new electrical service to serve the new and existing water treatment facilities, new telecommunications services, new motor control center with integral automatic transfer switch, exterior diesel generator in sound attenuated enclosure, lighting and emergency lighting systems, fire alarm systems in new and existing facilities, telephone system and instrumentation system/equipment wiring.

Mike Leach CWS, CPESC, CEWWI

Permitting

Office Location

Auburn, New Hampshire

Education

B.S., Soils, University of New Hampshire, 1988

Certifications

Certified Wetland Scientist, NH

Certified Erosion, Sediment and Stormwater Inspector, NH

Certified Erosion and Sediment Control, NH

Mike is a Certified Wetland Scientist, Certified Professional in Erosion and Sediment Control, and Design Engineer with over 20 years of experience on public and private projects. He has extensive field and design experience in soils, wetland soil delineation and permitting and facility layout and design. Mike's extensive field experience includes soils mapping, site feasibility studies, wetland delineation and environmental permitting through local, state and federal agencies.

PROJECT EXPERIENCE

Franconia Water System Improvements, Franconia, NH | Wetland Scientist

Wetland Scientist responsible for the wetland delineation and NHDES wetland delineation and NHDES Wetlands and Shoreland permitting for this waterline infrastructure improvement project. The work included wetland flagging, abutter notification for the project wetland and shoreland impact locations, and obtaining NHDES permitting for construction. The project permits were obtained and the improvements were constructed in 2010.

Water System Improvements, Glencliff Home, Benton, NH | Project engineer

Project Engineer responsible for the coordination and design of approximately 3,000 feet of new water main pipe to address deficiencies cited by the State at the facility. In addition, NHDES requested that an Operation and Maintenance (O&M) Manual be prepared for this unique facility. The deficiencies were incorporated as part of the improvements of the project and permitted with NHDES. Upon completion of construction, the O&M Manual was prepared and approved by NHDES. Mike was also responsible for wetland permitting for the project.

Brewster Street Sewer Separation and Drainage Improvements, Portsmouth, NH | Wetland Scientist

Wetland Scientist responsible for the wetland delineation and NHDES wetlands and Army Corps of Engineers permitting for this City infrastructure improvement project which began with a conceptual design meeting held with NHDES and the City. The project included temporary and permanent impacts to the tidal wetland and 100-foot upland tidal buffer area of North Mill Pond and for a NHDES Shoreland Permit for temporary impacts within 250-foot Shoreland Area of North Mill Pond.

Mammoth Road Interceptor Sewer, Londonderry, NH | Project Engineer

Project Engineer responsible for the wetland delineation, wetland permitting, and preliminary layout and design of this 25,000 linear foot municipal sewer project. This work included field investigation, wetland flagging, wetland verification of previously flagged areas, sewer facility layout and design, municipal, NHDES and Army Corps wetland permitting, NHDOT-District V permitting for roadway crossing, and assistance to the Town with easement negotiations with the abutters along the final sewer alignment. The design and permitting are completed and the project has been constructed.

Understanding of the Project Requirements

Pennichuck Water Works Inc. (PWW) operates a 32 million gallon per day (MGD) water treatment facility (WTF) that has undergone several upgrades to expand the capacity since the original 20 MGD plant went on-line in 1978. Stantec (formerly as Fay, Spofford & Thorndike) conducted a detailed treatment evaluation in 2004 including pilot plant studies that led to the last major facility upgrade completed in 2009. As part of this upgrade, Stantec converted, reconfigured, replaced and/or added each of the current chemical storage and feed systems, as well as the major treatment processes for the purpose of:

1. Meeting current and future proposed Safe Drinking Water Act (SDWA) requirements.
2. Maintaining National Partnership for Safe Water program filtered water turbidity goals of less than 0.1 NTU.
3. Replacing 25-year-old mechanical and electrical equipment that reached the end of its useful life, and
4. Significantly improving the integrity, reliability and flexibility of water treatment facilities and operations.

The successful completion of this $35 million project was recognized with a Gold Award from the American Council of Engineering Companies (ACEC) in 2010.

As mentioned in the Request for Proposal (RFP) and presented in **Figure 1** below, the impact of PFAS as a new primary drinking water standard, has caused PWW to change its practice of using Pennichuck Brook System as the primary source of raw water supply to the Merrimack River.

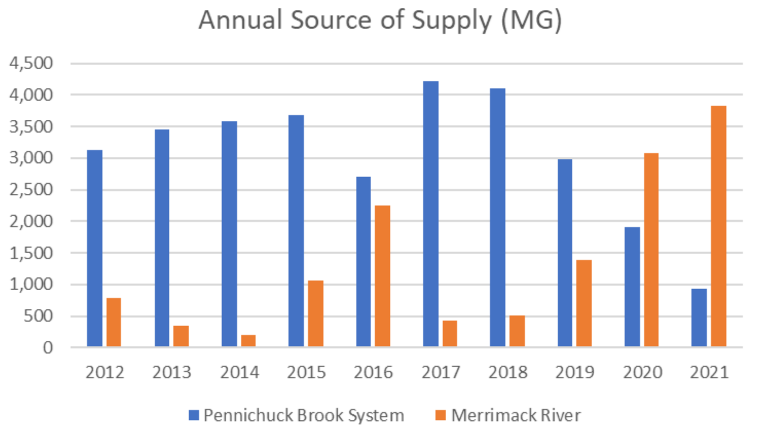
The variable and more challenging raw water quality from the Merrimack River compared to Pennichuck Brook System has resulted in an increase in average monthly ferric chloride coagulant use from the original design of 20,000 gallons to more than 26,000 gallons, requiring a 30% increase in the frequency of deliveries. The current ferric chloride feed pump rate is close to exceeding its capacity during the summer high demand season to treat the more variable and challenging Merrimack River water quality.

We understand that the goals and objectives of the project include the following elements:

- Evaluate condition of existing chemical storage and feed equipment and type of feed equipment and recommend replacement or upgrades, as needed.
- Size chemical storage and feed systems for Merrimack River only supply, as well as Pennichuck Brook System or some combination of the two considering:
  - Degrading raw water quality.
  - Increased water demands to plant capacity of 32 MGD in the future.
  - Future known SDWA changes and aesthetic water quality goal requirements.

Merrimack River Intake

Figure 1– Pennichuck Brook System vs Merrimack River Annual Water Supply Volume



- Evaluate existing chemical injection locations and recommend modifications to existing injection locations or additional injection locations, if needed.
- Conduct treatment process evaluation and make recommendations, if any, for upgrades that would help meet treatment goals and improve the Plant's performance.

SOME CRITICAL QUESTIONS FOR THE CHEMICAL STORAGE AND FEED DESIGN INCLUDE:

- **How much coagulant bulk storage is needed?**
- **Where can additional storage be located?**
- **What other upgrades will help meet water quality goals and improve performance?**
- **How can construction be phased to maintain continuity of service during chemical system upgrades including chemical deliveries?**
- **How can project quality and cost be controlled?**

COAGULATION BULK STORAGE SIZING

Stantec has developed a strong understanding of the treatment operation and chemicals used based on the information provided by PWW as part of this engineering procurement, our recent visits to the WTF over the last several months and having designed and overseen the construction of these systems in 2005 to 2009. There are many alternatives for equipment, features, and location that may be considered for expanded coagulant bulk storage volume.

Historical plant flows were evaluated based on the last 10 years of data to project future flow conditions (see Table 1). Chemical feed bulk storage is typically designed based on the average daily demands (ADD); the future ADD was estimated based on an assumed future maximum day demand (MDD) of 32 MGD and the historical ratio between the ADD and MDD.

Table 1 –Historical and Future Plant Flow Design Criteria

	Historical Average (2012 – 2021)	Future Estimated
Maximum Day Demand (MDD)	24.2 MGD	32 MGD
Annual Average Day Demand (ADD)	12.6 MGD	16.7 MGD
Average Day Demand during Maximum Month (ADD-MM)	19.6 MGD	20.5 MGD
MDD/ADD Ratio	1.92	1.92
MDD/ADD-MM Ratio	1.56	1.56

Table 2 – Preliminary Bulk Storage Volume Surplus/Deficit Evaluation

Chemical	2021 Gallons or Pounds/ Year	Delivery Gallons or Pounds/ Year	Avg. Delivery per Year	2021 Gallons or Pounds/ Month	Projected Gallons or Pounds/Year	Current Liquid Bulk Storage (gallons)	30-Day Criteria Surplus/ Deficit (gallons)	30-Day Criteria Surplus/ Deficit (percent)
Caustic Soda (WTP)	117,124	3,500	34	9,760	12,493	13,650	1,157	8%
Caustic Soda (FWPS)	82,487	3,500	24	6,874	8,799	14,000	5,201	37%
Caustic Soda (Total)	199,611	3,500	58	16,634	21,292	27,650	6,358	23%
Ferric Chloride	316,953	4,000	80	26,413	33,808	19,800	-14,008	-71%
Dry Nonionic Polymer *	8,525	2,100	5	710	909			
Sodium Hypochlorite **	60,209	4,000	16	5,017	6,422	10,000	3,578	36%
Sodium Permanganate	0	0	0	0	1,219	4,550	3,331	73%
Dry TKPP * Pyrophosphate	21,050	2,100	11	1,754	2,245			
Zinc Orthophosphate	8,153	3,500	3	679	870	6,000	5,130	86%

Table 2 shows current chemical use, bulk storage volume and chemical delivery volumes for the "core system" chemicals received at the WTF. Future chemical use estimates have been projected based on a future average daily demand of 16.7 MGD (ADD).

Figure 2 – Historical and Future Plant Flows

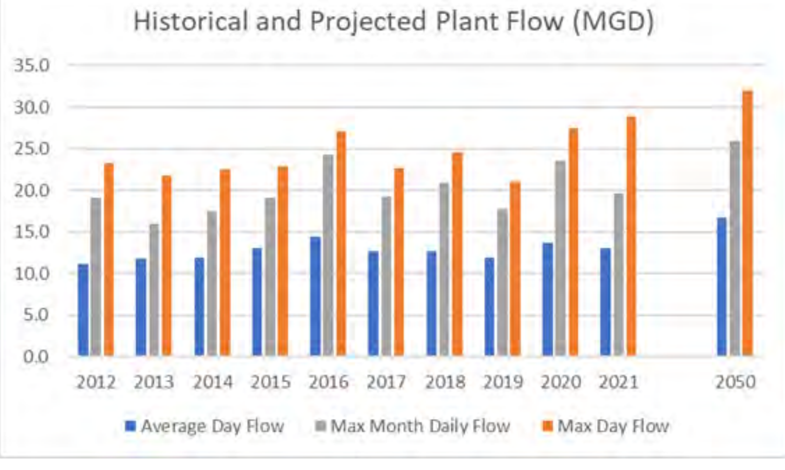


Figure 2 presents historical annual average day flows, maximum month daily flows, and annual maximum daily flows and a projected ADD increase of 28% from 13 MGD in 2021 to 16.7 MGD in the future.

A workshop will be organized to discuss and agree upon the required future chemical feed dose and monthly usage, bulk storage tank capacities, number of tanks, delivery volumes and other design options including storage options for community system chemicals with PWW Management, Operations, and Maintenance staff to select the preferred alternatives.

Stantec will review with PWW internal policies for receiving deliveries and chemical handling. Some of the chemical storage and feed observations and issues noted by PWW staff during our site visit included:

- Option of additional ferric chloride bulk storage located between Supply Pond and Plant will be difficult due to the existing major process lines and utilities in this area.
- Sodium hypochlorite bulk tanks are most problematic with leaking flanged outlets. Peristaltic feed pumps are working well.
- Sodium hydroxide (caustic soda) bulk tanks receive one to two deliveries per week depending upon the season and are adequately sized.
- Sodium permanganate bulk tank has never been used. Finished water manganese is generally less than 0.05 mg/L.
- Ferric chloride bulk tanks receive deliveries every 3 days in summer and additional storage capacity is needed. Evaluation of existing fill lines and transfer pump manifold suction piping is necessary to identify a simpler tanker truck unloading process.
- Condition assessment of existing polymer system is needed; the system is working well but PWW is open to other newer polymer feed technologies.
- Sodium hydroxide day tank, feed system, and containment for pulsator residuals pH adjustment needs to be modernized.
- Include condition assessment of carbon dioxide tank and feed system.
- Review/optimize chemical injection locations.

Leaking outlet flange from Hypochlorite IMFO bulk tank

Philip J. Holton Purification Plant, liquid ferric sulfate exterior bulk storage tanks

CHEMICAL STORAGE LOCATION

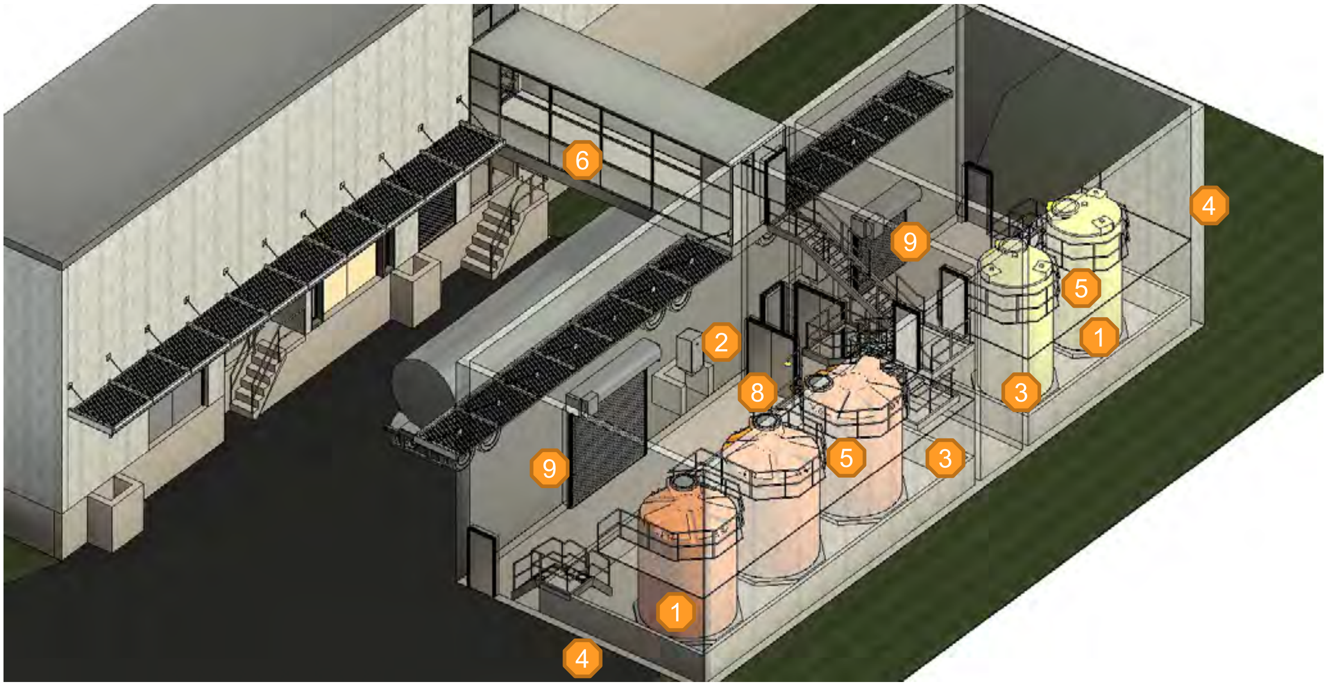
Table 1 indicates an additional 14,000 gallons of ferric chloride storage is needed to meet the 10 State Standards design guideline of a minimum of 30-days of bulk storage. Factors that will be considered in the evaluation for the design and location of chemical storage and feed systems include:

- Proximity to chemical application point
- Operator safety
- Ease of Operation and Maintenance
- Standardization
- Containment with chemical resistant coating
- Redundancy
- Security
- Cost
- Construction/phasing

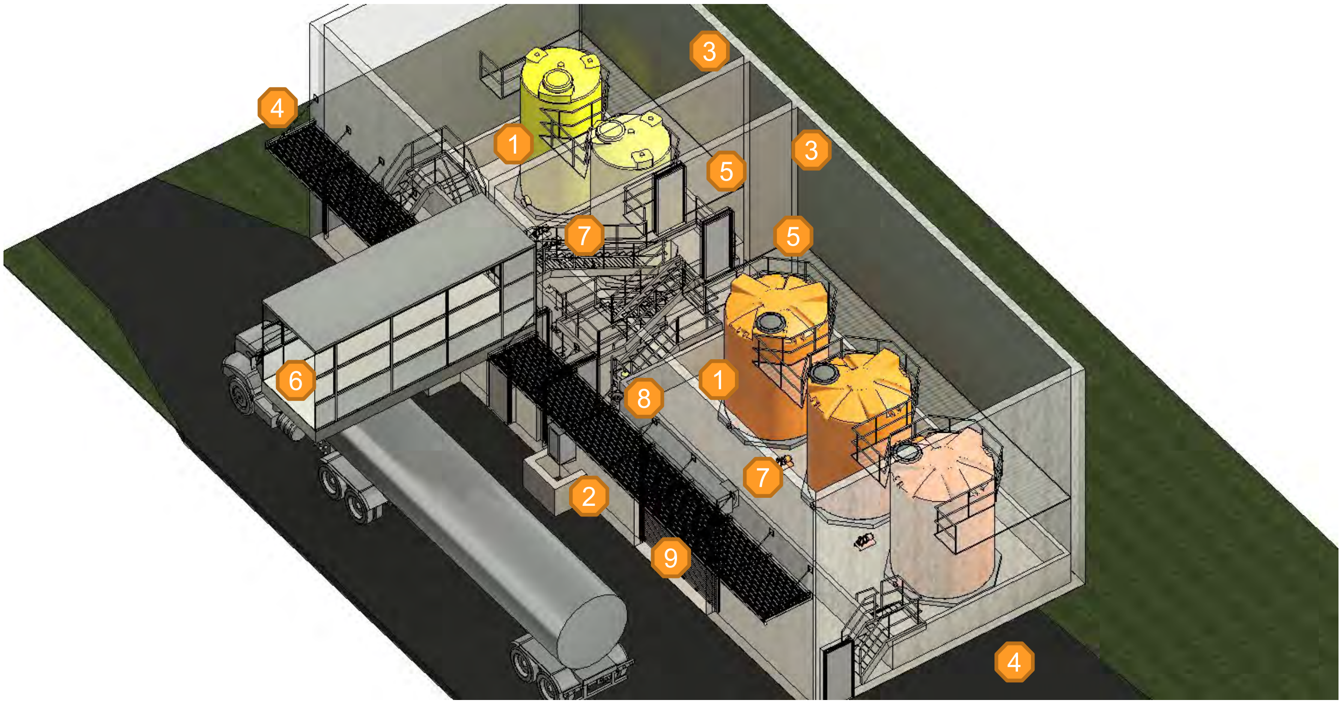
A conceptual ferric chloride bulk storage facility with design features is presented on the following pages. It is located across the access road from the existing water treatment plant loading dock in the parking area adjacent to the Snow Station. This rendering is representative of only one option to consider for future bulk chemical storage; Stantec has identified various alternatives that could be considered including, but not limited to: (1) retrofitting the existing chemical feed storage areas rather than constructing a new building, (2) a smaller new building that only provides enough space for bulk ferric, and/or (3) new exterior bulk storage tanks with insulation and heat tracing (assuming tanks are utilized in the winter) and a containment wall designed to support a future superstructure to enclose the bulk tanks.

Stantec completed a similar design that included the conversion from a dry silo type ferric sulfate coagulant storage system to three (3) 14,000-gallon liquid ferric sulfate exterior bulk storage tanks with insulation and heat tracing and a transfer pump house at the 144 MGD Philip J. Holton Purification Plant that has been in operation since 1996. The concrete containment area was designed to accommodate a superstructure, if desired, in the future.

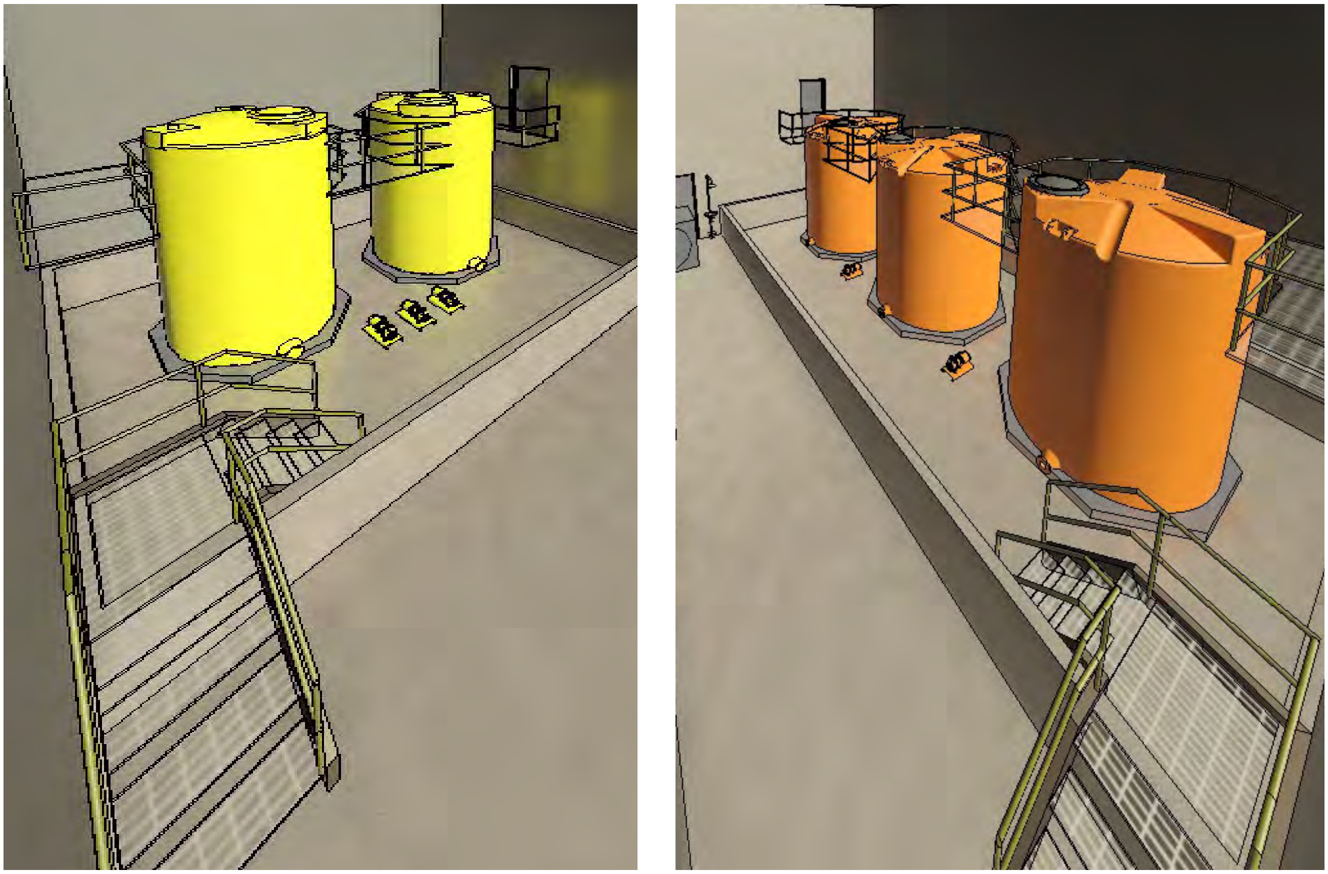
Concept rendering of new chemical building



1	High-density cross-linked polyethylene (HDPE) bulk chemical tanks with IMFO.
2	Covered loading area with tank level readouts and concrete containment box at loading station.
3	Separate rooms for Sodium Hypochlorite and Ferric Chloride.
4	Future building expansion flexibility.
5	Catwalk for easy access to field instruments and tank inspection.
6	Elevated walkway connector for ease of operator access and safety.
7	Transfer pumps to fill existing day tanks.
8	Emergency eye wash/shower with tepid water (in both rooms).
9	Overhead roll up door for equipment and chemical tank removal.



Concept rendering of new chemical building on left and existing plant on right looking west toward Snow Station



Concept renderings of liquid hypochlorite and ferric chloride bulk storage tank rooms

Table 3 – Merrimack River Treatment Plant Information Evaluation

Treatment Plant	Capacity (MGD)	Pre-Oxidant	Coag.	Pre-Treatment	Filtration	TOC/Color (min)	TOC/Color (avg)	TOC/Color (nmax)	LRAA TTHMM (ppb)	LRAA HAA5 (ppb)
Andover	18	Ozone	Alum	Convent. Settling	GAC 48"	3.5 / 16	5.5 / 24	7 / 30	49	9
Lawrence	14		Alum	Convent. Settling	GAC 33"	- / 25	- / 30	- / 75	46	23
Lowell	30	Chlorine Dioxide	Alum	Convent. Settling	Anth. 8"/ Sand 8"/ GAC 48"	2 / 25	3 / 40	- / 70	52	18
Methuen	10	Chlorine Dioxide	Alum	Convent. Settling	GAC 48"/ Sand 12"	- / 15	- / 34	- / 100	51	27
Tewksbury	7	Chlorine Dioxide	Alum	Convent. Settling	GAC 36"/ Sand 12"	- / 25	4 / 35	- / 200	62	15
PWW	32	Sodium Perman.	Ferric Chloride	Upflow Floc Blanket	GAC 54"	2 / -	4 / -	15 / -		

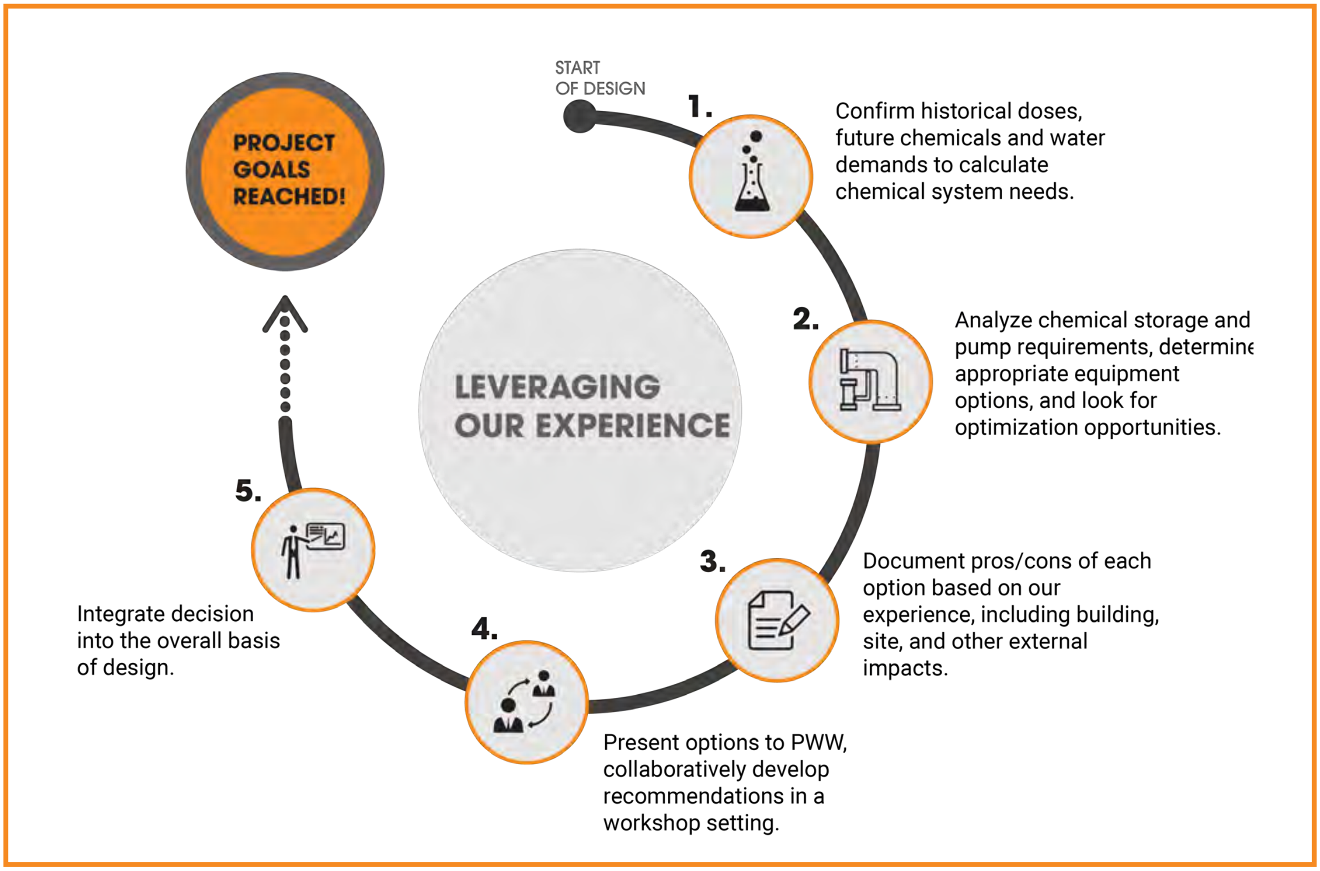
Other considerations that will be considered during the evaluation include:

- A safety factor above the minimum 30-day bulk storage guideline for water quality degradation; 25% safety factor would add another 7,000 gallons to the additional 14,000 gallons required for ferric chloride.
- Space in a new chemical storage building for other chemicals such as sodium hypochlorite and/or chlorine dioxide
    - Sodium hypochlorite bulk tanks are most problematic due to leaking outlets. Five (5) 2,000-gallon bulk tanks that have been shoe-horned into the original chlorine gas room could be replaced with two (2) 5,000-gallon bulk tanks in a new building and the existing bulk storage area could be repurposed for sodium permanganate or other pre-oxidant.
    - Chlorine dioxide was piloted successfully by Stantec in 2004 at PWW for manganese control and, as a strong oxidant, has additional benefits as compared to permanganate.
    - There are a number of utilities that use the Merrimack River as their primary source of supply and utilize chlorine dioxide. (See **Table 3**)
- Conversion of the unused 4,550-gallon permanganate bulk storage tank to ferric chloride for additional bulk storage.
- Install new day tank, metering pumps and controls in water treatment plant or finished water pump station caustic soda storage and feed area for Pulsator residuals pH adjustment.

As a partner with PWW in the development of the conceptual design, we welcome ideas and questions from PWW staff whenever they arise - the same process that was followed during the 2003 concept design.

However, formal collaboration and decision making during the concept engineering phase is recommended to be organized into three conceptual design phase workshops, one as part of the Kick-Off meeting, and then the next two concept design meetings. Each subsequent workshop will build on the concepts and decisions developed from the previous one. In order to efficiently drive towards decisions in each workshop we will prepare and distribute key information in advance, breakdown complex decisions into straightforward drivers and impacts, and guide decision making based on our team's experience from similar projects throughout the region and the country.

On the following page is an example of how leveraging our experience with chemical system design allows us to efficiently assess PWW needs, get your feedback, and quickly drive towards decisions.



LEVERAGING OUR EXPERIENCE

START OF DESIGN

1. Confirm historical doses, future chemicals and water demands to calculate chemical system needs.

2. Analyze chemical storage and pump requirements, determine appropriate equipment options, and look for optimization opportunities.

3. Document pros/cons of each option based on our experience, including building, site, and other external impacts.

4. Present options to PWW, collaboratively develop recommendations in a workshop setting.

5. Integrate decision into the overall basis of design.

PROJECT GOALS REACHED!

Leveraging Our Lessons Learned

Champain Water District (CWD), VT
Chemical Building Addition
Stantec Chemical Storage Evaluation
June 2022 Preliminary Engineering Report

It is critical to maintain access to chemical fill stations, or provide temporary relocated chemical fill stations during construction of improvements to maintain safe and uninterrupted plant operation.

Tanker Truck Chemical Delivery to Repurposed Maintenance Garage

Potential location of new chemical storage

WHAT OTHER UPGRADES WILL HELP MEET WATER QUALITY GOALS AND IMPROVE PERFORMANCE?

Stantec worked collaboratively with PWW in 2004 in developing and implementing the upgrades to the treatment facility that helped meet water quality goals and improve performance, reliability and redundancy. We are excited to continue this collaborative process with our unique insight of your facilities to address new water quality challenges, aged equipment, and provide additional process flexibility and further improve performance. We will review compliance with existing and future potential SDWA requirements and other aesthetic water quality considerations including:

- Filter Backwash Recycling Rule (FBRR)
- Stage 1 and Stage 2 Disinfectants and Disinfection By-Products Rule (Stage 2 D/D/DBPR)
- Surface Water Treatment Rule (SWTR)
- Interim Enhanced SWTR (IESWTR)
- Long Term 2 ESWTR (LT2ESWTR)
- Revised Total Coliform Rule (RTCR)
- Lead and Copper Rule Revisions (LCRR) and Lead and Copper Rule Improvements (LCRI)
- PFAS
- Manganese
- Strontium
- Perchlorate
- Chlorate, Nitrosamines, Other New DBP’s
- Chromium VI
- Microconstituents: Pharmaceuticals, Industrial Chemicals, and Others
- Algal Toxins

Some of the plant performance and operation and maintenance enhancements that will be reviewed and may be considered pending further discussion and/or testing include:

- Alternative coagulation strategy analysis through jar testing for TOC and Turbidity optimization, that may increase filter run times and result in reduced chemical use and cost savings.
- Application of potassium permanganate may improve treated water quality reducing oxidant demand and manganese.
- Chlorine dioxide is a stronger oxidant than permanganate, was successfully piloted by Stantec in 2004 and may further improve treated water quality.
- Replacement of submersible jet pumps for coagulant mixing with self-priming end suction pumps located on the operating floor for easier access for maintenance.
- Addition of a residuals flow meter to pace caustic metering pump for pH adjustment prior to discharge to sewer.
- Review of alternative valve control systems to the Rotork Pakscan system for improved reliability.
- Increase suction line size between ferric chloride bulk tanks for better flow balancing between tanks during fill process.
- Addition of an elevator on the south side of the plant at the service entrance between Pulsator #1 and #2 to facilitate equipment removal for maintenance, repair, or replacement. Also, reconsider plant front entrance design from 2007 that included an elevator but was value engineered out of the project.

CONSTRUCTION PHASING

The location of additional chemical storage in a new building or in the existing facility will be carefully evaluated to minimize impact on existing utilities, drain lines and/or process lines and this will need to be addressed to maintain continuity of service.

Provisions for relocation of existing gas lines, electric lines, sewer force mains, chemical fill and vent pipes, chemical transfer and feed lines, and other process pipe to keep existing systems operational until the additional chemical storage is complete will be critical and must be carefully planned. Early relocation or installation of these lines will eliminate risk of impacting these systems during construction. Maintaining access to the current chemical storage fill stations and to the existing loading docks are also important in phasing of the work.

Stantec and PWW worked collaboratively on identifying constraints and a construction sequence as part of the last major plant upgrade completed in 2009 that minimized risk and maintained continuity of service.

PROJECT QUALITY AND COST CONTROL

Controlling project quality and costs in any project requires a commitment from the start of conceptual design through construction and into operations. The key to controlling costs is for our team to communicate with you about decisions and their impacts. Our team's experience and commitment to value for PWW enable us to clearly communicate the full cost of the alternatives to you throughout the project. At the predesign level, management of overall project cost can be optimized by applying general best value practices. These include aspects such as identifying the most optimal equipment layout and positioning on site, considering constructability, and recognizing future needs. Alternatives that have significant cost impacts will be identified early and flagged for additional confirmation, so that PWW has a clear understanding of the cost implications. For example, creating a sunken containment volume around chemical tanks improves the overall operations and maintenance access but comes at a higher cost compared with building containment walls upward.

Our experience with chemical system design allows us to know where the significant costs lie – details such as chemical coating requirements or supplier differences – and incorporate them during the predesign phase to provide a reliable opinion of probable construction cost (OPCC).

Approach

Collaboration is critical during this phase to integrate PWW's vision for additional chemical storage with input from engineering disciplines, as well as our permitting and geotechnical specialists. Our team's unparalleled experience in chemical facility design combined with our in-depth knowledge of the facility and preliminary project understanding ensures we are ready to hit the ground running – we are prepared to quickly break down the critical decisions into succinct options, provide key drivers, pros/cons, and costs for each, visualize spatial impacts, and ultimately collaborate with PWW to create a facility layout that best meets your needs. Our use of visualization and collaboration tools efficiently conveys information to a wide audience, ensuring we are all on the same page.

WORKSHOP MEETINGS

- **Information transfer, design criteria, and key equipment workshop no. 1 (Kick-Off)**— Present observations and recommendations for sizing; discuss equipment types and options with operations staff, and preliminary process evaluation based on data review.
- **Performance evaluation and building layout workshop no. 2**— Review jar test results (if included in scope), final process evaluation, SDWA assessment and building layout options for additional chemical storage. Use rapid collaborative 3D modeling to clearly communicate and easily adjust the building model to establish a clear basis for design.

Maintaining access to chemical fill stations and loading dock is critical

- **Plant upgrades and construction phasing workshop no. 3**— Review recommended plant upgrades and coordinate information from operations staff on access for chemical deliveries. Work collaboratively on finalized plant upgrade plan to meet water quality goals and improve performance and construction phasing plan to minimize or eliminate required plant shutdowns, and to maintain a safe operating environment and accessibility during construction.

A conceptual design report will be generated that incorporates all aspects of the scope requirements in the RFQ/P including but not limited to:

- **Define need for project**— additional bulk coagulant storage, replace sodium hypochlorite tanks that have exceeded their useful life of 10 to 15 years (as compared to the other chemical tanks that have a useful life of 25 to 30 years) as well as other process equipment that has outlived its useful life, improve operator safety and efficiency. Optimize new configuration to allow most flexibility for future operations.
- **Documentation of existing conditions**—review of existing plans and reports. Site survey to be completed in next phase.
- **Identify existing deficiencies and needs**—review current notes and interview staff.
- **Evaluation of current and future chemical storage and treatment needs**—confirm existing data and future projections.
- **Evaluation of existing sodium permanganate treatment system as compared to chlorine dioxide or other pre-oxidant** - maximize operator efficiency of the selected system.
- **Alternatives evaluation**—Use 3-D design programs such as Revit to help all stakeholders clearly understand alternatives to allow ideal alternatives selection.
- **Capital and life cycle cost analysis**—critical analysis for selection of the best alternatives for PWW.
- **Proposed project**—Reach consensus on selected alternative

- **Phasing of project**—critical discussion to ensure plant operations during construction activities.
- **Construction and total project cost opinion**—30% to 50% contingency at this stage.
- **Environmental impacts**—mitigate impacts during both construction activities and future plant operations
- **Permitting requirements**—by Auburn, NH, office for wetlands, planning and zoning, storm water.
- **Conceptual drawings**—build 3-D model of concept design to facilitate inception of final design documents.

Permanganate Tank Re purposed as Ferric Chloride #4

Our Experience Brings You Value Now And Value In The Future

Our knowledge of PWW's WTF and expertise in chemical facility design ensures you are getting the most from your money now and laying out a design that will serve you for the life of your WTF.

VALUE NOW ...

Our conceptual chemical facility layout incorporates a vision for additional ferric chloride bulk storage that provides easy access for chemical deliveries and operator convenience. We have integrated these concepts into our vision of what your future facility layout could look like and optimized them for additional purposes:

- The new bulk chemical storage facility would be constructed on the southwest side of the existing WTF. In the new storage facility built into the hill would be potentially three (3) new 7,000-gallon ferric chloride storage tanks and two (2) new 5,000-gallon sodium hypochlorite storage tanks.

- The existing permanganate tank would potentially be repurposed as a fourth ferric chloride tank and the existing sodium hypochlorite room would potentially be repurposed for potassium permanganate.

- A new 2,000-gallon 25% sodium hydroxide storage tank would potentially be installed in the existing 50% Sodium Hydroxide bulk room for use in servicing the community systems.

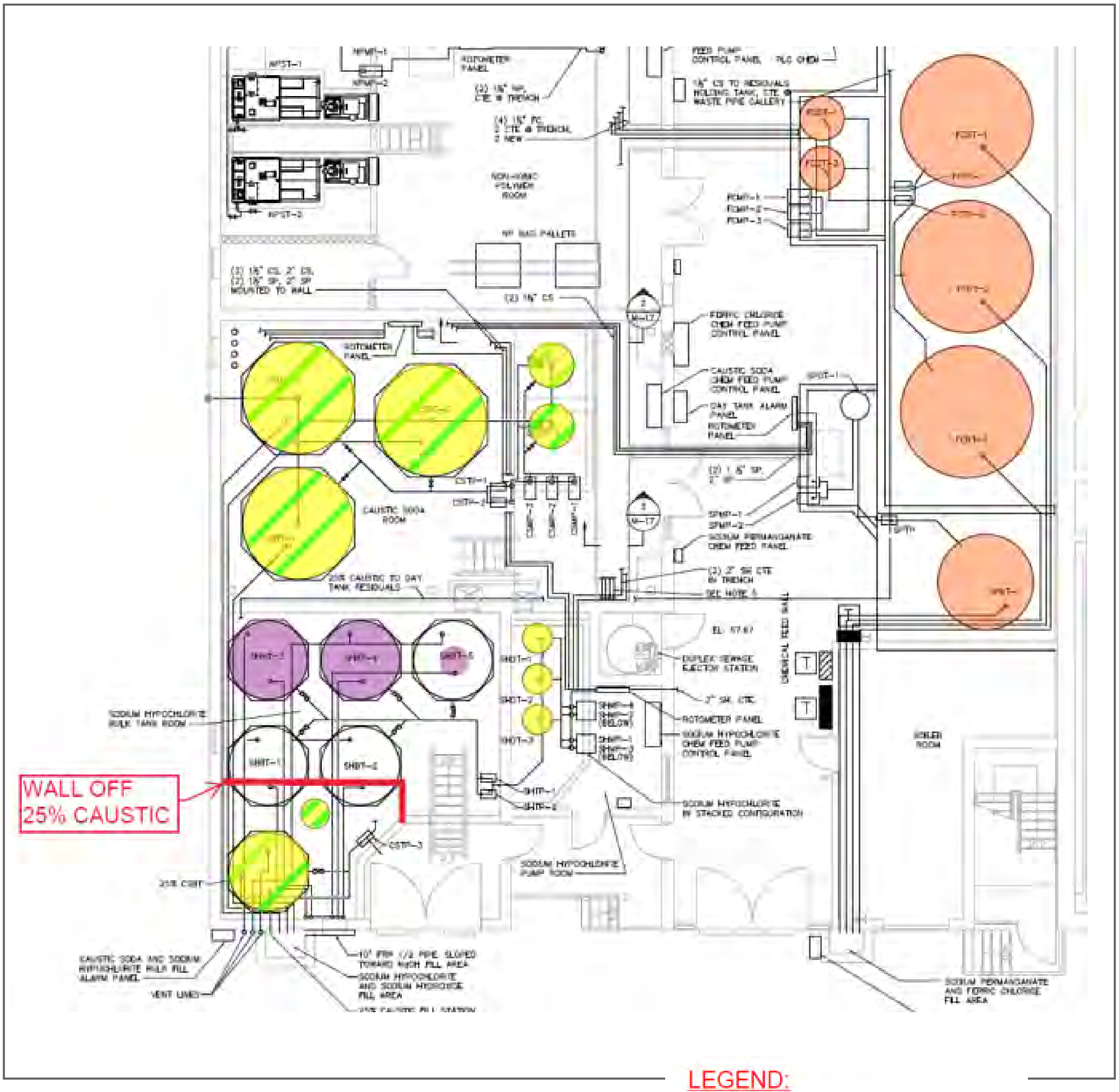
- An aerial walkway from the existing south stairwell to the new chemical storage building to provide covered access for operators and potential pathway for chemical transfer between the two facilities.

VALUE INTO THE FUTURE ...

- Storage capacity. Potential future degradation of the Merrimack River supply to the WTF and potential demand increase will require additional storage volume for chemicals. Tanks would be sized to provide you with storage capacity to match the full load of chemical deliveries and future needs. By constructing the tank pads to accommodate larger diameter tanks and the building with some additional height, future chemical storage needs can be met in this same building footprint by replacing the existing tanks with larger/taller tanks.

- Stronger pre-oxidant. Design repurposed Sodium Hypochlorite Room for easy conversion from potassium permanganate to chlorine dioxide if a stronger pre-oxidant is needed in the future for degrading raw water quality or future more stringent drinking water regulations.

→ See plan on the following page for chemical storage layout concept in existing water treatment plant.



LEGEND:

🟧 FERRIC CHLORIDE

▨ CAUSTIC SODA

🟪 SODIUM PERMANGANATE

🟨 SODIUM HYPOCHLORITE

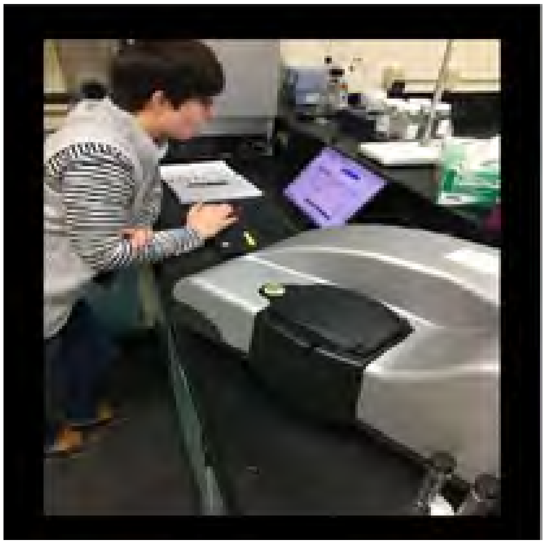
Reconfigured chemical storage tank layout concept in existing plant

Value Added Services

Generally, optimizing the coagulation and flocculation stages of a treatment process has a combined effect of improving water quality, maximizing performance (e.g., extended filter run times), and reducing total chemical usage and operating costs. Consequently, reducing the overall amount of chemicals required for efficient treatment would also reduce the total required chemical storage capacity. Thus, optimizing the coagulation stage is critical to ensure that the storage tanks are not oversized for the treatment process.

Zeta potential analyzers are reliable tools for quickly and accurately quantifying the efficiency of the coagulation process. Unfortunately, zeta potential analyzers do not measure floc treatability (e.g., settling efficiency). Jar testing can estimate floc treatability, but optimizing full-scale treatment plants based on settled water turbidity in jar tests could lead to substantial increases in chemical costs and overfeeding chemicals. Additionally, results based on settled water turbidity are not easily scalable to the full-scale process without a labor-intensive calibration process. On the other hand, granular media filtration is a scalable process; therefore, the results are expected to match the full-scale operation closely.

Media filtration-based bench scale jar testing apparatus developed by Stantec's Amir Alansari.



Katie Chamberlain conducting on-site zeta potential and UFRV analysis for Mannheim WTP, Region of Waterloo, Ontario, Canada

To optimize chemical dosages for coagulant, polymer, and caustic we propose to use a jar test procedure based on bench-scale granular media filtration instead of settling and supplementing the optimization process with zeta potential analysis. Optimization will be performed using an alternating single-parameter optimization approach. This approach isolates the effects of each chemical and is generally more effective at identifying global optimum conditions. Finally, optimization of the polymer dose will be performed at the optimal coagulant dose and pH condition. Ultimately, this approach ensures that the contaminant removal efficiency is maximized while considering the amount of chemicals being used.

Amir Alansari, our Treatment Evaluation Lead Engineer, developed this procedure while completing his graduate studies. Stantec owns a zeta potential analyzer that can be utilized for this project, and the media filtration-based jar test apparatus will be available for our use on loan from UNC-Charlotte.

Scope of Work and Budget

Scope of Work

The following is a detailed Scope of Work based on our understanding of the project.

Task 1 – Project Management, QA/QC, and Coordination

Meetings
Develop agendas and provide meeting minutes of all project meetings as well as for Workshops.

Deliverables:
- Meeting/Workshop Agenda and Minutes

Task 2 – Existing Document Review and Kick-Off Meeting

Existing Document Review
Review PWW existing record documents and reports provided in PDF format, and last 3 years of process performance data and water quality information provided in Excel format, including the following:

- Record Documents and Reports
  - Original Treatment Plant Installation 1979
  - Contract No. 2 Harris Pond Intake Utility Installation 2004
  - Contract No. 3 Finished Water Pumping Station 2005
  - Contract No. 4 Water Treatment Plant Improvements 2006
  - Merrimack River Raw Water Transmission Line Improvements
- Chemical Delivery and Handling Guidelines and Policies
- Historical Chemical Delivery Size and Frequency
- Historical Chemical Use and Feed Rates
- Historical and Projected Plant Flow Rates (Average, Minimum and Maximum)
- Historical Raw, Inter-process and Finished water quality data
- Historical Plant Process Control data including temperature, pH, streaming current, particle counts, chlorine residual, backwash and pulsator residuals extraction waste volume and frequency.
- Geotechnical and Wetlands survey Information at WTF

Kick-Off Meeting (Workshop No. 1)
Project Manager, Project Technical Lead Treatment and Project Technical Lead Process Design to attend 3-hour meeting including plant site visit, and information transfer, design criteria, plant performance and key equipment workshop.

- Present preliminary observations and recommendations for bulk storage tank sizing,
- Confirm future water demand projections,
- Discuss equipment types and options, and
- Collect and confirm information on PWW operations staff equipment preferences and facility layout, plant performance, and operation and maintenance challenges.

Task 3 – SDWA Assessment, Preliminary Chemical System and Plant Performance Evaluations

Chemical storage and feed evaluation
Evaluate chemical storage and feed systems including number and size of bulk storage, transfer and day tanks, transfer pumps and metering pumps for:

- Sodium Permanganate
- Ferric Chloride
- Non-Ionic Polymer
- 50% Caustic Soda
- Sodium Hypochlorite
- Tetrapotassium Pyrophosphate (TKPP)
- Zinc Orthophosphate
- Community chemicals including
  - 25% Caustic Soda
  - Blended Phosphate
  - Potassium Carbonate
  - Potassium Chloride
  - Sodium Chloride

Preliminary chemical storage building and site plan layouts
Develop preliminary chemical storage building (3-Dimensional Revit Visualization Drawing) and site plan layouts based on needed additional chemical storage from evaluation. Available space in existing WTF will also be considered. Up to two alternative layouts will be developed.

Preliminary Safe Drinking Water Act (SDWA) and Process Performance Evaluation
Develop preliminary SDWA assessment, process performance evaluation and equipment replacement needs. Prepare Technical Memos for the following evaluations:

- SDWA Assessment
- Process Performance Evaluation

Conduct Jar Tests (Optional)

- Conduct jar tests to confirm optimum coagulation dosing strategy and alternative coagulants. Prepare Technical Memo on Jar Test results.

Workshop No. 2 (Performance Evaluation and Building Layout Workshop)
Project Manager, Project Technical Lead Treatment Evaluation, Project Technical Lead Process, Senior Technical Advisor, 3D Process Modeling Engineer, Process Specialist and Architect to attend 2-hour meeting to review and comment on:

- Safe Drinking Water Act Assessment
- Process Performance Evaluation Technical Memo
- Jar Test Technical Memo (if selected)
- Chemical Storage and Feed Evaluation (Basis of Design tabulation), and
- Preliminary Site and Building Layouts (Two options)

Rapid collaborative 3D modeling will be used to clearly communicate and easily adjust the building model during this meeting to establish a clear basis for design.

Deliverables:
- Draft Technical Memo's (SDWA, Process Performance and Coagulant Jar Testing)
- 3-D Revit Building Plan and Site Plan

Task 4 – Plant Upgrades, Construction Phasing, Chemical Storage Layout Refinement

Upgrades to meet water quality goals and improve performance
Identify equipment replacement needs and other enhancements to improve performance and ease of operation and maintenance in tabular form.

Develop preliminary outline of construction phasing plan
Develop preliminary construction phasing plan to minimize impact on chemical deliveries and other plant operations and access for selected chemical storage option.

Refine preliminary building and site plan layout
Based on comments received at Workshop No. 2, refine selected preliminary building and site plan layout.

Identify required permits and environmental impacts
Based on the refined preliminary building and site plan layout, identify the environmental impacts and required permits for construction.

Workshop No. 3 (Plant Upgrades and Construction Phasing Workshop)
Project Manager and Project Technical Lead Process Design to attend 2-hour "in-person" (Project Technical Lead Treatment Evaluation, 3D Process Modeling Engineer and Architect will be virtual) construction phasing workshop to review and comment on:

- Plant Upgrade Recommendations
- Construction Phasing Plan,
- Final Chemical Storage and Feed Basis of Design,
- Permits and Environmental Impacts, and
- Refined Preliminary Site and Building Layout.

Deliverables:
- Draft Plant Upgrade Technical Memo
- Draft Construction Phasing Outline Technical Memo
- Draft Permits and Environmental Impacts Technical Memo
- 3-D Revit Building Plan and Site Plan

Task 5 – Concept Design Finalization

Finalize outline of construction phasing plan

Finalize chemical building and site plan layouts

Finalize upgrades to improve performance

Prepare Opinion of Probable Construction Cost (OPCC)

Concept design finalization meeting

Project Manager, Project Technical Lead Treatment Evaluation, Project Technical Lead Process Design to attend 2-hour meeting (3D Process Modeling Engineer and Architect will be virtual) to review and comment on:

- Construction Phasing Plan,
- Site and Building Layouts,
- Upgrades to Improve Performance, and,
- OPCC

Deliverables:

- 3-D Revit Building Plan and Site Plan
- Draft Conceptual Design Report (CDR)

Task 6 – Final CDR

Update Draft CDR incorporating PWW comments and submit to PWW for review and comment

Update Final Draft CDR incorporating PWW comments for submittal to NH DES

Prepare Final CDR incorporating comments from NH DES

ASSUMPTIONS

1. It is anticipated that appropriate PWW staff will be made available to assist with WTF tours and access to critical process locations.
2. Report content will focus on tabular summaries and layout plans and will minimize text.
3. All deliverables will be in electronic PDF and Word format.
4. Jar testing allowance of 24 hours.
5. Piloting and full-scale demonstration testing of alternative coagulation or treatment process strategies are not included.
6. Professional Land Survey, Geotechnical Investigations and Hazardous Materials testing are not included.
7. Engineering final design, bidding and award, and construction phase services are not included.

Budget

Our team has visited the site, reviewed the request for proposal (RFP) as well as additional information provided on May 16, 2022. The RFP was clear and well written, and the supplemental documentation and information received during our site visit was very helpful in formulating our approach. We appreciate the time that you and the staff spent with us during our site visit.

A detailed task outline is included in the table below summarizing the tasks to be performed, the hours by task for each team member, team member 2022 billing rates per hour and expenses. No sub-consultants such as survey or geotechnical borings are being proposed at this stage.

The overall budget fee proposed for the conceptual phase is $79,950 and is based on a level of effort of 418 hours at an average labor rate of $189 per hour. Expenses are estimated at $720. The average labor rate is representative of a higher percentage of time from senior level staff guiding the concept at this important preliminary engineering stage. This average rate typically decreases during the final design and construction phases of the project.

We feel that the level of effort is reasonable based on our interpretation of the RFP and our experience preparing conceptual phase evaluations. If you feel that the level of effort is not at the level you were anticipating we would be more than happy to modify the effort and fee commensurate with the scope so that it meets your expectations.
We also presented a jar testing value-added option that is not currently included in the scope and fee. This includes 4 days of on-site jar testing to determine if there may be opportunities for optimization of the current coagulation strategy or other alternative coagulant strategies that will reduce chemical use and cost and optimize treatment performance. This task is estimated at $15,000 assuming 82 hours.

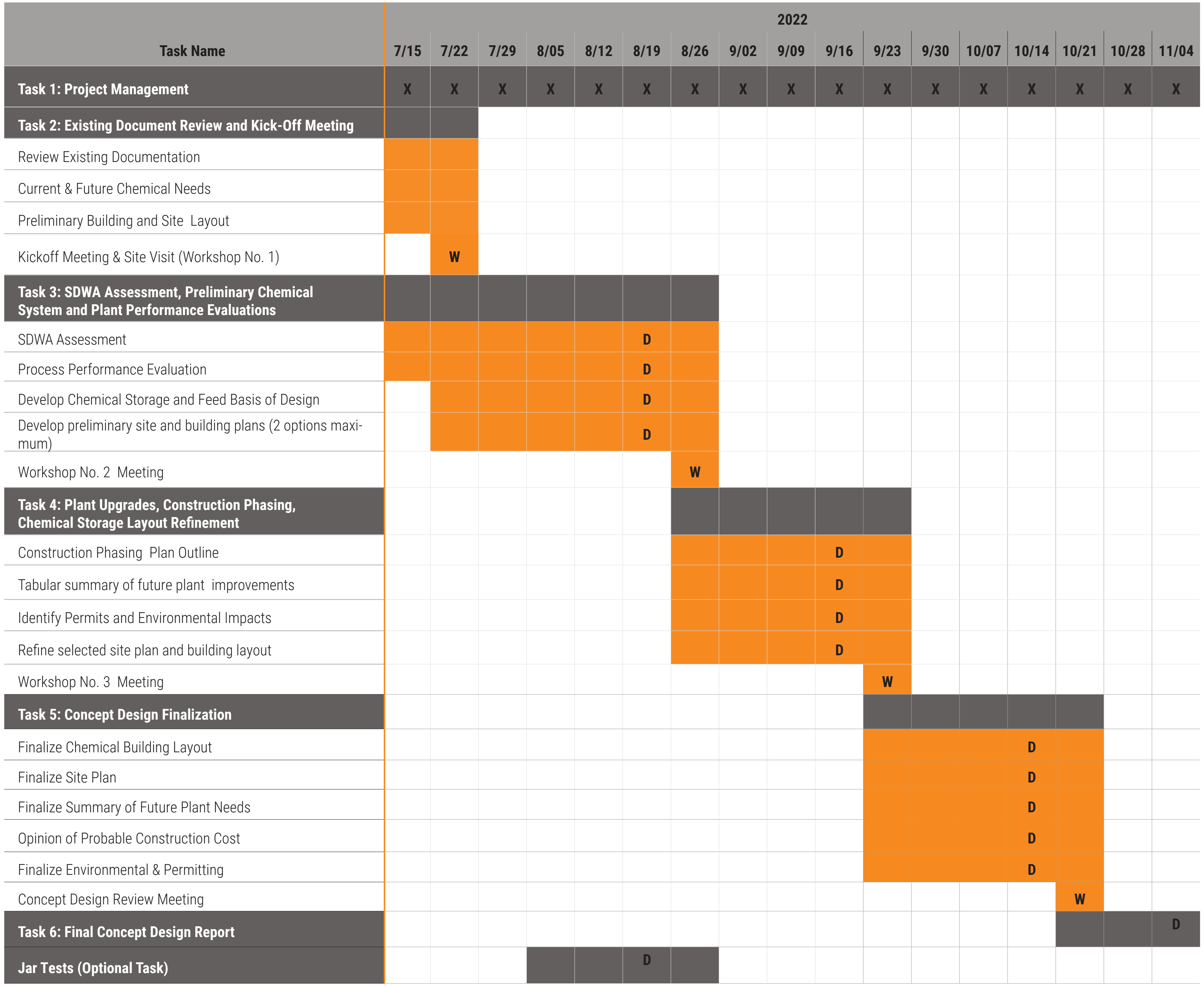
	Yannoni, Christopher	Chamberlain, Katie	Bartley, Michael	Paone, Paul	Alansari, Amir	Akerley, Caroline	Price, Michael/ Pernitsky, David	Nichols, Christopher	Polla, Don	Konary, Katie	Cohen, Jeffrey	Bagdasarian, George	Dykstra, Trey	Cota, Jeffrey	Bucher, Kevin	Relf, Phil	Leach, Michael				
Task Name	**$248.00**	**$207.00**	**$187.00**	**$172.00**	**$166.00**	**$147.00**	**$251.00**	**$207.00**	**$207.00**	**$172.00**	**$181.00**	**$187.00**	**$181.00**	**$207.00**	**$166.00**	**$181.00**	**$181.00**	**Total Hours**	**Total Labor**	**Expenses**	**Total**
Task 1: Project Management	**12**					**8**												**20**	**$4,130.00**	**$55.00**	**$4,185.00**
Task 2: Existing Document Review and Kick-Off Meeting																		**98**	**$18,393.00**	**$205.00**	**$18,598.00**
Review Existing Documentation	4	4	4	8	16	8	2	1		2	2	2	1	2	2			58	$10,492.00	$0.00	$10,492.00
Current & Future Chemical Needs	1	2			2													5	$994.00	$0.00	$994.00
Preliminary Building and Site Layout	2		2	8				1		4	4							21	$3,865.00	$55.00	$3,920.00
Kickoff Meeting & Site Visit (Workshop No. 1)	6	4	4															14	$3,042.00	$150.00	$3,192.00
Task 3: SDWA Assessment, Preliminary Chemical System and Plant Performance Evaluations																		**102**	**$19,105.00**	**$150.00**	**$19,255.00**
SDWA Assessment	1	4			12													17	$3,068.00	$0.00	$3,068.00
Process Performance Evaluation	2	4			12													18	$3,316.00	$0.00	$3,316.00
Develop Chemical Storage and Feed Basis of Design	2	2			4													8	$1,574.00	$0.00	$1,574.00
Develop preliminary site and building plans (2 options maximum)	2		4	20				1		4	4	2	1			1		39	$7,039.00	$0.00	$7,039.00
Workshop No. 2 Meeting	4	4	4	2	2		2				2							20	$4,108.00	$150.00	$4,258.00
Task 4: Plant Upgrades, Construction Phasing, Chemical Storage Layout Refinement																		**52**	**$9,764.00**	**$100.00**	**$9,864.00**
Construction Phasing Plan Outline	2		2															4	$870.00	$0.00	$870.00
Tabular summary of future plant improvements	2		4			8		1										15	$2,627.00	$0.00	$2,627.00
Identify Permits and Environmental Impacts	1																3	4	$791.00	$0.00	$791.00
Refine selected site plan and building layout	1		2	12						2								17	$3,030.00	$0.00	$3,030.00
Workshop No. 3 Meeting	4		4	2							2							12	$2,446.00	$100.00	$2,546.00
Task 5: Concept Design Finalization																		**95**	**$18,717.00**	**$159.00**	**$18,876.00**
Finalize Chemical Building Layout	2		2	8				1			2	3	2	4	4	2		30	$5,592.00	$0.00	$5,592.00
Finalize Site Plan	1		2					1		2								6	$1,173.00	$0.00	$1,173.00
Finalize Summary of Future Plant Needs	1		2			4												7	$1,210.00	$0.00	$1,210.00
Opinion of Probable Construction Cost	1		2					1	32									36	$7,453.00	$0.00	$7,453.00
Finalize Environmental & Permitting	1																1	2	$429.00	$0.00	$429.00
Concept Design Review Meeting	4	2	4	2							2							14	$2,860.00	$159.00	$3,019.00
Task 6 : Final Concept Design Report	**6**	**4**	**4**	**6**	**4**	**16**		**1**		**2**	**2**	**1**		**2**	**2**	**1**		**51**	**$9,117.00**	**$55.00**	**$9,172.00**
TOTAL	**62**	**30**	**46**	**68**	**52**	**44**	**4**	**8**	**32**	**16**	**20**	**8**	**4**	**8**	**8**	**4**	**4**	**418**	**$79,226.00**	**$724.00**	**$79,950.00**
Jet Tests (Optional Task)		**8**			**40**	**32**	**2**											**82**	**$13,500.00**	**$1,500.00**	**$15,000.00**

Schedule

The following schedule has been developed by week for each task in the scope of work for the duration of the project starting on July 11, 2022 and reaching completion on November 1, 2022 following the anticipated start and end dates outlined in the RFP.

X — Weekly Update with PWW PM
W — Workshop and/or Review Meeting
D — Deliverable

Note: Week ending date is Friday



Task Name	2022																
	7/15	7/22	7/29	8/05	8/12	8/19	8/26	9/02	9/09	9/16	9/23	9/30	10/07	10/14	10/21	10/28	11/04
Task 1: Project Management	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Task 2: Existing Document Review and Kick-Off Meeting	■	■															
Review Existing Documentation	▨	▨															
Current & Future Chemical Needs	▨	▨															
Preliminary Building and Site Layout	▨	▨															
Kickoff Meeting & Site Visit (Workshop No. 1)		W															
Task 3: SDWA Assessment, Preliminary Chemical System and Plant Performance Evaluations	■	■	■	■	■	■	■										
SDWA Assessment	▨	▨	▨	▨	▨	D	▨										
Process Performance Evaluation	▨	▨	▨	▨	▨	D	▨										
Develop Chemical Storage and Feed Basis of Design		▨	▨	▨	▨	D	▨										
Develop preliminary site and building plans (2 options maximum)		▨	▨	▨	▨	D	▨										
Workshop No. 2 Meeting							W										
Task 4: Plant Upgrades, Construction Phasing, Chemical Storage Layout Refinement							■	■	■	■	■						
Construction Phasing Plan Outline							▨	▨	▨	D	▨						
Tabular summary of future plant improvements							▨	▨	▨	D	▨						
Identify Permits and Environmental Impacts							▨	▨	▨	D	▨						
Refine selected site plan and building layout							▨	▨	▨	D	▨						
Workshop No. 3 Meeting											W						
Task 5: Concept Design Finalization											■	■	■	■	■		
Finalize Chemical Building Layout											▨	▨	▨	D	▨		
Finalize Site Plan											▨	▨	▨	D	▨		
Finalize Summary of Future Plant Needs											▨	▨	▨	D	▨		
Opinion of Probable Construction Cost											▨	▨	▨	D	▨		
Finalize Environmental & Permitting											▨	▨	▨	D	▨		
Concept Design Review Meeting															W		
Task 6: Final Concept Design Report															■	■	D
Jar Tests (Optional Task)				■	■	D	■										

PWW Financing Petition
Docket DW 24-089
Exhibit DOE DR 1-4(b)
Page 1 of 6

PENNICHUCK®

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REQUEST FOR PROPOSALS

Pennichuck Water Works, Inc.

Nashua Treatment Plant Chemical Feed System Upgrades

April 15th, 2022

BACKGROUND

Pennichuck Water Works Inc. (PWW) is requesting written proposals for Professional Engineering Services for a project at its Nashua Water Treatment Plant (the Plant). The project will consist of an evaluation of the Plant's existing chemical feed systems and chemical storage capacities. The project may also include design and construction management services, depending on the information gathered during the evaluation phase. There is no guarantee that subsequent work shall result from the proposal and the cost of proposal preparation shall be borne by the Engineering Consultant.

PWW's Nashua NH Treatment Plant serves as the main supply for the Nashua Core System. The Plant has a capacity of approximately 32 million gallons a day.

Prior to 2019, Pennichuck Brook was utilized as the primary water supply for the Nashua Treatment Plant. Water was pumped from the Merrimack River Intake (MRI) on the Merrimack River in to the Pennichuck Brook Supply Ponds where it then fed into the plant. In 2016, PWW completed the first phase of improvements to allow operation of Pennichuck Brook and the Merrimack River as two completely independent sources of supply or a blend of the two as necessary. The first phase was to make modifications to its raw water pipeline to enable water from the Merrimack River to be piped directly into the treatment facility bypassing the Pennichuck Brook reservoirs. The second phase was the completion of a new deep-water intake on the Merrimack River capable of withdrawing in excess of 35 mgd. This new intake allowed for operation of the Merrimack River Source throughout the year as opposed to just the warm weather months of the year. The third phase included upgrades to the Merrimack River raw water pumping station to ensure a withdrawal of up to 22 mgd with one of its pumps out of service. A possible fourth phase in the future will be to add pumping capacity to achieve the current treatment facility capacity including upgrades/additions to the raw water transmission main.

Raw water from the Merrimack River, when compared with the Pennichuck Brook Supply Ponds, is considerably more variable (color, turbidity, organic carbon). When upgrades to the plant were designed in 2005, they were done so under the assumption that the Pennichuck Brook System would continue to be the primary source of supply with the Merrimack River supplementing flow during the high demand periods of the summer. Due to the addition of PFAS compounds as primary drinking water standards PWW has begun to use the Merrimack River as its primary water supply more heavily and throughout the year (due to the Merrimack River raw water having significantly lower levels of PFAS than the Pennichuck Brook raw water). The Merrimack River raw water quality has proved more challenging to treat than initially anticipated. The effects of the variable raw water have at times stretched the capacity of certain components of the current chemical treatment system.

Chemical usage during treatment has been steadily increasing over the last 16 years. During high turbidity events, the chemical feed system is operating between 90-97% of its capacity. Preliminary evaluations by Pennichuck staff have determined that both chemical feed pumping capacity and storage are not adequate to treat raw water from the Merrimack River during certain climatic conditions. Undersized pumps put strain on the treatment system and have made it impossible to dose at high enough levels to keep up with the Merrimack River's raw water quality during certain times of the year. Undersized chemical storage facilities force Pennichuck to rely on frequent chemical deliveries; a disruption of which would leave the Plant vulnerable.

Upgrades are likely required to not only maintain status quo as regulations and water quality change, but also to utilize the plant at its full 32 MDG capacity in the future. As PFAS contamination continues to spread throughout Southern New Hampshire, it is imperative that Pennichuck Water Works can be relied upon as a safe, containment free drinking water source for those effected. These upgrades to the Plant's chemical feed system would need to occur before Pennichuck has the capability to supply impacted areas and new customers. It is imperative that the Treatment Facility be capable of meeting drinking water quality standards regardless of which source of supply (Pennichuck Brook or Merrimack River or some combination) is used to meet 100% of the demand.

PENNICHUCK WATER WORKS TEAM

Below are the Pennichuck team members who will take lead rolls in this project:

John Boisvert, P.E. – Chief Engineer

Chris Countie – Director, Water Supply & Community Systems

Matt Day – Water Quality & Laboratory Manager

Alicia Dufresne – Supervisor Corporate Communications

Mark Filion, P.E. – Construction Services Manager

Casey Harding, E.I.T, - Engineer

Hannah Marshall, E.I.T. - Engineer

Ashley Piper – Environmental and Operational Data Analyst

Donald Ware, P.E. – Chief Operating Officer

SCOPE OF WORK

Chemical Feed System Evaluation:

The Nashua Treatment Plant treats surface water from two locations: the Pennichuck Brook and the Merrimack River. These two sources vary in water quality; the Merrimack River typically has higher turbidity and more variable water quality. At any given point, the Plant may be utilizing one source or the other, or any combination of the two. The current chemical treatment system was designed to utilize the Pennichuck Brook raw water quality and has struggled to adapt to the less stable conditions presented by the Merrimack River. Pennichuck requires a comprehensive evaluation of the Plant's chemical feed and storage systems.

The chemical feed systems must be adaptable to the variety of raw water conditions that can be present at any given time. Pennichuck staff have completed a preliminary evaluation of the chemical feed system and found it to be undersized for the current water quality and flow rates. Partially due to this factor, the potential of increasing the Plant's capacity utilization from its current maximum day level of about 25 MGD to plant design capacity of 32 MGD is not currently feasible. The evaluation shall include an analysis of the Plant's chemical feed systems and associated pumps and storage tanks including but not limited to sodium hypochlorite, sodium hydroxide, ferric chloride, TKPP, zinc ortho phosphate, and polymer for the following parameters:

- Chemical feed pumps
- Chemical usage
- Chemical storage capacity
- Raw water quality analysis and comparison
- Development of conceptual plans to support funding requests
- Life cycle cost analysis of proposed upgrades

Along with the evaluation, recommendations, if any, for upgrades that would help meet treatment goals and improve the Plant's performance are required. Potential upgrades shall be presented to Pennichuck in a summary report with comparisons to the existing system as well as preliminary layouts and budgeting costs for any proposed plant additions associated with the recommended chemical feed and storage upgrades.

Considerations

- PWW is not requesting a full revisit of the FS&T evaluation (hydraulic capacity, raw water pumping, dams, current and future demands, etc. are to be excluded)
- PWW is asking for a detailed scope for the 2022 work only. The scope shall detail projected hours by employee class along with 2022 billing rates per hour for each employee class resulting in an overall budgeted fee. Future phases (2023 and on) are not to be included in the scope and budget presented in this proposal. If the project moves beyond the conceptual phase provided by the proposal PWW reserves the right to either negotiate additional scope of work and associated costs with the consultant selected to perform the work of this RFP or to issue a new RFP for the work to be performed beyond the 2022 scope.
- The project team must be diverse and bring to the table:
  - Planning (climate change and resiliency)
  - Science (chemistry, chemical processes, environmental processes)
  - Engineering (drinking water, wastewater, remediation, waste management, industrial processes along with supporting disciplines)
  - Public relations (education and presentation)
- Raw water pumping and transmission are not the responsibility of the consultant.

PROJECT SCHEDULE

Pennichuck anticipates that the project last two to three years in duration. Approximate yearly timelines are shown below.

2022:

2022 will likely focus predominantly on the evaluation of the current chemical feed systems as well as future needs. By November 1st, a rough layout of recommended upgrades would be anticipated as well as a budgetary estimate for the cost of improvements and is the work expected to be completed in response to this proposal. Design may commence in 2022, if the Company decided to move forward with the project. Design work, as noted above, is not part of the scope of work of this RFP.

2023:

If Pennichuck elects to move forward with the treatment system upgrade recommendations, the design phase shall commence or continue in 2023. Permitting for all upgrades shall also occur during this time and funding shall be secured.

The bidding and construction phase may commence mid-late 2023. Depending on the upgrades required, construction may be completed by years end, though may continue in to 2024.

2024:

All upgrades are complete and fully operational.

PROVIDED INFORMATION

Pennichuck shall be responsible for proving the following:

- Historical water quality
- Chemical information
- Access to the facility
- Sampling data
- Disinfection by-product data
- Original Plant upgrade plans and FS&T study
- Project management and coordination of Pennichuck staff and resources

Pennichuck staff take a hands-on approach to address and solve challenges that the company faces. The Consultant should anticipate that the Pennichuck Team will be actively engaged in all aspects of Consultant's work. The project manager, Hannah Marshall, will be the primary day to day point of contact for the Consultant.

Pennichuck will hold a preproposal meeting at the Facility on Thursday, May 5th, 2022 at 10:00 AM. to walk interested consultants through the Facility and to answer questions regarding the RFP. Attendance at the preproposal meeting is not mandatory.

Additionally, Consultants may submit questions regarding this RFP on or before Friday, May 27th, 2022. PWW will provide responses to the submitted questions on Friday, Jun 3rd, 2022.

SUBMITTAL REQUIREMENTS

The Consultant should present a dedicated project team with demonstrated evaluation, design, and permitting experience of similar scale and location. The project team shall have multidiscipline expertise including but not limited to civil engineering, structural, electrical, mechanical, water treatment, geotechnical, hydrology, geology, environmental science, remediation, and permitting.

The submittal shall be limited to sixty (60) pages to help account for team bio's and representative project descriptions. The submittal shall be submitted electronically to:

John J. Boisvert, P.E., Chief Engineer

John.boisvert@Pennichuck.com

And concurrently to:

Hannah Marshall, E.I.T.

hannah.marshall@pennichuck.com

Proposals will be reviewed for completeness then forwarded to the entire Pennichuck Team.

Deadline: Friday June 10th, 2022 at 2 PM

All submittals will become the property of Pennichuck. Each submittal must include the following in order to be considered:

1. Statement of Interest: This shall clearly indicate Consultant's interest in securing funding for the project and performing the work on this project.
2. Past Experience and References for Similar Projects: Provide references (including name and contact information for the client) and summaries for five (5) similar projects your team has completed within the past five (5) years for other clients. Also indicate who served as your project manager for each project, and who had key lead technical roles in those projects. Summarize the current status of the client's decisions/actions taken in response to your recommendations (have your recommendations been implemented?).
3. Project Team: The members of the consultant's project team shall be recognized leaders in their field. The consultant's Project Manager shall be identified by name, and the proposal will clearly outline the consultant's intentions regarding the Project Manager's availability for all required on-site work and for any review and coordination meetings that will be necessary to successfully secure funding and complete the project. Each proposal will include a list of the proposed project team members, including sub-consultants, and clearly identify their respective roles on the project and their anticipated level of effort. Each proposal shall include resumes of key team members with their home office locations. (Resumes count towards the page limit.)
4. Understanding of the Project Requirements.
5. Detailed Scope of Work and Budget

SELECTION PROCESS AND CRITERIA

Pennichuck staff will review and evaluate the submittals based on:

- Responsiveness to the RFP.
- Experience, qualifications and availability of the proposed Project Manager.
- Experience and qualifications of key project staff.
- Selected consultants may require a virtual interview
- Consultant's related experience and performance on other projects, especially the quality of work, budget control, overall cooperation and responsiveness.
- Proposed project approach.
- References on past similar projects.
- Cost

Pennichuck anticipates that two or more of the most qualified consultants may be asked to submit more detailed proposals and participate in a more detailed evaluation and selection process that may include meeting interviews. Pennichuck anticipates engaging the selected consultant by July 11th, 2022.

Pennichuck Water Works
Docket No. DW 24-089
PFAS Holt - Merrimack River - 2019 - Present
Exhibit DOE DR 1-9(c)
7/25/2024

Merrimack River		
Date	PFOA (ng/L)	PFOS (ng/L)
3-Sep-2019	5.50	<1.84
1-Oct-2019	4.84	<1.75
4-Nov-2019	<2.00	<2.00
12-Feb-2020	3.04	<2.00
12-Mar-2020	<2.00	<2.00
1-Apr-2020	<2.00	<2.00
4-May-2020	<2.00	<2.00
8-Jun-2020	3.28	<1.78
6-Jul-2020	3.03	<1.80
10-Aug-2020	3.72	2.07
14-Sep-2020	4.36	<2.00
5-Oct-2020	3.53	<2.00
16-Nov-2020	2.72	<2.00
1-Dec-2020	2.43	<2.00
18-Jan-2021	<2.00	<2.00
8-Feb-2021	2.74	<2.00
1-Mar-2021	2.90	<2.00
5-Apr-2021	<1.73	<1.73
3-May-2021	<2.00	<2.00
3-Jun-2021	2.49	<2.00
6-Jul-2021	2.53	<2.00
2-Aug-2021	2.86	<2.00
3-Sep-2021	5.49	3.36
5-Oct-2021	3.49	<2.00
8-Nov-2021	2.75	<2.00
6-Dec-2021	3.26	<2.00
3-Jan-2022	2.81	<2.00
22-Feb-2022	<2.00	<2.00
15-Mar-2022	2.10	<2.00
4-Apr-2022	<2.00	<2.00
2-May-2022	2.37	<2.00
2-Jun-2022	4.65	18.8
7-Jul-2022	5.72	2.57
1-Aug-2022	4.42	<2.00
7-Sep-2022	6.32	3.02
4-Oct-2022	3.29	<2.00
1-Nov-2022	2.10	<2.00
9-Dec-2022	<2.00	<2.00
16-Jan-2023	<2.00	<2.00
2-Feb-2023	2.44	<2.00
9-Mar-2023	2.20	<2.00
10-Apr-2023	<2.00	<2.00
2-May-2023	<2.00	<2.00
5-Jun-2023	3.93	<2.00
24-Jul-2023	3.60	<2.00
16-Aug-2023	2.56	<2.00
12-Sep-2023	5.04	2.88
3-Oct-2023	3.56	1.80
1-Nov-2023	2.31	1.07
5-Dec-2023	2.49	1.21
8-Jan-2024	2.24	0.954
1-Feb-2024	2.59	1.26
5-Mar-2024	2.20	1.03
1-Apr-2024	2.18	0.836
9-May-2024	2.91	1.05
4-Jun-2024	5.28	1.94

Holt		
Date	PFOA (ng/L)	PFOS (ng/L)
8-Jan-19	14.9	3.04
4-Feb-19	14.4	2.49
5-Mar-19	11.9	2.12
2-Apr-19	13.7	2.86
8-May-19	11.9	2.95
3-Jun-19	18.8	5.13
9-Jul-19	20.0	4.40
1-Aug-19	19.4	5.34
21-Aug-19	23.4	7.12
3-Sep-19	27.6	6.19
1-Oct-19	25.3	8.63
4-Nov-19	23.6	3.77
17-Dec-19	10.5	2.54
9-Jan-20	11.2	2.01
26-Feb-20	12.2	3.38
12-Mar-20	13.8	3.27
1-Apr-20	10.3	2.41
4-May-20	12.1	3.67
8-Jun-20	22.1	7.44
6-Jul-20	25.0	7.44
10-Aug-20	19.7	6.73
14-Sep-20	20.3	9.16
5-Oct-20	18.9	11.3
16-Nov-20	24.4	15.8
1-Dec-20	23.1	6.19
11-Jan-21	12.0	5.32
1-Feb-21	13.6	3.07
1-Mar-21	13.4	2.98
5-Apr-21	13.0	3.10
3-May-21	12.1	3.29
3-Jun-21	17.0	3.30
6-Jul-21	21.4	3.80
2-Aug-21	18.7	5.46
3-Sep-21	24.9	4.24
5-Oct-21	17.4	4.50
8-Nov-21	18.3	4.40
6-Dec-21	19.2	2.89
3-Jan-22	17.7	3.26
22-Feb-22	16.5	2.95
15-Mar-22	13.6	3.73
4-Apr-22	15.5	3.11
2-May-22	15.6	2.48
2-Jun-22	29.3	3.26
7-Jul-22	30.8	6.96
1-Aug-22	46.0	9.36
7-Sep-22	27.6	12.5
4-Oct-22	29.6	16.6
1-Nov-22	28.2	9.09
9-Dec-22	18.4	7.10
16-Jan-23	10.6	4.19
2-Feb-23	11.7	2.50
9-Mar-23	11.5	3.11
10-Apr-23	10.7	3.56
2-May-23	16.9	3.49
5-Jun-23	17.8	3.59
24-Jul-23	19.3	4.62
16-Aug-23	16.9	5.67
12-Sep-23	22.4	5.67
3-Oct-23	16.5	6.56
1-Nov-23	18.6	4.80
5-Dec-23	16.8	4.64
8-Jan-24	13.1	4.39
1-Feb-24	12.0	3.43
5-Mar-24	15.5	3.60
1-Apr-24	12.3	4.28
9-May-24	23.5	3.07
4-Jun-24	29.7	5.34

PENNICHUCK WATER SPECIAL COMMITTEE

JULY 18, 2024

A meeting of the Pennichuck Water Special Committee was held Thursday, July 18, 2024, at 7:00 p.m. in the Aldermanic Chamber.

Let's start the meeting by taking a roll call attendance.

The roll call was taken with 5 Members of the Board of Aldermen present: Alderman Patricia Klee, Alderman-at-Large Michael B. O'Brien, Sr., Alderman Tyler Gouveia, Alderman Ernest A. Jette, and Alderman-at-Large Melbourne Moran, Jr. (via Zoom).

Also in Attendance:	Don Ware, COO, Pennichuck
	Thomas J. Leonard, Director, Pennichuck Corporation
	John Boisvert, Chief Executive Officer
	George Torres, Chief Financial Officer and Treasurer

PUBLIC COMMENT - None

COMMUNICATIONS

From: John J. Boisvert, Chief Executive Officer and Chief Engineer of Pennichuck
Re: Pennichuck Corporation Quarterly Report to the Sole Shareholder for the Quarter Ended March 31, 2024

There being no objection, Chairman Klee accepted the communications and placed them on file.

UNFINISHED BUSINESS – None

NEW BUSINESS – RESOLUTIONS

R-24-064

Endorsers: Alderman Patricia Klee
Alderman-at-Large Melbourne Moran, Jr.
Alderman Tyler Gouveia
Alderman-at-Large Ben Clemons
Alderman Derek Thibeault
Alderman Patricia Klee
Alderman Richard A. Dowd
Alderwoman-at-Large Shoshanna Kelly
Alderman-at-Large Lori Wilshire

AUTHORIZING PENNICHUCK CORPORATION AND PENNICHUCK WATER WORKS, INC. TO BORROW FUNDS FROM THE STATE OF NEW HAMPSHIRE PFAS REMEDIATION AND GRANT FUND

MOTION BY ALDERMAN GOUVEIA TO RECOMMEND FINAL PASSAGE, BY ROLL CALL

A viva voce roll call was taken which resulted as follows:

Yea:	Alderman Klee, Alderman O'Brien, Alderman Gouveia, Alderman Jette, Alderman Moran	5
Nay:		0

MOTION CARRIED

NEW BUSINESS – ORDINANCE - None

GENERAL DISCUSSION

Alderman Jette

PUBLIC COMMENT - None

REMARKS BY THE ALDERMEN

Chairman Klee

ADJOURNMENT

MOTION BY ALDERMAN O'BRIEN TO ADJOURN, BY ROLL CALL

A viva voce roll call was taken which resulted as follows:

Yea:	Alderman Klee, Alderman O'Brien, Alderman Gouveia, Alderman Jette, Alderman Moran	5
Nay:		0

MOTION CARRIED

The meeting was declared closed at 7:37 p.m.

Alderman Tyler Gouveia
Committee Clerk

PWW Financing Petition
Docket DW 24-089
Exhibit DOE DR 1-19
Page 1 of 1

The State of New Hampshire
Department of Environmental Services

Robert R. Scott, Commissioner

April 12, 2024
VIA EMAIL (*Chris.Countie@pennichuck.com*)

Christopher Countie
Director of Operations
Pennichuck Water Works
25 Walnut St
Nashua, NH 03060

Subject: PFAS Remediation Grant and Loan Fund Eligibility Approval
PWS #1621010, Pennichuck Water Works

Dear Mr. Countie,

The NH Department of Environmental Services (NHDES) completed their review of the Eligibility Request received March 25, 2024 for the Per- and Polyfluoroalkyl Substances Remediation Grant & Loan Fund. NHDES authorized an award of loan funds to Pennichuck Water Works for the following project:

Project Description	Funding Award Amount
PWW Nashua WTP Chemical Systems Upgrades	$11,450,000

We ask that you keep NHDES informed of progress made toward seeking the authority to accept funding. Should your project not move forward, please contact us as soon as possible. If you have any questions, please contact Jennifer Brady at 603-271-8522 or at Jennifer.E.Brady@des.nh.gov.

Sincerely,

Amy E. Rousseau

Amy Rousseau
PFAS Response Administrator | MtBE Remediation Bureau

cc.
Hannah Marshall, Engineer, Pennichuck Water Works (hannah.marshall@pennichuck.com)

EXHIBIT C
PROMISSORY NOTE

$11,450,000 Concord, New Hampshire
(PRLF-45) ______, 2024

FOR VALUE RECEIVED, Pennichuck Water Works, Inc., a New Hampshire corporation with a principal place of business at 25 Walnut St, PO Box 428, Nashua, NH 03061-0428 (the "Maker"), promises to pay to the State of New Hampshire with an address of c/o Department of Environmental Services, 29 Hazen Drive, P.O. Box 95, Concord, New Hampshire 03302-0095, or its order (the "Payee"), the sum of Eleven Million Four Hundred Fifty Thousand Dollars ($11,450,000) or such lesser amount as shall be disbursed from time to time to Borrower by State pursuant to a Loan Agreement of near or even date by and between Borrower and State (the "Loan Agreement"), in lawful money of the United States, together with interest thereon at the annual rate of one percent (1%) until the earlier of (i) the date of substantial completion of the Improvements (as defined in the Loan Agreement) or (ii) December 31, 2026 (such earlier date being the "Interest Rate Change Date") and commencing on the Interest Rate Change Date at the annual rate of 3.5% (the interest rate at any given time, the "Applicable Interest Rate") until paid in full as set forth herein. Capitalized terms used but not defined herein have the meaning given to them in the Loan Agreement.

1. <u>Payments</u>. The interest and principal of this Note shall be paid as follows:

(a) Commencing on the first day of the sixth month after the Interest Rate Change Date, interest only shall be paid in six (6) consecutive monthly installments on the first day of each month.

(b) Commencing with the first day of the twelfth month after the Interest Rate Change Date, the principal and interest of the Note shall be paid in Two Hundred and Forty (240) consecutive equal monthly installments of principal and interest on the first day of each month with the installment amount calculated to amortize the principal balance of the Note over the 240 month period at the Applicable Interest Rate; provided, however, that the Maker shall have the option to elect prior to the first installment payment under paragraph 1(a) to have the interest accruing prior to the Interest Rate Change Date be capitalized and added to the principal amount of the Note rather than paid in the first installment of interest to be paid pursuant to paragraph 1(a); so long as the sum of the principal balance of the Note plus interest accruing prior to the Interest Rate Change Date (such sum being the "Capitalized Amortization Amount") shall not exceed $11,450,000, and if the sum of unpaid principal plus interest accruing prior to the Interest Rate Change Date exceeds $11,450,000, such excess amount of interest shall be due and payable with the first payment of interest pursuant to paragraph 1(a) above. If the Maker elects to have such interest capitalized, then the Capitalized Amortization Amount shall be paid in Two Hundred and Forty (240) consecutive equal monthly installments of principal on the first day of each month, commencing with the first day of the thirteenth month after the Interest Rate Change Date, with interest with the installments calculated to amortize the Capitalized Amortization Amount over such 240 month Period at the Applicable Interest Rate. Notwithstanding the foregoing, the repayment of principal and interest pursuant to this Note is subject to Section 12 of the Loan Agreement.

2. Prepayment. The Maker shall have the right to prepay any or all sums due under this Note without penalty. Prepayments shall be applied first to accrued interest and then to principal. Partial prepayments of principal shall be applied against the outstanding principal balance; provided, however, that the Maker shall continue to make principal payments in the amounts specified above and on the dates specified above, with interest on the outstanding principal balance recomputed accordingly, until the Maker's obligations under this Note are satisfied in full.

3. Due Date; Late Payment. All payments of principal and interest shall be due on or before the due date specified above; provided, however, that the Maker shall not be deemed in default hereunder if payment is received by the Payee on or before 4:00 p.m. of the seventh day following the due date. The Maker agrees to pay a late charge of five percent (5%) of the amount of any payment due under this Note that is not paid within seven (7) days of its due date.

4. Applicable Interest. The Maker expressly agrees that the Applicable Interest Rate specified in this Note shall be the applicable interest rate due (i) on amounts outstanding during the term hereof and (ii) with respect to any amount outstanding on and after the maturity date hereof.

5. Default; Acceleration. The Maker shall be in default of this Note, and all principal and accrued interest thereon shall immediately become due and payable, without notice or demand, upon the occurrence of any of the following events: (a) failure to make prompt payment of any principal or interest installment due hereunder (or within such grace period as may be provided herein), (b) the failure of the Maker to observe or perform any of the other obligations to the Payee under this Note, and the same remains unremedied for a period of thirty (30) days after the date of notice thereof to the Maker by the Payee, (c) the occurrence of an Event of Default under the Loan Agreement or a default under the Guaranty of even date (the "Guaranties") or (d) a default in any other obligation of the Maker to the Payee, whether now existing or hereinafter incurred.

If the Maker shall file a petition under any section of the Bankruptcy Code, shall make an assignment for the benefit of creditors, shall have a receiver appointed over its affairs who shall not be discharged within sixty (60) days from the date of appointment, or shall have filed against it a petition under a section of the Bankruptcy Code, or any debtor-creditor act, which petition shall not be dismissed within sixty (60) days of the date of filing of the same, then the balance of principal and interest remaining unpaid on this Note shall become due and payable forthwith without demand or notice.

6. Costs of Collection. If this Note is not paid in full when it becomes due, or if any payment required hereunder shall not be paid when due, or within such grace period as may be expressly provided herein, the Maker agrees to pay all costs and expenses of collection, including attorneys' fees, regardless of whether legal proceedings have been formally commenced.

7. Waiver of Presentment. The Maker hereby waives presentment, demand for payment, notice of dishonor, and all other notices or demands in connection with the delivery, acceptance, performance, default, or endorsement of this Note.

8. Non-Forfeiture of Rights. It is agreed and understood that the waiver by the Payee of any particular default in the terms of this Note shall not constitute waiver of any further default and that acceptance of any payment after it is due shall not be deemed a waiver of the right to require prompt payment when due on all other sums and that acceptance of any payment after default shall not cure said default or operate as a waiver of any rights of the Payee hereunder unless otherwise agreed in writing.

9. Payments, Notices. All payments due under this Note, and any notice required to be made hereunder shall be directed to the Payee or to the Maker, as the case may be, at the addresses above specified, or such other address as the Payee and the Maker may hereafter direct, in writing.

10. Binding on Successors, Etc. The obligation of this Note shall be binding upon the heirs, successors and assigns of the Maker herein and shall inure to the benefit of the successors or assigns of the Payee herein or any holder hereof. Notwithstanding the preceding sentence, the Maker shall not assign this Note without the prior written consent of the Payee.

11. Gender. Whenever the content so requires, reference herein to the neuter gender shall include the masculine and/or feminine gender, and the singular number shall include the plural.

12. References. All references herein to the Loan Agreement and the Guaranty shall be construed to refer to such instruments as they may be amended from time to time.

13. Governing Law. The Note has been made in the State of New Hampshire, and the provisions hereof shall be governed by and construed in accordance with the laws of the State of New Hampshire (excluding the laws applicable to conflicts or choice of laws).

14. Jurisdiction. The Maker hereby consents to the jurisdiction of all state and local

courts of the State of New Hampshire and the United States District Court of the District of New Hampshire in connection with any suit to enforce any rights of the Payee under this Note.

15. Guaranty. The Maker's obligations hereunder are guaranteed pursuant to the Guaranty.

16. Sovereign Immunity. Nothing contained in this Note, the Loan Agreement, or any guaranty guarantying this Note shall be deemed to constitute a waiver of the sovereign immunity of the Payee, which immunity is hereby reserved to the Payee.

EXECUTED as of the day and year first above written.

PENNICHUCK WATER WORKS, INC.

____
Witness

By:______________________________
John Boisvert
Chief Executive Officer

DW 24-089

PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 1

Date Request Received: 7/16/2024
Request No. Department 1-12
Date of Response: 7/25/24
Date of Supplemental Response: 9/13/24
Witness: Chris Countie

REQUEST:
Reference: Pre-filed Testimony of George Torres, Bates Page (Approvals), Bates Page 21

The Company indicated that certain other approvals were necessary to consummate the loan. Besides the approval of the Commission, it appears that an approval by the City of Nashua is the sole listed approval that remains. Further, it appears that a request for approval by the City was submitted on June 20, 2024. Please indicate the status of that approval by the City of Nashua.

RESPONSE:

A meeting of the City of Nashua, Pennichuck Water Special Committee was held on July 18, 2024. At this meeting, specifically called to address this project and its proposed funding. The Committee unanimously voted in favor of Resolution R-24-064 by all members of the Committee was made recommending approval by the full Board of Aldermen at a future meeting (at a time to be determined). A copy of the July 18, 2024 Pennichuck Water Special Committee minutes is attached as Exhibit DOE DR 1-12.

SUPPLEMENTAL RESPONSE:

On August 13, 2024, the City of Nashua Board of Alderman voted to approve and adopt Resolution R-24-064 authorizing the PFAS Remediation Loan. A copy of the August 13, 2024 Board of Alderman meeting minutes and Resolution R-24-064 is attached as Supplemental Exhibit DOE DR 1-12.

A regular meeting of the Board of Aldermen was held Tuesday, August 13, 2024, at 7:30 p.m. at the Brian S. McCarthy Middle School, 41 DiAntonio Drive, and the meeting was duly noticed in two places, including the City's website, in accordance with the requirements of RSA 91-A:2 II.

President Lori Wilshire presided; City Clerk Dan Healey recorded.

Prayer was offered by City Clerk Dan Healey; Alderman Thomas Lopez led in the Pledge to the Flag.

Let's start the meeting by taking a roll call attendance.

The roll call was taken with 13 members of the Board of Aldermen present: Alderman O'Brien, Alderwoman Timmons, Alderman Thibodeau, Alderman Gouveia, Alderman Lopez, Alderman Sullivan, Alderman Clemons, Alderman Sennott, Alderman Thibeault, Alderman Klee, Alderman Dowd, Alderwoman Kelly, Alderman Wilshire.

Alderman Moran and Alderman Jette were recorded absent.

Corporation Counsel Steve Bolton was also in attendance.

REMARKS BY THE MAYOR - None

RESPONSE TO REMARKS OF THE MAYOR - None

RECOGNITION PERIOD – None

READING MINUTES OF PREVIOUS MEETINGS

There being no objection, President Wilshire declared the minutes of the special and regular Board of Aldermen meetings of June 11, June 17, and June 24, 2024 be accepted, placed on file, and the readings suspended.

COMMUNICATIONS REQUIRING ONLY PROCEDURAL ACTIONS AND WRITTEN REPORTS FROM LIAISONS

From: Lisa M. Fauteux, Director of Public Works
Re: Referrals from Board of Aldermen – R-24-069

From: Dawn K. Enwright, Treasurer/Tax Collector
Re: Fire Department – Purchase of four Fire Marshal's vehicles (3 Ford Explorers, 1 Chevrolet Tahoe) from FY2025 Capital Equipment Reserve Fund (CERF)

There being no objection, President Wilshire accepted the communications and placed them on file.

PERIOD FOR PUBLIC COMMENT RELATIVE TO ITEMS EXPECTED TO BE ACTED UPON THIS EVENING

Gary Hoffman
Paula Johnson
Sonrisa O'Toole

COMMUNICATIONS REQUIRING FINAL APPROVAL

From: Mayor Jim Donchess
Re: Replacement Vehicles for the Fire Marshals'

MOTION BY ALDERMAN KLEE TO APPROVE THE PURCHASE OF (4) 2024 FORD F-150 LIGHTNING EV TRUCKS AND ASSOCIATED EQUIPMENT FOR THE VEHICLE FIT-UP WITH GRAPPONE FORD AND

GLOBAL PUBLIC SAFETY IN THE AMOUNT NOT TO EXCEED $240,000. FUNDING WILL BE THROUGH DEPARTMENT: 152 FIRE RESCUE; FUND: 81500 VEHICLES/CERF
MOTION CARRIED

From: Mayor Jim Donchess
Re: Million Dollar Contract Award – RWC Enterprises

MOTION BY ALDERMAN GOUVEIA TO APPROVE CHANGE ORDER 4 TO THE 2023 SEWER REHABILITATION PROGRAM CONTRACT 3 WITH RWC ENTERPRISES OF NASHUA, NH, IN THE AMOUNT NOT TO EXCEED $368,798. FUNDING WILL BE THROUGH DEPARTMENT: 169 WASTEWATER; FUND: 81700 INFRASTRUCTURE IMPROVEMENTS/BOND
MOTION CARRIED

From: Mayor Jim Donchess
Re: Multi-Year Contract Award – Haley Ward, Inc.

MOTION BY ALDERMAN THIBODEAU TO APPROVE A THREE-YEAR CONTRACT FOR WATER QUALITY TESTING SERVICES AT NASHUA LANDFILL SITES FOR THE SOLID WASTE DEPARTMENT WITH HALEY WARD, INC., OF PORTSMOUTH, NH, IN THE AMOUNT OF $205,207.25. FUNDING WILL BE THROUGH DEPARTMENT: 168 SOLID WASTE; FUND: 55699 OTHER CONTRACTED SERVICES/GENERAL FUND
MOTION CARRIED

From: Mayor Jim Donchess
Re: Tax Increment Finance Development Program – The Doty Group

MOTION BY ALDERMAN CLEMONS TO APPROVE AND AWARD A CONTRACT FOR ENHANCEMENTS TO THE EAST SIDE RIVERFRONT BEHIND THE LIBRARY WITH THE DOTY GROUP IN THE AMOUNT NOT TO EXCEED $9,430. FUNDING WILL BE THROUGH DEPARTMENT: 183 ECONOMIC DEVELOPMENT; FUND: 55699 OTHER CONTRACTED SERVICES/RIVERFRONT TIF FUND
MOTION CARRIED

From: Mayor Jim Donchess
Re: Emergency PO Request – New England Boring Contractors

MOTION BY ALDERWOMAN TIMMONS TO APPROVE AN EMERGENCY PURCHASE ORDER FOR GEOTECHNICAL INVESTIGATION DUE TO CONCERNS REGARDING THE RIVERBANK STABILITY NEAR LE PARK DE NOTRE RENAISSANCE FRANCAISE UTILIZING THE TAX INCREMENT FINANCING BOND WITH NEW ENGLAND BORING CONTRACTORS IN THE AMOUNT OF $5,165.95
MOTION CARRIED

From: Mayor Jim Donchess
Re: Multi-Year Contract Award – Whitney Consulting Group

MOTION BY ALDERMAN GOUVEIA TO APPROVE AND AWARD A THREE-YEAR CONTRACT FOR PROFESSIONAL CONSULTING SERVICES TO ASSIST THE ASSESSING OFFICE RELATIVE TO PROVIDING CHIEF ASSESSOR DUTIES WITH WHITNEY CONSULTING GROUP IN THE AMOUNT OF $360,000 OR $120,000 ANNUALLY. FUNDING WILL BE THROUGH DEPARTMENT: 132 ASSESSING; FUND: 53452 STAFFING SERVICES/GENERAL FUND
MOTION CARRIED

From: Mayor Jim Donchess
Re: Tax Increment Finance Development Program – Parke MacDowell

MOTION BY ALDERMAN KLEE TO APPROVE AND AWARD A THREE-YEAR CONTRACT WITH PARKE MACDOWELL FOR CONCEPT DESIGN FOR THE RIVERWALK ENTRANCEWAY/SIGNAGE AT BICENTENNIAL PARK IN THE AMOUNT OF $4,640. FUNDING WILL BE THROUGH DEPARTMENT: 183 ECONOMIC DEVELOPMENT; FUND: 81700 INFRASTRUCTURE IMPROVEMENTS/RIVERFRONT TIF FUND
MOTION CARRIED

From: Mayor Jim Donchess
Re: Tax Increment Finance Department Program – E.D. Swett, Inc.

MOTION BY ALDERMAN CLEMONS TO APPROVE CHANGE ORDER 4 WITH E.D. SWETT, INC., TO ADDRESS MISCELLANEOUS CHANGES IN THE WORK RELATED TO COAL TAR EPOXY COATING, A CORRUGATED POLYETHYLENE PIPE UNDERDRAIN, STEEL HANDRAIL MODIFICATIONS, CONTAINMENT AND TESTING OF CONTAMINATED GROUNDWATER, AS WELL AS REMOVAL OF SOME UNUSED ORIGINAL CONTRACT ITEMS IN THE AMOUNT OF $15,428.16. FUNDING WILL BE THROUGH DEPARTMENT: 183 ECONOMIC DEVELOPMENT; FUND: 81700 INFRASTRUCTURE IMPROVEMENTS/RIVERFRONT TIF BOND
MOTION CARRIED

PETITIONS

Petition for Abatement of Real Estate Taxes Pursuant to RSA 76:19-a (Brownfields Property)

There being no objection, President Wilshire accepted the Petition for Abatement of Real Estate Taxes Pursuant to RSA 76:19-a (Brownfields Property) and refer to the Budget Review Committee.

Petition for Street Discontinuance – Portion of Veterans Memorial Parkway (right of way)

There being no objection, President Wilshire accepted the Petition for Street Discontinuance – Portion of Veterans Memorial Parkway (right of way) refer to the Committee on Infrastructure and the Nashua City Planning Board, and scheduled a public hearing on Wednesday, September 25, 2024, at 7:00 p.m. in the Aldermanic Chamber.

NOMINATIONS, APPOINTMENTS AND ELECTIONS

The following appointments by the Mayor were read into the record:

Board of Public Works Retirement System Trustees

David Fredette (new appointment) Term to Expire: December 31, 2025
4 Henry Drive, #408
Nashua, NH 03062

Nashua Arts Commission

Jane Marquis (new appointment) Term to Expire: September 11, 2027
4 Farley Street
Nashua, NH 03064

Nashua Center for the Arts Board of Trustees

Amber Morgan (re-appointment) Term to Expire: February 14, 2025
20 Lock Street
Nashua, NH 03064

There being no objection, President Wilshire accepted the Appointments by the Mayor as read and referred them to the Personnel/Administrative Affairs Committee.

REPORTS OF COMMITTEE

Personnel/Administrative Affairs Committee…………………..…………..……………………. 06/03/2024

There being no objection, President Wilshire declared the report of the June 3, 2024 Personnel/Administrative Affairs Committee be accepted and placed on file.

Budget Review Committee……..……………………… 06/04/2024, 06/06/2024, 06/12/2024, 06/24/2024

There being no objection, President Wilshire declared the reports of the June 4, June 6, June 12, and June 24, 2024 Budget Review Committee be accepted and placed on file.

Finance Committee…..……………………………..…………………...……………. 06/05/2024, 06/20/2024

There being no objection, President Wilshire declared the reports of the June 5 and June 20, 2024 Finance Committee be accepted and placed on file.

Ad Hoc Capital/Debt Committee…..……………………………..……………..…………………. 06/13/2024

There being no objection, President Wilshire declared the report of the June 13, 2024 Ad Hoc Capital/Debt Committee be accepted and placed on file.

Human Affairs Committee…..……………………………..…………………...……………………. 06/25/2024

There being no objection, President Wilshire declared the report of the June 25, 2024 Human Affairs Committee be accepted and placed on file.

CONFIRMATION OF MAYOR'S APPOINTMENTS

Cultural Connections Committee

***There being no objection, President Wilshire confirmed the new appointment of* Ayda Nadeer, 130 Flagstone Drive, Apt. 4, Nashua, to the Cultural Connections Committee with a term to expire May 28, 2027.**

Oath of Office administered at a later date.

UNFINISHED BUSINESS – RESOLUTIONS

R-24-063

Endorsers: Mayor Jim Donchess
Alderman-at-Large Michael B. O'Brien, Sr.
Alderwoman-at-Large Gloria Timmons
Alderman-at-Large Melbourne Moran, Jr.
Alderman Thomas Lopez
Alderman Patricia Klee
Alderman Richard A. Dowd
Alderman-at-Large Lori Wilshire

RELATIVE TO THE ACCEPTANCE AND APPROPRIATION OF $500,000 FROM THE STATE OF NEW HAMPSHIRE DEPARTMENT OF BUSINESS AND ECONOMIC AFFAIRS INVEST NH DEMOLITION GRANT PROGRAM AND APPROVAL FOR THE CITY TO GRANT SAID FUNDS TO BLAYLOCK

HOLDINGS, LLC FOR DEMOLITION OF THE MOHAWK TANNERY SITE THROUGH A GRANT AGREEMENT

Given its second reading;

MOTION BY ALDERMAN DOWD FOR FINAL PASSAGE OF R-24-063 BY ROLL CALL PURSUANT TO CHARTER SECTION 49

A viva voce roll call was taken which resulted as follows:

Yea:	Alderman O'Brien, Alderwoman Timmons, Alderman Thibodeau, Alderman Gouveia, Alderman Sullivan, Alderman Clemons, Alderman Sennott, Alderman Thibeault, Alderman Klee, Alderman Dowd, Alderwoman Kelly, Alderman Wilshire	12
Nay:		0

MOTION CARRIED

Resolution R-24-063 is declared duly adopted.

R-24-064

Endorsers: Alderman Patricia Klee
Alderman-at-Large Melbourne Moran, Jr.
Alderman Tyler Gouveia
Alderman-at-Large Ben Clemons
Alderman Derek Thibeault
Alderman Patricia Klee
Alderman Richard A. Dowd
Alderwoman-at-Large Shoshanna Kelly
Alderman-at-Large Lori Wilshire

AUTHORIZING PENNICHUCK CORPORATION AND PENNICHUCK WATER WORKS, INC. TO BORROW FUNDS FROM THE STATE OF NEW HAMPSHIRE PFAS REMEDIATION AND GRANT FUND

Given its second reading;

MOTION BY ALDERMAN KLEE FOR FINAL PASSAGE OF R-24-064
MOTION CARRIED

Resolution R-24-064 is declared duly adopted.

R-24-065

Endorsers: Alderman Richard A. Dowd
Alderwoman-at-Large Gloria Timmons
Alderman-at-Large Melbourne Moran, Jr.
Alderman Tyler Gouveia
Alderman Thomas Lopez
Alderman-at-Large Ben Clemons
Alderman Tim Sennott
Alderman Patricia Klee
Alderwoman-at-Large Shoshanna Kelly
Alderman-at-Large Lori Wilshire

APPROVING THE COST ITEMS OF A COLLECTIVE BARGAINING AGREEMENT BETWEEN THE NASHUA BOARD OF EDUCATION AND THE NASHUA TEACHERS' UNION, LOCAL 1044, AFT, AFL-CIO, UNIT D, FOOD SERVICE WORKERS FROM SEPTEMBER 1, 2024 THROUGH AUGUST 31, 2027

Given its second reading;

MOTION BY ALDERMAN DOWD FOR FINAL PASSAGE OF R-24-065

ON THE QUESTION

Alderman Dowd
Alderman Sullivan

MOTION CARRIED

Resolution R-24-065 is declared duly adopted.

R-24-066

Endorsers: Mayor Jim Donchess
Alderman Chris Thibodeau
Alderman John Sullivan
Alderman Patricia Klee
Alderman Richard A. Dowd
Alderman-at-Large Lori Wilshire

RELATIVE TO THE SUPPLEMENTAL APPROPRIATION OF $301,026.90 OF FY2024 UNANTICIPATED REVENUE INTO FUND #7024 "OPIOID ABATEMENT EXPENDABLE TRUST FUND"

Given its second reading;

MOTION BY ALDERWOMAN KELLY FOR FINAL PASSAGE OF R-24-066 BY ROLL CALL PURSUANT TO CHARTER SECTION 49

A viva voce roll call was taken which resulted as follows:

Yea:	Alderman O'Brien, Alderwoman Timmons, Alderman Thibodeau, Alderman Gouveia, Alderman Lopez, Alderman Sullivan, Alderman Clemons, Alderman Sennott, Alderman Thibeault, Alderman Klee, Alderman Dowd, Alderwoman Kelly, Alderman Wilshire	13
Nay:		0

MOTION CARRIED

Resolution R-24-066 is declared duly adopted.

R-24-068

Endorsers: Mayor Jim Donchess
Alderman-at-Large Michael B. O'Brien, Sr.
Alderman Thomas Lopez
Alderman Patricia Klee
Alderman Richard A. Dowd
Alderman-at-Large Lori Wilshire

RELATIVE TO THE TRANSFER OF $246,000 FROM DEPARTMENT 193 "DEBT SERVICE", ACCOUNT 75200 "INTEREST" TO DEPARTMENT 159 "HYDRANTS – FIRE PROTECTION", ACCOUNT 54835 "HYDRANT FEES"

Given its second reading;

MOTION BY ALDERMAN O'BRIEN FOR FINAL PASSAGE OF R-24-068
MOTION CARRIED

Resolution R-24-068 is declared duly adopted.

R-24-069

Endorsers: Mayor Jim Donchess
Alderman-at-Large Michael B. O'Brien, Sr.
Alderman Patricia Klee
Alderman Richard A. Dowd

AUTHORIZING A TOWER CELL SITE LEASE AGREEMENT WITH DISH WIRELESS, L.L.C. REGARDING A WIRELESS COMMUNICATIONS FACILITY LOCATED AT 10 WHIPPLE STREET

Given its second reading;

MOTION BY ALDERMAN THIBODEAU FOR FINAL PASSAGE OF R-24-069
MOTION CARRIED

Resolution R-24-069 is declared duly adopted.

<u>UNFINISHED BUSINESS – ORDINANCES</u>

O-24-014, Amended

Endorsers: Alderman-at-Large Michael B. O'Brien, Sr.
Alderman Chris Thibodeau
Alderman Tyler Gouveia
Alderman John Sullivan
Alderman Tim Sennott
Alderman Patricia Klee
Alderman Richard A. Dowd
Alderman-at-Large Lori Wilshire

INCREASING FEES AND FINES IN THE PARKING ORDINANCES

Given its second reading;

MOTION BY ALDERWOMAN KELLY TO AMEND O-24-014 BY REPLACING IT WITH THE GOLDEN ROD COPY OF RECOMMENDED AMENDMENTS MADE AT THE PERSONNEL/ADMINISTRATIVE AFFAIRS COMMITTEE

<u>ON THE QUESTION</u>

<u>Alderman Klee</u>
<u>Alderman Clemons</u>
<u>Liz Hannum, Economic Development Director</u>

MOTION CARRIED

MOTION BY ALDERWOMAN KELLY TO FURTHER AMEND SECTION 320-87 B. OFFENSES AND FINES BY RENAMING FIRST COLUMN HEADING "ESCALATION SCHEDULE" TO "VIOLATION BASE AMOUNT IF PAID WITHIN 15 DAYS"; TITLE COLUMN 2 "VIOLATION AMOUNT IF PAID WITHIN 16-30 DYAS", TITLE COLUMN 3 "VIOLATION AMOUNT IF PAID WITHIN 31-89 DAYS, AND TITLE COLUMN 4 "VIOLATION AMOUNT IF PAID 90+ DAYS"

<u>ON THE QUESTION</u>

<u>Alderwoman Kelly</u>

MOTION CARRIED

MOTION BY ALDERWOMAN KELLY FOR FINAL PASSAGE OF O-24-014 AS AMENDED

ON THE QUESTION

Alderwoman Kelly
Alderman Clemons
Alderman Klee
Alderman Thibeault

MOTION CARRIED

Ordinance O-24-014 is declared duly adopted as amended.

O-24-016, Amended

Endorsers: Alderman Derek Thibeault
Alderwoman-at-Large Gloria Timmons
Alderman Thomas Lopez
Alderman-at-Large Ben Clemons

REGARDING THE TIME LIMIT FOR PUBLIC COMMENT

Given its second reading;

MOTION BY ALDERMAN THIBEAULT TO AMEND O-24-016 BY REPLACING IT WITH THE GOLDEN ROD COPY OF RECOMMENDED AMENDMENTS MADE AT THE PERSONNEL/ADMINISTRATIVE AFFAIRS COMMITTEE

ON THE QUESTION

Alderman Thibeault

MOTION CARRIED

MOTION BY ALDERMAN THIBEAULT FOR FINAL PASSAGE OF O-24-016 AS AMENDED

ON THE QUESTION

Alderman Thibeault
Alderman Lopez
Alderman Sennott

MOTION CARRIED

Ordinance O-24-016 is declared duly adopted as amended.

O-24-021

Endorsers: Mayor Jim Donchess
Alderman-at-Large Michael B. O'Brien, Sr.
Alderwoman-at-Large Gloria Timmons
Alderman Richard A. Dowd
Alderman-at-Large Lori Wilshire

UPDATING THE INSURANCE AND RISK MANAGEMENT ORDINANCES

Given its second reading;

MOTION BY ALDERMAN SENNOTT FOR FINAL PASSAGE OF O-24-021
MOTION CARRIED

Ordinance O-24-021 is declared duly adopted.

O-24-023

Endorsers: Alderman-at-Large Melbourne Moran, Jr.
Alderman-at-Large Gloria Timmons

PROHIBITING ELECTRONIC PARTICIPATION IN MEETINGS IF THE PERSON IS PARTICIPATING FROM OUTSIDE THE UNITED STATES

Given its second reading;

MOTION BY ALDERMAN O'BRIEN FOR INDEFINITE POSTPONEMENT OF O-24-023

ON THE QUESTION

Alderwoman Kelly

MOTION CARRIED

Ordinance O-24-023 is declared indefinitely postponed.

O-24-025

Endorsers: Alderman-at-Large Ben Clemons
Alderman-at-Large Michael B. O'Brien, Sr.
Alderwoman-at-Large Gloria Timmons
Alderman-at-Large Melbourne Moran, Jr.
Alderman Tim Sennott
Alderman Derek Thibeault
Alderman Patricia Klee

AMENDING THE KEEFE AUDITORIUM COMMISSION

Given its second reading;

MOTION BY ALDERMAN CLEMONS FOR FINAL PASSAGE OF O-24-025
MOTION CARRIED

Ordinance O-24-025 is declared duly adopted.

BUSINESS UNFINISHED AT THE PREVIOUS MEETING

MOTION BY ALDERMAN O'BRIEN TO REMOVE FROM THE TABLE R-24-035
MOTION FAILED

R-24-035

Endorsers: Mayor Jim Donchess
Alderman-at-Large Michael B. O'Brien, Sr.
Alderman Richard A. Dowd
Alderman Patricia Klee
Alderman Tyler Gouveia
Alderman Derek Thibeault
Alderman Chris Thibodeau
Alderman Tim Sennott
Alderman-at-Large Melbourne Moran, Jr.
Alderman Thomas Lopez
Alderman-at-Large Ben Clemons

CHANGING THE PURPOSE OF UP TO TWO MILLION TWO HUNDRED THOUSAND DOLLARS ($2,200,000) OF UNEXPENDED BOND PROCEEDS FROM THE DESIGN AND CONSTRUCTION OF A DIVISION OF PUBLIC WORKS OFFICE FACILITY TO THE DESIGN OF A PUBLIC WORKS DIVISION GARAGE

NEW BUSINESS – RESOLUTIONS

R-24-070

Endorsers: Mayor Jim Donchess
Alderman Richard A. Dowd
Alderman Patricia Klee
Alderman-at-Large Michael B. O'Brien, Sr.
Alderman Thomas Lopez
Alderman-at-Large Lori Wilshire

AUTHORIZING THE MAYOR AND CITY TREASURER TO ISSUE BONDS NOT TO EXCEED FOURTEEN MILLION FOUR HUNDRED THOUSAND DOLLARS ($14,400,000) FOR VARIOUS IMPROVEMENTS AT THE SOLID WASTE DEPARTMENT FOUR HILLS LANDFILL

Given its first reading; Assigned to the BUDGET REVIEW COMMITTEE, BOARD OF PUBLIC WORKS, and SCHEDULE A SPECIAL BOARD OF ALDERMEN PUBLIC HEARING ON MONDAY, AUGUST 26, 2024 AT 7:00 P.M., in the aldermanic chamber by President Wilshire

R-24-071

Endorsers: Mayor Jim Donchess
Alderman Richard A. Dowd
Alderman Patricia Klee
Alderman Tim Sennott
Alderman Thomas Lopez
Alderman-at-Large Michael B. O'Brien, Sr.

AUTHORIZING THE MAYOR AND CITY TREASURER TO ISSUE BONDS NOT TO EXCEED ONE MILLION FIFTY-TWO THOUSAND EIGHT HUNDRED AND NINETY-SEVEN DOLLARS ($1,052,897) FOR VARIOUS WASTEWATER CAPITAL IMPROVEMENTS

Given its first reading; Assigned to the BUDGET REVIEW COMMITTEE, BOARD OF PUBLIC WORKS, and SCHEDULE A SPECIAL BOARD OF ALDERMEN PUBLIC HEARING ON MONDAY, AUGUST 26, 2024 AT 7:00 P.M., in the aldermanic chamber by President Wilshire

R-24-072

Endorsers: Mayor Jim Donchess
Alderman-at-Large Michael B. O'Brien, Sr.
Alderman Thomas Lopez
Alderman Tim Sennott
Alderman Patricia Klee
Alderman Richard A. Dowd

AUTHORIZING THE MAYOR AND CITY TREASURER TO ISSUE BONDS NOT TO EXCEED THREE MILLION EIGHT HUNDRED SIXTY-TWO THOUSAND DOLLARS ($3,862,000) FOR THE CITY'S SEWER INFRASTRUCTURE IMPROVEMENT AND SEWER AND DRAIN CASTING REPLACEMENT PROGRAMS

Given its first reading; Assigned to the BUDGET REVIEW COMMITTEE, BOARD OF PUBLIC WORKS, and SCHEDULE A SPECIAL BOARD OF ALDERMEN PUBLIC HEARING ON MONDAY, AUGUST 26, 2024 AT 7:00 P.M., in the aldermanic chamber by President Wilshire

R-24-073

Endorsers: Mayor Jim Donchess
Alderman Richard A. Dowd
Alderman Patricia Klee
Alderman Tim Sennott
Alderman Thomas Lopez
Alderman-at-Large Michael B. O'Brien, Sr.

AUTHORIZING THE MAYOR AND CITY TREASURER TO BORROW AN AMOUNT NOT TO EXCEED FOUR MILLION ONE HUNDRED NINETY-TWO THOUSAND DOLLARS ($4,192,000) THROUGH THE ISSUANCE OF BONDS AND/OR A LOAN THROUGH THE NEW HAMPSHIRE DEPARTMENT OF

ENVIRONMENTAL SERVICES STATE REVOLVING LOAN FUND FOR THE WASTEWATER TREATMENT PLANT PHASE 1 UPGRADES PROJECT

Given its first reading; Assigned to the BUDGET REVIEW COMMITTEE, BOARD OF PUBLIC WORKS, and SCHEDULE A SPECIAL BOARD OF ALDERMEN PUBLIC HEARING ON MONDAY, AUGUST 26, 2024 AT 7:00 P.M., in the aldermanic chamber by President Wilshire

R-24-074

Endorsers: Alderman-at-Large Lori Wilshire
Alderman Richard A. Dowd
Alderman-at-Large Michael B. O’Brien, Sr.
Alderman Tyler Gouveia
Alderman Thomas Lopez
Alderman-at-Large Ben Clemons
Alderman Patricia Klee
Alderman Derek Thibeault
Alderwoman-at-Large Shoshanna Kelly

APPROVING THE COST ITEMS OF A SIDEBAR AGREEMENT BETWEEN THE NASHUA BOARD OF POLICE COMMISSIONERS AND TEAMSTERS LOCAL 633 REGARDING THE CITY’S INSURANCE CONTRIBUTIONS AND AUTHORIZING RELATED TRANSFERS

Given its first reading; Assigned to the BUDGET REVIEW COMMITTEE, by President Wilshire

R-24-075

Endorser: Alderman Thomas Lopez

RECOGNIZING THE UNITED NATIONS’ UNIVERSAL DECLARATION OF HUMAN RIGHTS AND URGING THE RESPONSIBLE AND MORAL OVERSIGHT OF AND ACCOUNTABILITY FOR MILITARY EQUIPMENT USED BY INTERNATIONAL ALLIES

Given its first reading; Assigned to the HUMAN AFFAIRS COMMITTEE and CULTURAL CONNECTIONS COMMITTEE, by President Wilshire

R-24-076

Endorsers: Mayor Jim Donchess
Alderman-at-Large Michael B. O’Brien, Sr.
Alderwoman-at-Large Shoshanna Kelly
Alderman Richard A. Dowd
Alderman Patricia Klee
Alderman Derek Thibeault
Alderman Tim Sennott
Alderman-at-Large Ben Clemons

RELATIVE TO THE ACCEPTANCE AND APPROPRIATION OF $1,000,000 FROM THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY MULTIPURPOSE GRANT PROGRAM INTO COMMUNITY DEVELOPMENT GRANT ACTIVITY “BROWNFIELDS MULTIPURPOSE GRANT” FOR THE PURPOSE OF BROWNFIELDS ASSESSMENT AND REMEDIATION ACTIVITIES

Given its first reading; Assigned to the BUDGET REVIEW COMMITTEE and SCHEDULE A SPECIAL BOARD OF ALDERMEN PUBLIC HEARING ON MONDAY, AUGUST 26, 2024 AT 7:00 P.M., in the aldermanic chamber by President Wilshire

R-24-077

Endorsers: Mayor Jim Donchess
Alderman-at-Large Lori Wilshire
Alderman-at-Large Michael B. O’Brien, Sr.
Alderman-at-Large Ben Clemons
Alderman Patricia Klee
Alderman Tyler Gouveia
Alderman Richard A. Dowd

SUPPORTING THE FIVE-YEAR GENERAL FUND GENERAL OBLIGATION BONDING PLAN RECOMMENDED BY THE AD HOC JOINT MAYORAL – BOARD OF ALDERMEN COMMITTEE ON CAPITAL EXPENDITURES AND DEBT SERVICE PLAN

Given its first reading;

MOTION BY ALDERMAN O'BRIEN TO SUSPEND THE RULES FOR A SECOND READING OF RESOLUTION R-24-077
MOTION CARRIED

R-24-077

Endorsers: Mayor Jim Donchess
Alderman-at-Large Lori Wilshire
Alderman-at-Large Michael B. O'Brien, Sr.
Alderman-at-Large Ben Clemons
Alderman Patricia Klee
Alderman Tyler Gouveia
Alderman Richard A. Dowd

SUPPORTING THE FIVE-YEAR GENERAL FUND GENERAL OBLIGATION BONDING PLAN RECOMMENDED BY THE AD HOC JOINT MAYORAL – BOARD OF ALDERMEN COMMITTEE ON CAPITAL EXPENDITURES AND DEBT SERVICE PLAN

Given its second reading;

MOTION BY ALDERMAN O'BRIEN FOR FINAL PASSAGE OF RESOLUTION R-24-077

<u>ON THE QUESTION</u>

<u>Alderman Lopez</u>
<u>Alderman Gouveia</u>
<u>Alderman Clemons</u>
<u>Alderman Klee</u>
<u>Alderman Sullivan</u>

MOTION CARRIED

Resolution R-24-077 is declared duly adopted.

R-24-078

Endorsers: Mayor Jim Donchess
Alderwoman-at-Large Gloria Timmons
Alderwoman-at-Large Shoshanna Kelly
Alderman Patricia Klee
Alderman Derek Thibeault
Alderman-at-Large Lori Wilshire

AMENDING THE U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT HOME INVESTMENT PROGRAM AMERICAN RESCUE PLAN ACT FUND ALLOCATION PLAN

Given its first reading; Assigned to the HUMAN AFFAIRS COMMITTEE, by President Wilshire

R-24-079

Endorsers: Mayor Jim Donchess
Alderman-at-Large Lori Wilshire
Alderman Thomas Lopez
Alderman-at-Large Michael B. O'Brien, Sr.
Alderwoman-at-Large Gloria Timmons
Alderman Tyler Gouveia

Alderman Thomas Lopez
Alderman Chris Thibodeau
Alderwoman-at-Large Shoshanna Kelly
Alderman Richard A. Dowd
Alderman Patricia Klee
Alderman Derek Thibeault
Alderman Tim Sennott
Alderman-at-Large Ben Clemons

APPROVING THE MOHAWK TANNERY REDEVELOPMENT PLAN TO PERMIT THE INITIATION OF A REDEVELOPMENT PROJECT IN ACCORDANCE WITH RSA 205

Given its first reading; Assigned to the PLANNING AND ECONOMIC DEVELOPMENT COMMITTEE, by President Wilshire

NEW BUSINESS – ORDINANCES

O-24-026

Endorser: Alderman Patricia Klee

REMOVING THE NO PARKING RESTRICTION ON A SECTION OF THE EAST SIDE OF MANCHESTER STREET

Given its first reading; Assigned to the COMMITTEE ON INFRASTRUCTURE, by President Wilshire

O-24-027

Endorser: Alderman Chris Thibodeau

NO PARKING ON THE WEST SIDE OF ZELLWOOD STREET

Given its first reading; Assigned to the COMMITTEE ON INFRASTRUCTURE, by President Wilshire

O-24-028

Endorsers: Alderman-at-Large Ben Clemons
Alderman-at-Large Michael B. O’Brien, Sr.
Alderwoman-at-Large Gloria Timmons
Alderman Thomas Lopez
Alderwoman-at-Large Shoshanna Kelly
Alderman Richard A. Dowd
Alderman Patricia Klee
Alderman Derek Thibeault
Alderman Tim Sennott
Alderman-at-Large Lori Wilshire

REQURING FOOD SERVICE UNTIL MIDNIGHT FOR CHARITABLE GAMING FACILITIES THAT EXTEND THEIR HOURS OF ON-PREMISES SALES OF ALCOHOLIC BEVERAGES TO 2 A.M.

Given its first reading; Assigned to the PERSONNEL/ADMINISTRATIVE AFFAIRS COMMITTEE, by President Wilshire

O-24-029

Endorsers: Alderman John Sullivan
Alderman Tyler Gouveia
Alderman Richard A. Dowd
Alderman Chris Thibodeau

NO PARKING ON THE SOUTH SIDE OF SECTIONS OF SPIT BROOK ROAD

Given its first reading; Assigned to the COMMITTEE ON INFRASTRUCTURE, by President Wilshire

O-24-030

Endorsers: Alderman Chris Thibodeau
Alderman John Sullivan

AUTHORIZING STOP SIGNS ON FAIRLANE AVENUE, FOREST PARK DRIVE, KNOLLWOOD AVENUE AND WILDWOOD LANE

Given its first reading; Assigned to the COMMITTEE ON INFRASTRUCTURE, by President Wilshire

O-24-031

Endorsers: Alderman Chris Thibodeau
Alderman John Sullivan

ESTABLISHING A 25 MPH SPEED LIMIT ON FAIRLANE AVENUE, FOREST PARK DRIVE AND KNOLLWOOD AVENUE

Given its first reading; Assigned to the COMMITTEE ON INFRASTRUCTURE, by President Wilshire

O-24-032

Endorsers: Alderman-at-Large Lori Wilshire
Alderwoman-at-Large Gloria Timmons
Alderman-at-Large Michael B. O'Brien, Sr.
Alderman Richard A. Dowd
Alderman Patricia Klee

AMENDING LIAISON ORDINANCES

Given its first reading; Assigned to the PERSONNEL/ADMINISTRATIVE AFFAIRS COMMITTEE, by President Wilshire

PERIOD FOR GENERAL PUBLIC COMMENT

Meghan Schmitt
Nicholas Scalera
Bradley Conway
Laurie Ortolano
Paula Johnson

REMARKS BY THE MEMBERS OF THE BOARD OF ALDERMEN

Alderman Lopez
Alderwoman Kelly
Alderman Dowd
Alderman Klee
Alderman Thibeault
Alderman Sennott
Alderman Clemons
Alderman Wilshire

Committee announcements:

Alderman Sullivan
Alderman Lopez
Alderwoman Timmons

ADJOURNMENT

MOTION BY ALDERMAN O'BRIEN THAT THE AUGUST 13, 2024, MEETING OF THE BOARD OF ALDERMEN BE ADJOURNED
MOTION CARRIED

The meeting was declared adjourned at 9:05 p.m.

Attest: Dan Healey, City Clerk

R-24-064

RESOLUTION

AUTHORIZING PENNICHUCK CORPORATION AND PENNICHUCK WATER WORKS, INC. TO BORROW FUNDS FROM THE STATE OF NEW HAMPSHIRE PFAS REMEDIATION AND GRANT FUND

CITY OF NASHUA

In the Year Two Thousand and Twenty-Four

WHEREAS, the City of Nashua is the sole shareholder of Pennichuck Corporation and each of its subsidiaries;

WHEREAS, Article IX (3) of the Articles of Incorporation of Pennichuck Corporation and Article V §2 of the by-laws of Pennichuck Corporation require the approval of the sole shareholder (the City of Nashua) for Pennichuck to create, incur, assume, or guarantee any indebtedness for borrowed money, which includes contracting a loan on behalf of the Corporation; and

WHEREAS, Pennichuck Water Works, Inc. is a regulated New Hampshire public water utility corporation providing retail water service to New Hampshire customers, and is a wholly owned subsidiary of Pennichuck Corporation which, in turn, is wholly owned by the City of Nashua.

NOW, THEREFORE, BE IT RESOLVED by the Board of Aldermen of the City of Nashua that the City approves the borrowing by Pennichuck Water Works, Inc. of up to $11,450,000 from the State of New Hampshire pursuant to the PFAS Remediation Grant and Loan Fund to fund the design and construction of a new Chemical Feed and Storage Improvement project at the Company's Nashua Water Treatment Facility.

LEGISLATIVE YEAR 2024

RESOLUTION: **R-24-064**

PURPOSE: **Authorizing Pennichuck Corporation and Pennichuck Water Works, Inc., to borrow funds from the State of New Hampshire PFAS Remediation Grant and Loan Fund**

ENDORSERS: **Alderman Patricia Klee**

COMMITTEE ASSIGNMENT: **Pennichuck Water Special Committee**

FISCAL NOTE: **None.**

ANALYSIS

This resolution approves the proposal by Pennichuck Corporation and one of their regulated public water subsidiaries to borrow funds as described in the resolution.

Pennichuck has provided additional information on the proposal, which has been forwarded to the Board of Aldermen.

Article IX (3) of Pennichuck Corporation's Articles of Incorporation and Article V §2 of the Pennichuck Corporation's by-laws requires City approval for the borrowing.

Approved as to form: **Office of Corporation Counsel**

By: Dorothy Clarke

Date: 24 June 2024

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/2024
Request No. Department 2-1	Witness: George Torres

REQUEST:

Ref: PFAS Grant and Loan Remediation Fund

Relative to the Loan from NHDES, has the Company discussed or been informed as to whether the proposed loan qualifies for loan forgiveness pursuant to NH RSA 485-H:5? Please explain further.

RESPONSE:

On August 9, 2024, Amy Rosseau, the PFAS Response Administrator at the NHDES responded to the Company's inquiry regarding the possibility of the Pennichuck PFAS Remediation Loan qualifying for any debt forgiveness:

"The terms of the loan as far as the contingent reimbursement is concerned is that if the State received funds from litigation or settlements there is the potential to receive up to 50% loan forgiveness. However, this ***will not apply*** *to the settlement funds received from the 3M, Dupont and Tyco settlements concerning PWW."*

Based upon Ms. Rosseau's response, the Company's PFAS Remediation Loan may be eligible for up to 50% loan forgiveness subject to the availability of litigation or settlement funds received by the State outside of the three stated matters.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024
Request No. Department 2-2

Date of Response: 8/16/2024
Witness: George Torres

REQUEST:

Ref: Bates Page 30, Projected Rate Impact on Single Family Residential Customer from the Proposed Financing; DOE 1-15, and DW 23-101 Request for Merger; and DW 24-027 PWW QCPAC

As the Company is currently before the Commission in DW 23-101 to consider whether or not a consolidation of Pennichuck Water Works (PWW), Pennichuck East Utility (PEU), and Pittsfield Aqueduct Company (PAC) in in the public interest, please provide a rate impact scenario of the proposed financing whereby the three Pennichuck utilities listed above were to merge. For purposes of this response, please utilize the most recent Revenue Requirement and Rate Design information that was also used in the calculation of the rate impact of the Consolidated PWW QCPAC in DW 24-027.

RESPONSE:

Based on a projected revenue requirement of the Consolidated Utility (as submitted in April 2024 as part of the Supplemental PWW QCPAC filing in DW 24-027) of $54,131,797, and a projected total cost of $11,450,000 for the project, the rate impact would be as follows

1.0 DSRR - $ 805,634 based on a 20-year term loan with an interest rate of 3.5%
0.1 DSRR - $ 80,563
Property Tax Expense - $ 266,327 based on current combined Nashua and State tax rate of $23.26 per $1,000
Total Revenue impact -$1,152,525

% Impact = $1,152,525/$54,131,797 = 2.13%

Current Monthly Single Family Residential Bill - $61.27

Monthly Impact on Single Family Residential Bill of this Financing - $1.354

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/2024
Request No. Department 2-3	Witness: George Torres

REQUEST:

Ref: Bates Page 30, Projected Rate Impact on Single Family Residential Customer from the Proposed Financing; DOE 1-15, and DW 23-101 Request for Merger; and DW 24-027 PWW QCPAC

As the Company is currently before the Commission in DW 23-101 to consider whether or not a consolidation of Pennichuck Water Works (PWW), Pennichuck East Utility (PEU), and Pittsfield Aqueduct Company (PAC) in in the public interest, please provide a rate impact scenario of the proposed financing whereby the three Pennichuck utilities listed above were to merge. For purposes of this response, please utilize the most recent Revenue Requirement and Rate Design information that was also used in the calculation of the rate impact of the Consolidated PWW QCPAC in DW 24-027.

RESPONSE:

Please see responses to DOE 2-2 above.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/24
Request No. Department 2-4	Witness: Chris Countie

REQUEST:

Ref: Petition, Bates Page 5, para. 8; and the '2022 Ten States Standard' as published by the Minnesota Department of Health, Section 5.5.9, Storage of Chemicals, Page 122 (173 of 220)[1]

After review, when discussing the amount of bulk chemical storage, and specifically, the 30 days at average demand, it appears that the 'Ten States Standard' includes the phrase,

> "5.5.9 Storage of chemicals
> a) Adequate space shall be provided for:
> 1) **At least** 30 days of chemical supply." (emphasis added)

Please confirm and provide additional explanation regarding the purpose of the term 'at least' when considering the desired amount of bulk chemical storage the Company believes is necessary to provide safe and adequate water.

RESPONSE:

The Company believes, because of its experience over the last 10 years, that *at least* 30 days at average demand is inadequate for ferric chloride storage capacity. The Company believes that, as noted in The Report (provided previously as Exhibit DOE DR 1-1), page 6-3, Section 6.2.1, Table 6-1, 35 days of storage is believed to be adequate at average demand to mitigate the impact of the periodic unreliability of the supply chain of this chemical. This amount of storage also accounts for the anticipated increase in chemical demand forecasted due to the continued and constant use of the Merrimack River Supply.

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[1] https://www.health.state.mn.us/communities/environment/water/tenstates/standards.html

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024
Request No. Department 2-5

Date of Response: 8/16/24
Witness: Chris Countie

REQUEST:

Ref: Company's Response to DOE 1-2; and Evaluation of the Chemical Feed System by CDM Smith, page 44, Section 2.5.2, Current Ferric Chloride Capacity, and Table 2-28

The Company cited, and discussed, the need for increased ferric chloride as one of the main reasons for its Petition. In addition, both the Petition and the CDM Smith Evaluation concluded that the Company has approximately 20-22 days of bulk storage, based on average demand, of ferric chloride, which does not meet the 'Standard' of (at least) 30 days. The Evaluation then calculated an approximate daily usage of 999 gallons. Therefore, does the Company agree that in order to meet the 'Standard', the Company would need to increase its bulk ferric chloride storage by at least 10,000 gallons? (999 gallons * 10 days). Please explain further.

RESPONSE:

The Company agrees that the approximate average daily usage for ferric chloride, based on all available historical records, is forecast to be 999 gallons per day. The Company also agrees that to meet the standard of at least 30 days of supply at average demand, the capacity needs to be increased by 10,000 gallons. The project proposes to increase the storage capacity for ferric chloride by 15,000 gallons to achieve 35 days of storage at average demand as previously referenced in the Company's response to DOE Request No. 2-4.

The proposed additional storage mitigates the impact of periodic disruptions to the supply chain for this chemical. Past disruptions have been attributed to manufacturing capacity shortages and truck driver availability, that typically happen during the highest demand periods for this chemical.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/24
Request No. Department 2-6	Witness: Chris Countie

REQUEST:
If not provided previously, please <u>briefly</u> discuss, with references, the current Water Treatment Facility's capacity as a structure to house <u>any</u> increase in bulk chemical storage.

RESPONSE:

Section 5, Figures 5-4 and 5-5 of The Report (Exhibit DOE DR 1-1), depicts the existing bulk chemical storage areas. It is evident in these figures that additional tanks would not be feasible. Additionally, the ceiling height in these areas would not accommodate higher tanks that would allow for increased capacity in the same footprint. For these reasons, a new chemical storage building was deemed necessary.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/24
Request No. Department 2-7	Witness: Chris Countie

REQUEST:

Ref: The Evaluation of the Chemical Feed System by CDM Smith, page 89, Section 6.3
The Evaluation from CDM Smith appears to indicate that the most current and updated proposal includes keeping the current ferric chloride day tanks, bulk chemical storage, and associated systems, and that the proposed additions to the ferric chloride system will supplement the existing system. Please confirm and explain further.

RESPONSE:

Yes, because the existing tanks are only 15 years old and, according to the manufacturer, should last at least 25 years. The Company believes it is prudent to continue utilizing the existing storage tanks. By continuing to use the existing tanks, the new building can be smaller, construction of the new area can be completed without disruption of the chemical feed, and the maximum utilization of the existing tanks can be achieved.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/24
Request No. Department 2-8	Witness: Chris Countie

REQUEST:

Ref: The Evaluation of the Chemical Feed System by CDM Smith, page 45, Section 2.5.3, Current Sodium Hypochlorite Capacity, and Table 2-29; ad page 56, Section 2.6.2, and Table 2-39

The Company also cited the need for improvements or replacements of the current sodium hypochlorite as another of the main reasons for the Petition. From the CDM Smith Evaluation, it was concluded that the Company has exactly 30 days of bulk storage, based on average demand, and 7 days of storage, based on maximum demand, for sodium hypochlorite, which meets the Standard, but just meets it. When comparing the current capacity to the 'Standard', it appears the Company's overall sodium hypochlorite systems, with a capacity of 9,000 gallons, is currently at the bare minimum of what the Ten States Standards lists. In that regard, please discuss the process the Company used to conclude, or agree with the Evaluation, and its proposed improvements or replacement of the sodium hypochlorite system, that resulted in the proposed capacity of 18,000 gallons of sodium hypochlorite bulk storage.

RESPONSE:

The water treatment facility was originally designed to accommodate 1-ton cylinders of 100% chlorine gas. At some point, it was determined that it was safer to utilize sodium hypochlorite (bleach) as the primary disinfectant instead of chlorine gas due to safety concerns for employees and surrounding neighborhoods. The room originally intended for gas cylinders was then converted to accommodate liquid bleach bulk tanks with 2,000 gallons capacities. The room was always too small to house tanks that were at least 4,000 gallons, which is the capacity of a standard bulk chemical tanker utilized by our chemical suppliers. It is therefore desirable for the Company to have tanks at least the size of one standard delivery vehicle's capacity to allow for continued delivery should other tanks need to be taken out of service for repair or inspection.

Furthermore, the Company has a history of significant maintenance on the piping system attached to the existing 5 storage tanks. In fact, temporary piping is now in place because the tanks themselves are leaking from the connections to this piping system.

The Company's goal is to size the new tanks such that each tank can hold at least one bulk tanker truck's capacity. Secondarily, the design of the storage should limit the piping system connecting these tanks to avoid leaking in the future and reduce maintenance. Because the final design has not been completed, it is the Company's intention to verify the capacities of the tanks noted in The Report (Exhibit DOE DR 1-1) to ensure adequate storage without oversizing. In reviewing the sizing of the sodium hypochlorite storage tanks proposed, the Company has questions regarding the need for 18,000 gallons of storage capacity and will likely ask that this be reviewed and possibly decreased.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/24
Request No. Department 2-9	Witness: Chris Countie

REQUEST:

Ref: DOE 1-17

As part of the process or evaluating design proposals, did the Company consider, and discuss with CDM Smith, any and all significant alternative building designs or construction materials, and / or construction methods, that would still meet the requirements of bulk chemical storage, adequate security of public water systems, etc…? Please discuss how the cost of those alternative designs, if any, compare to the current proposal.

RESPONSE:

The Company asked that CDM Smith prepare their opinion of cost for this project based on the most effective solution compared to many alternatives discussed. The Report (Exhibit DOE DR 1-1) discusses certain alternatives considered in Section 6.1 **Assessment of Additional Design Items at** pages 6-1 through 6-2. As the Company continues through the process of final design, it will look to maximize the efficient use of space in the new building, look for lower cost alternatives for building materials while still maintaining architectural consistency with existing structures on the site.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/2024
Request No. Department 2-10	Witness: George Torres

REQUEST:

Ref: DOE 1-21

The Calculation of the Tax Impact uses a NH Business Profits Tax rate of 7.6%. However, according to the NH Department of Revenue Administration, it appears that the NH BPT was decreased to 7.5% as of 12/31/2023.[2]

a) Please update the Tax Impact calculation as necessary; and
b) Provide the calculation for the "Federal Deduction of BPT Rate'.

RESPONSE:

a) Below is the *revised* Tax Impact Calculation:

Federal Rate	21.00%
NH BPT Rate (2023)	7.50%
Federal deduction of BPT Rate	-1.58%
Combined Federal & State Rate	26.92%

b) The calculation for the "Federal Deduction of BPT Rate" is as follows:

Federal Rate	X	NH BPT Rate	=	Federal Deduction
21.00%	X	-7.50%	=	-1.58%

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[2] https://www.revenue.nh.gov/taxes-glance/business-taxes

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/24
Request No. Department 2-11	Witness: Chris Countie

REQUEST:

Ref: DOE 1-9

The Company submitted historical data regarding four PFAS/PFOA related contaminants in ‘Part C’ of its response using a measurement of ‘ng/l’. However, the levels indicated in ‘Part A’ are in ‘ppt’. Please indicate what is meant by ng/l and the conversion, if any, from ng/l to ppt.

RESPONSE:

Ng/l or nanograms per liter is the same unit of concentration as parts per trillion or ppt. There is no need for a conversion as they can be used interchangeably.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/24
Request No. Department 2-12	Witness: Chris Countie

REQUEST:

Ref: Pre-filed Testimony of Christopher Countie, Bates Pages 42-43; and Response to DR 1-9 (d)
The referenced sentence in the Testimony reads "The new MCL's for two chemicals were below the now detectable levels of 1.4 to 1.8 parts per trillion (ppt) in the PBR", which does not appear to make sense on its face (the new MCL's were below 1.4 to 1.8 ppt). Is the following closer to what the author was trying to convey? Please confirm or explain.

> Given a newer, lower MRDL of 1.4 to 1.8 parts per trillion (ppt), the new MCL's for two chemicals were below the now detectable levels in the PBR.

RESPONSE:

The intent of the sentence was to convey that the MCL's established for PFOA and PFOS set by the State of NH in 2019, were below the levels detected in the Pennichuck Brook Reservoir (PBR) and. Therefore, the PBR would not meet the MCL levels without treatment, particularly for PFOA.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024 Date of Response: 8/16/24
Request No. Department 2-13 Witness: Chris Countie

REQUEST:

Ref: Response to DR 1-9 (e)

In what general range have PFOA and PFOS been maintained in the water leaving the water treatment plant (for example, slightly below the current MCL's, or closer to zero as a result of the GAC filters)? Please explain.

RESPONSE:

Levels of PFOA and PFOS have been maintained closer to the minimum reliable detection limit (MRDL) range as practical. Since 2019, PFOA levels have ranged between <2 ppt and 10.6 ppt and PFOS levels have ranged between <2 ppt or below MRDL. The Company intends to operate its system as close to the non-detectable range as possible in the future. The Company anticipates that the demand for GAC will be significant and therefore, it is important to operate the system as close to the MRDL as possible to not risk an MCL violation due to delays in GAC availability. Compliance with the MCL is based on the averaging of 4 samples gathered quarterly. If the Company operates the system to just below the MCL, and there is a delay in replacing the GAC media, a high single result may cause the average of the quarterly samples to be over the MCL.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval of Financing
DOE Data Requests - Set 2

Date Request Received: 8/6/2024	Date of Response: 8/16/24
Request No. Department 2-14	Witness: Chris Countie

REQUEST:

Ref: Response to DR 1-14

Will engineering/design of the project be the responsibility of CDM Smith, internal Pennichuck staff, a combination of the two, or other? Please explain.

RESPONSE:

The engineering/design of the project will be a joint effort of the team from CDM Smith and the Company's engineering and operating staff. Monthly progress meetings are planned with significant input from the Company's team at all levels of design.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 3

Date Request Received: 8/29/2024	Date of Response: 9/5/24
Request No. Department 3-1	Witness: Chris Countie

REQUEST:

Ref: Company Response to DOE DR 1-2, PWW Evaluation of Chemical Storage and Feed Systems, prepared by CDM Smith, Bates Page 86

It appears that the most recent design iteration included in the CDM Smith Evaluation is titled, "Finalized Conceptual Design of Chemical System Upgrades – September 2023."

a) Please indicate if there has been any additional formal update to the project since that time. b) If yes, please provide that update and please summarize any significant design changes that are contained in that update.

RESPONSE:

a) & b) There has been no formal update on this project. A design "kick off" meeting was held on August 8, 2024. At that meeting, it was agreed that the project will move forward as originally, conceptually identified in the above referenced document.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 3

Date Request Received: 8/29/2024
Request No. Department 3-2

Date of Response: 9/5/24
Witness: Chris Countie

REQUEST:

Ref: August 28, 2024 Technical Session; and Company Response to DOE 1-15
The Company indicated that the expansion of the water treatment facility (WTF) that is the subject of the instant financing petition will encompass two construction seasons: 2025 and 2026.

a) If construction is to begin in 2025, what is the timeline by which the Company anticipates completing the design portion of the project; and
b) In light of the Company's intention to utilize the QCPAC mechanism for recovery of the project's costs, would the Company be amenable to providing detailed reports regarding the WTF project as part of its required QCPAC annual filings and updates, including both a narrative summary and financial summary of the status of this project?

RESPONSE:

a) The design process will move forward with the following milestones:
   a. 30% Design: 10/11/24
   b. 60% Design: 11/22/24
   c. 90 % Design: 1/17/25
   d. 100% Design: 3/28/25

b) The Company has no objections to this request and will include a project summary in its 2025 and 2026 QCPAC filings, as requested.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 3

Date Request Received: 8/29/2024
Request No. Department 3-3

Date of Response: 9/5/24
Witness: Chris Countie

REQUEST:

Ref: Company Responses to DOE DR 1-5, DR 1-9 (e), and DOE DR 2-13:
In the response to DR 1-9 (e), the Company anticipated minimal impact on ferric chloride storage needs going forward as a result of new, lower Federal standards for PFOA and PFOS. In the response to DOE DR 2-13, the Company anticipated maintaining low levels of those chemicals in the treated water leaving the water treatment facility going forward. In the response to DOE DR 1-5, the Company indicated the Merrimack River (MR) became a co-primary source of supply to the Pennichuck Brook Reservoir system (PBR) in 2020. The CDM Smith Evaluation was issued in May
2023. The new, lower Federal standards were promulgated in March 2023, and became effective in June 2024. In these regards, please indicate:

a) The total gallons obtained from each source (PBR and MR) by year, from 2020 to present; and b) The extent to which use of the MR is expected to increase even further as a result of the new
Federal standards imposed this year; and

c) The extent to which any increase in ferric chloride demand resulting from increased usage of MR water going forward was considered in the CDM Smith Evaluation regarding the sizing of storage tanks for that chemical. Please include the relevant page number to the CDM Smith
Evaluation;

d) The extent to which any increase in ferric chloride demand resulting from increased usage of MR water going forward has been considered subsequent to the CDM Smith Evaluation; or is otherwise accommodated by the building design itself.

RESPONSE:

a) Total annual withdrawals in millions of gallons (MG), from the MR and PBR since 2020 are as follows:

Year:	PB (MG)	MR (MG)
2020	1,909.02	3,082.42
2021	410.18	4,349.52

2022	1,165.31	4,450.15
2023	1,232.1	3,518.26
2024 through 7/31	256.01	2,660.047

b) The Company anticipates that the future withdrawals will vary as they have since 2020. The Merrimack River pumping station has a mechanical limitation of 20 million gallons per day. There may be times when the system demand is greater than this limitation and consequently, more water will be withdrawn from the PBR to account for the deficit. Mechanical failure of components at the pumping station, rapid deterioration of water quality necessitating the elimination of the use of the MR, icing of the intake structure and other factors yet to be experienced may account for variations in supply usage. The Company will endeavor to maximize the utilization of the MR.

c) CDM Smith evaluated historical trends in ferric chloride usage and forecasted future utilization in their conceptual design. This is discussed in The Report (provided previously as Exhibit DOE DR 1-1), Section 2.3.2, pp. 2-12 through 2-14.

d) There has been no further evaluation (inclusive of chemical usage data) since The Report was finalized. The conceptual design for ferric chloride storage and chemical pump capacity is based on the linear regression of historical data shown in The Report (Exhibit DOE DR 1-1), Table 2-7, p. 2-14 which projects dosing rates until 2042.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 3

Date Request Received: 8/29/2024	Date of Response: 9/5/24
Request No. Department 3-4	Witness: Chris Countie

REQUEST:

Ref: August 28, 2024 Technical Session
During the referenced Technical Session, there was a high-level discussion regarding the Company's decision to rely on the MR for the majority of the Company's water, and the resulting increase in usage of, and future need for sodium hypochlorite and ferric chloride, which is a main subject of the instant financing petition, rather than relying on the PB. In that regard, please provide a high-level summary of the known challenges with such an approach, including but not limited to:

a) The need to replace various components of the chemical feed and storage systems, such as pumps, controllers, day tanks, etc... which are at or nearing the end of their estimated service life, regardless of water source;
b) Withdrawal limits on the Pennichuck Brook and if the Merrimack River would still need to be relied upon; as well as
c) PFAS/PFOA concerns, and
d) Some of the complexities and increased annual cost associated with an increased use of the GAC Media as the primary method to treat PFAS/PFOA.

RESPONSE:

The Company believes, based on its relatively limited experience in treating for the removal of PFAS chemicals, that choosing to utilize the MR as its predominant, primary source of supply for the near (and potentially) long term future is the most effective alternative. The PBR has significantly greater levels of PFOA than the MR. The Company's evaluation of results of water tests to determine levels of PFAS at various points in the treatment process, indicates that by utilizing the MR as much as practical, while not sacrificing other treatment goals relative to finished water quality, will maximize the adsorptive capacity or "life" of the GAC media it is already fortunate enough to have in its tool box of available treatment technologies. This fact should not be overlooked, the Company is very fortunate to have not only GAC available, but also the filter configuration that allows for enough contact time for effective adsorption of PFAS. If the facility did not have either of these, the scope of this project would be significantly different and it is safe to assume, much more costly.

The Company is confident that the higher chemical and pumping costs associated with greater use of the MR will offset the potential need of replacing the GAC media at a more frequent rate.

This cost is currently a $2.1 million dollar expense if it is to be replaced annually as predicted. Logically, by significantly reducing the concentration of the amount of PFAS to be removed, the longer the GAC media will last.

Furthermore, regardless of the source utilized, the frequency and duration of major storm events and droughts also impacts both primary supplies. Precipitation and its impact on chemical demand was discussed in The Report (Exhibit DOE DR 1-1) in Section 2.2.3, p 2-5. It's worth noting that this trend was from 2014 on, but the use of the MR as the predominant supply only began in 2020.

It has been the Company's experience that certain components related chemical feed systems will become either obsolete or generally wear out within 15 to 20 years. This of course varies with the type of equipment and the chemical it's handling. For example, components in direct contact with sodium hypochlorite tend fail sooner due to the highly corrosive nature of this chemical. Normally, these replacements are part of what the Company considers "run rate" capital improvements and would not necessarily elevate in scope to a project requiring special financing. The Company has purposely chosen to include some of this run-rate replacement in its goal of taking a holistic approach to an overall evaluation of the chemical supply facilities in all areas of the plant. This holistic approach is evident in Section 3 of The Report (Exhibit DOE DR 1-1) entitled Condition Assessment. Within this section, evaluations are made to all major components of all chemical feed systems. It's important to note that not all improvements are a part of this proposed project. Section 4.3 discusses an implementation schedule for improvements that may not occur until 2032, as noted.

DW 24-089
PENNICHUCK WATER WORKS, INC.
Request For Approval Of Financing
DOE Data Requests - Set 3

Date Request Received: 8/29/2024
Request No. Department 3-5

Date of Response: 9/5/24
Witness: Chris Countie

REQUEST:

Ref: Petition, Bates page 11 and 12
The Company stated that it believes that this financing request is routine in nature[11], specifically mentioning the insignificant impact to the monthly bill of single-family residential customers, the non- deleterious effect on the Company's debt ratio, and that this financing is to "enable numerous investments appropriate in the ordinary course of utility operations."[2] Please further explain why the investments described in the Petition are within the ordinary course of operations of a public water utility.

RESPONSE:

The primary goal of a water utility is to produce and deliver a sufficient amount of water with adequate pressure to its customers with water quality that is in compliance with the Safe Drinking Water Act water quality standards in an efficient manner. The Water Treatment Plant chemical feed replacement and expansion project is necessary to replace aging infrastructure, ensure the ability to produce sufficient quantities of water and to maintain compliance with the PFAS water quality standard. As such the WTP chemical feed replacement and expansion project is essential to Pennichuck, a public water utility, to allow it to meet its goals as a provider of Safe Drinking Water. Therefore, The Company asserts that this project falls within the ordinary course of operations of a public water utility.

The Company also asserts that its petition qualifies as a routine financing because the PFAS Remediation Loan is consistent with its overall goal of providing safe drinking water to its customers in compliance with the Safe Drinking Water which is the ordinary course for the Company's operations; the financing will have no discernible or significant impact on rates; or cause deleterious effects on capitalization for the Company.[3] The Company provided an updated rate impact of the proposed financing in response to DOE DR 2-2 which it believes is not discernible or significant impact and the financing will not otherwise impair its capitalization.

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[1] *See Appeal of Easton*, 125 N.H. 205, 211 (1984).

[2] *Pennichuck Water Works, Inc.*, Order 26,197 (December 3, 2018).

[3] See In re PSNH, Order No. 25,050 at 13 (December 8, 2009), Petition at Bates 011-012.

MEMO REPORT

Date: September 16, 2024

From: Douglas W. Brogan, P.E.

To: Jayson Laflamme, Asst. Director - Water Group, Regulatory Support Div., NH Dept. of Energy

Re: DW 24-089 Pennichuck Water Works, Inc.
Petition for Approval of Financing for Upgrades to Nashua Water Treatment Facility

I am writing this memo report as an engineering consultant to the Water Group, Regulatory Support Division to summarize my findings in the above-referenced docket. Pennichuck Water Works, Inc. (Pennichuck or Company) is requesting authority to finance up to $11,450,000 to design and construct solutions to chemical feed and storage concerns at its primary Water Treatment Facility (WTF) in Nashua. My review is limited primarily to the engineering and operational aspects of the filing, and is based on review of the filing as well as participation in case discovery and an August 28, 2024 technical session.

For background leading up to the proposed chemical feed and storage project, Pennichuck's primary water source historically was Pennichuck Brook (PB). The Company began using the Merrimack River (MR) as a secondary source in 1984, primarily to supplement PB during the higher demand summer months (MR water was pumped into the PB reservoir system). However, by 2020 two significant changes had occurred:

1) As a culmination of raw water intake, pumping and transmission main upgrades, the Company gained the ability to use the MR as an independent, year-round source directly supplying the WTF.
2) New standards were established by the State of New Hampshire for PFAS[1]. Testing revealed two of the PFAS chemicals (PFOA[2] and, to a lesser extent, PFOS[3]) to be of concern; and that PFAS levels were significantly higher in PB than in the MR - see table below (MCL is Maximum Contaminant Level, the highest level allowed by the applicable drinking water standard; values are in parts per trillion).

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[1] Per- and Polyfluoroalkyl Substances.

[2] Perfluorooctonoic Acid.

[3] Perfluorooctane Sulfonic Acid.

	PFOA	**PFOS**
State of NH MCL (2020)[4]	12	15
Average Levels in Pennichuck Brook[5]	15.6	4.11
Average Levels in Merrimack River[6]	2.87	3.82
New Federal MCL (2024, see below)	4	4

Pennichuck is fortunate in that the Nashua WTF already incorporated Granular Activated Carbon (GAC) as part of its treatment train in a configuration making it very effective in removing PFAS. However, the Company has estimated that continued use of PB as its primary source would exhaust the GAC two to three times more quickly than use of the MR due to the former's higher PFAS levels. This would require a comparable increase in the frequency of GAC change-outs at a cost of $2.1 million each. New federal PFAS standards noted in the table above will only exacerbate this reality.[7] As a result, Pennichuck has used the MR as its primary source from 2020 onward. However, both sources will continue to be required to meet peak demands and other contingencies for the foreseeable future.[8]

As a result of the impact of drought and storm activity affecting both sources, the more variable water quality of the MR compared to PB, and other factors, use of the coagulant ferric chloride has increased over time. This, combined with Covid-related delivery issues, led to a near crisis in ferric chloride availability in 2022. Also by that time, certain chemical feed and storage systems in the WTF were approaching the end of their useful lives, had become strained in their capacity to meet demands, or both. These chemicals are critical to the delivery of drinking water. As a result, the Company engaged a consultant (CDM Smith) through a thorough RFP process to undertake a comprehensive review of these systems.[9]

CDM Smith has worked closely with the Company to consider aspects such as:

- Historic and projected demands in relation to the half dozen or so primary chemicals used in the WTF.
- Chemical storage and feed equipment capacity and condition.
- The ability to accommodate standard bulk delivery volumes.
- The continued use of equipment with remaining service life.
- Safety and supply chain concerns.

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[4] DOE 1-9 a. Discovery responses are referenced herein in the form the requests were issued (DOE x-x) as opposed to the form in which they were responded to by the Company (Department x-x).

[5] Testimony of Christopher J Countie, Bates p. 43, lines 8-9.

[6] Countie testimony, Bates p. 43, lines 12-13.

[7] See Countie testimony at Bates p. 43 and responses to DOE 1-9 e and DOE 3-4 for a discussion of these issues.

[8] The MR has accounted for an average 83 percent of source water from 2021 to present (DOE 3-3 a).

[9] The result, a May 2023 CDM Smith report with updates through September 2023, was provided in response to DOE 1-2.

- The ability to maximize or re-use space within the existing building to limit the size of a new facility.
- Whether additional storage could best be accommodated in an attached vs a standalone building.

Based on this evaluation, the Company is proposing to add new storage for two chemicals, ferric chloride and the primary disinfectant sodium hypochlorite, in a new building adjacent to the WTF. The project includes needed upgrade of pumps and other equipment as well. The Company is continuing to assess various aspects of the proposal, with design refinements continuing through March 2025.[10] Construction is anticipated to begin in 2025 and be completed in 2026.

Pennichuck has received loan approval from the New Hampshire Department of Environmental Services, the agency responsible for oversight of such projects, through the PFAS Remediation Grant and Loan Fund. The Company has noted that the program's funds are competitively awarded based on project need and merit.[11]

In conclusion, I believe the Company has taken necessary and prudent steps in addressing notable chemical feed and storage concerns in its Nashua WTF. In this regard I would support the Company's request to secure the proposed financing.

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[10] DOE 3-2 a.

[11] DOE 1-14 a.