CADMUS Jacobs

Preliminary Engineering Report

Sterling, Connecticut

Revision: Draft

July 8, 2025

Professional Engineer's Certification

I certify that this document was prepared by me or under my direct control and personal supervision, based on knowledge and information in general accordance with commonly accepted standards of practice. This certification is not a guarantee or warranty, either expressed or implied.

REPLACE WITH SIGNED PAGE

Commented [JP1]: This page will be signed and stamped on the final version.

(Signature and stamp here)

Russell Ford
No. (######)

Date:

Contents

Appendices

Tables

Figures

Acronyms and Abbreviations

Acronym	Definition
CT	Connecticut
CT DEEP	Connecticut Department of Energy & Environmental Protection
CT DPH	Connecticut Department of Public Health
EC	Evaluation Criterion
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
gpm	gallons per minute
MGD	million gallons per day
NDDB	Natural Diversity Database
NPV	Net Present Value
O&M	operations and maintenance
PER	Preliminary Engineering Report
ROW	Right-of-Way
SPPW(S)	Single Payment Present Worth of the Salvage Value
USGS	United States Geological Survey
USPW(O&M)	Present Worth of Uniform Series of Annual O&M Costs

1 Project Planning

This Project Planning section describes the area under consideration and discussed in a) Location. The description includes information on the project purpose, location, environmental resources present, population trends, and community engagement.

The Town of Sterling has experienced issues with discolored water, due to elevated iron and manganese levels from all three supply wells. The main purpose of this project is to improve the water quality for Sterling in regard to iron and manganese. Sample results from 2020 indicate iron and manganese concentrations above the Connecticut Department of Public Health (CT DPH) secondary goal of 0.3 mg/L and CT DPH action level of 0.3 mg/L, respectively. Options include the installation of a new treatment system to remove iron and manganese from the raw water at their existing wells, and regionalizing with Connecticut Water, a public water utility operating system near Sterling, with the intent to purchase wholesale water to serve the residents of Sterling.

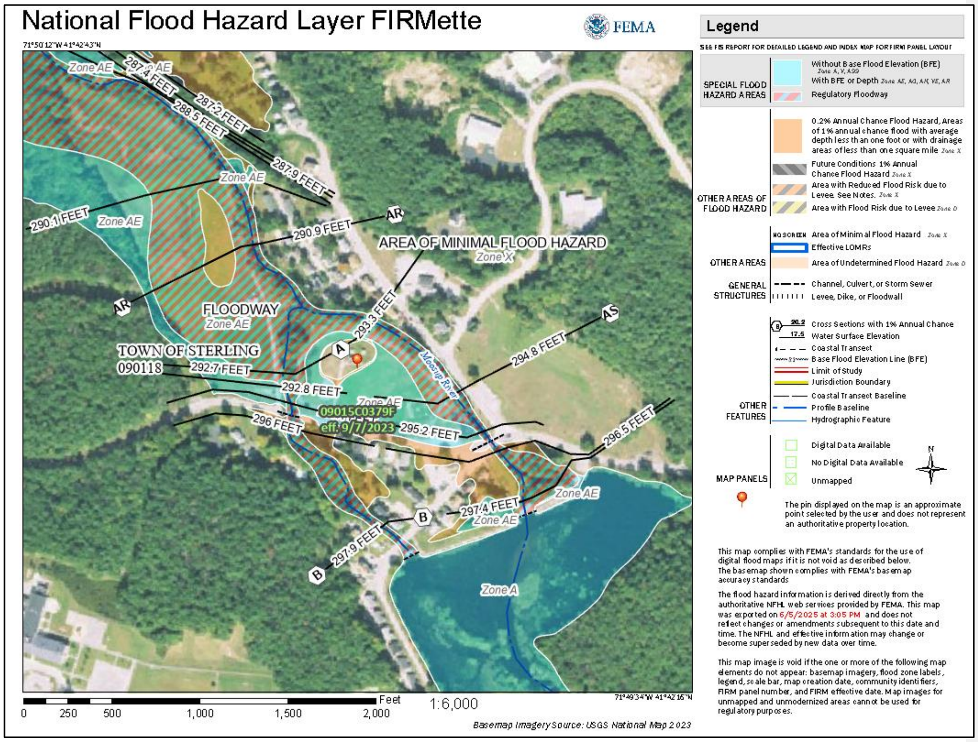
1.1 Location

The Town of Sterling is in Windham County, Connecticut. The project area lies within the Oneco quadrangle. A 7.5-minute topographical map of the quadrangle provided by the United States Geological Survey (USGS) is provided in Appendix A. The center of Sterling has a latitude of approximately 41.707517 and a longitude of -71.829093. Sterling is located on moderately hilly terrain and has an average elevation of 431 feet.

1.2 Environmental Resources Present

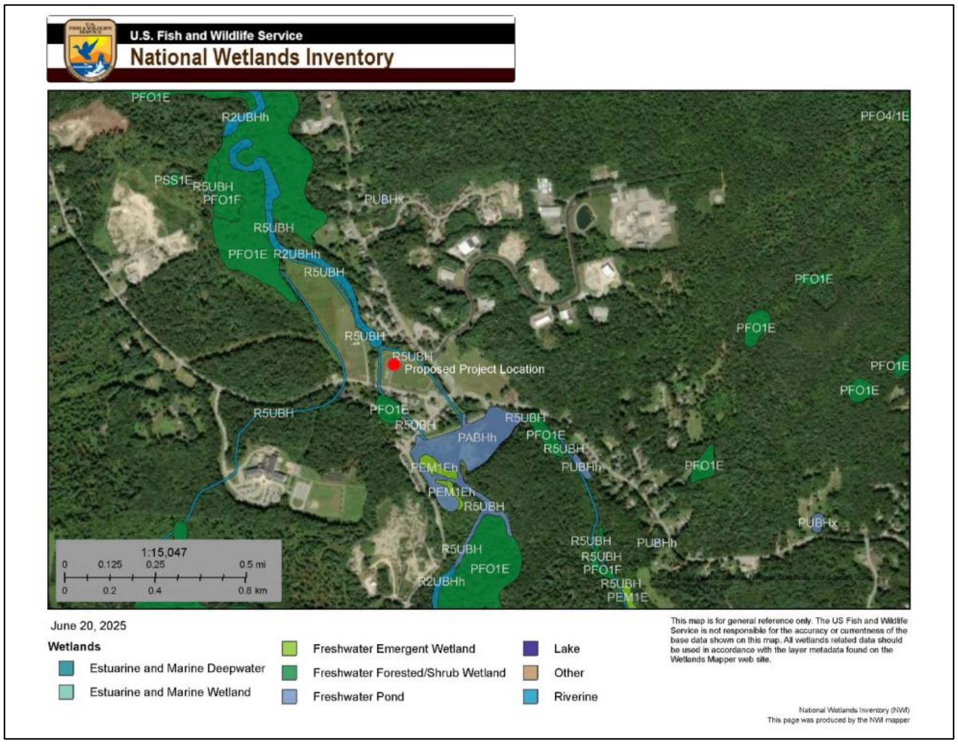
National Flood Hazard Layer Flood Insurance Rate Maps (FIRMettes) for the project area is included as Figure 1-1. The location for the proposed project is at the same site as the wells (i.e., 304 Sterling Road) and is located in an AE Flood Zone (according to the Federal Emergency Management Agency, FEMA). The GPS Coordinates for this location are 41.7082381, -71.8308273,21 (Figure 1-1).

Figure 1-1. FEMA Flood Zone Map for Proposed Location (304 Sterling Road)



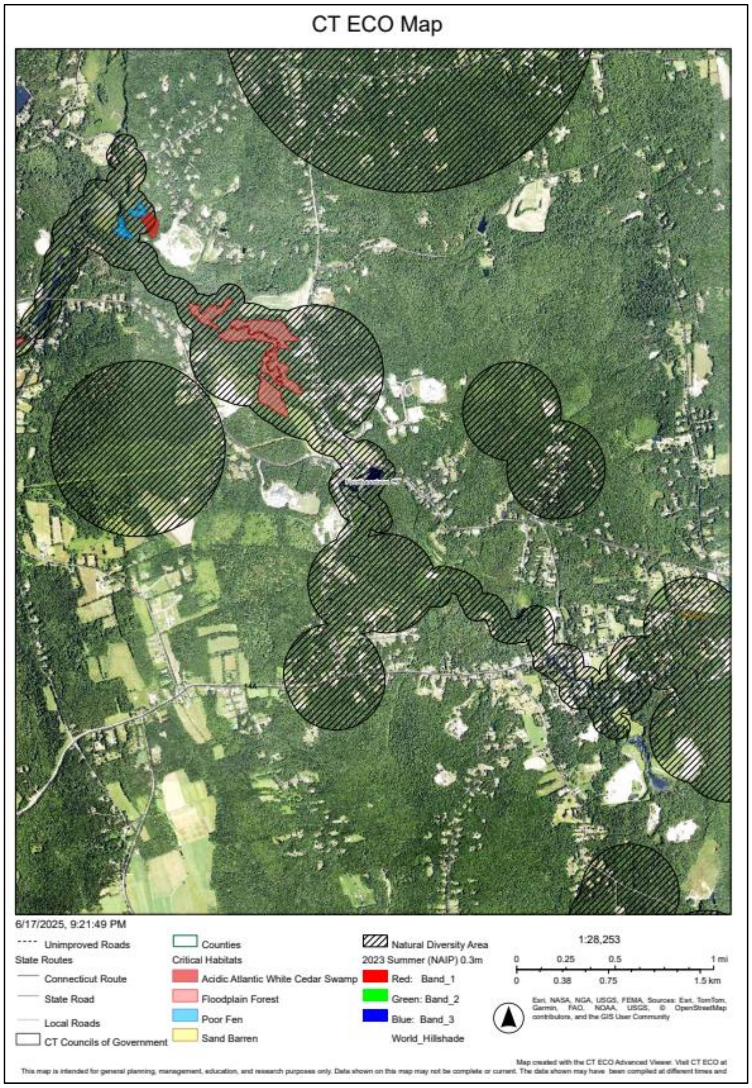
Sterling has freshwater wetlands that run through the center of town along the Moosup River, as shown in Figure 1-2, a June 2025 map of the U.S. Fish and Wildlife Service National Wetlands Inventory. The proposed project location is marked on the map and is located outside of a wetland resource area.

Figure 1-2. National Wetlands Inventory (United States Fish and Wildlife)



Connecticut Department of Energy & Environmental Protection's (CT DEEP's) Natural Diversity Database (NDDB) for State Listed Species, shown for the potential project locations in Figure 1-3 as reviewed for the potential project areas. The potential project location is within areas flagged by CT DEEP as containing state or federal listed species or significant natural communities. The proposed project is anticipated to be located within previously disturbed areas. It is not anticipated that impacts to wetlands, farmland, historic resources, or endangered species will be part of the project. Specific environmental impacts for each alternative, if any, are discussed further in Section 4.

Figure 1-3. Map of Sterling Natural Diversity Areas (Connecticut Department of Energy & Environmental Protection, Natural Diversity Database)



1.3 Population Trends

The population served by the Sterling Water System (approximately 308 residents) is a fraction of the overall population of Sterling (3,688, based on projections of the latest US Census estimate (released May 2024)). The water system population has remained relatively stable over the past 10 years, and expansion of the water system has not been considered.

1.4 Community Engagement

Sterling has been actively engaged throughout the development of this Preliminary Engineering Report (PER). The PER was developed through a process of technical assistance as part of the U.S. Environmental Protection Agency's (EPA's) WaterTA program. After the initial request for technical assistance was submitted to the EPA, multiple coordination meetings were held to gain an understanding of the water system's needs and goals for this project. Monthly meetings were held with water system representatives throughout the PER development process to confirm their agreement with the evaluation's direction and to make any adjustments as needed to better accommodate Sterling's needs. A site visit was conducted on April 16, 2025, to meet with water system representatives in-person to gather relevant information for the development of this PER. Additionally, a public meeting is scheduled to be conducted on August 27, 2025, with Town of Sterling City Council representatives to gather feedback, address concerns, and answer questions about the project. Historically, Sterling has logged meeting minutes and customer complaints about discolored water. Water quality, flushing, and the potential for a filtration system or other options have been discussed at regular Water Pollution Control Authority meetings. Water system customers are encouraged to provide written complaints to the First Selectman's office and the WPCA in order to provide documentation of any issues.

Commented [EL2]: Sterling is looking for additional information on community engagement including any meeting dates, feedback, when flushing began, etc.

2 Existing Facilities

This section includes an account of the existing facilities including a location map, a brief history and description of the existing condition and financial status of the water system, and discussion of available water and energy audits.

2.1 Location Map

Sterling is on the eastern border of Connecticut. Figure 2-1 shows the boundaries of the town. Sterling's water system serves a small, central portion of the Town with potable water. There are currently 110 service connections, with some properties having more than one meter. Table 2-1 provides a breakdown of the number and types of properties within the service area. Additional properties in Sterling rely on private wells and are not included in this summary.

Figure 2-1. Town of Sterling

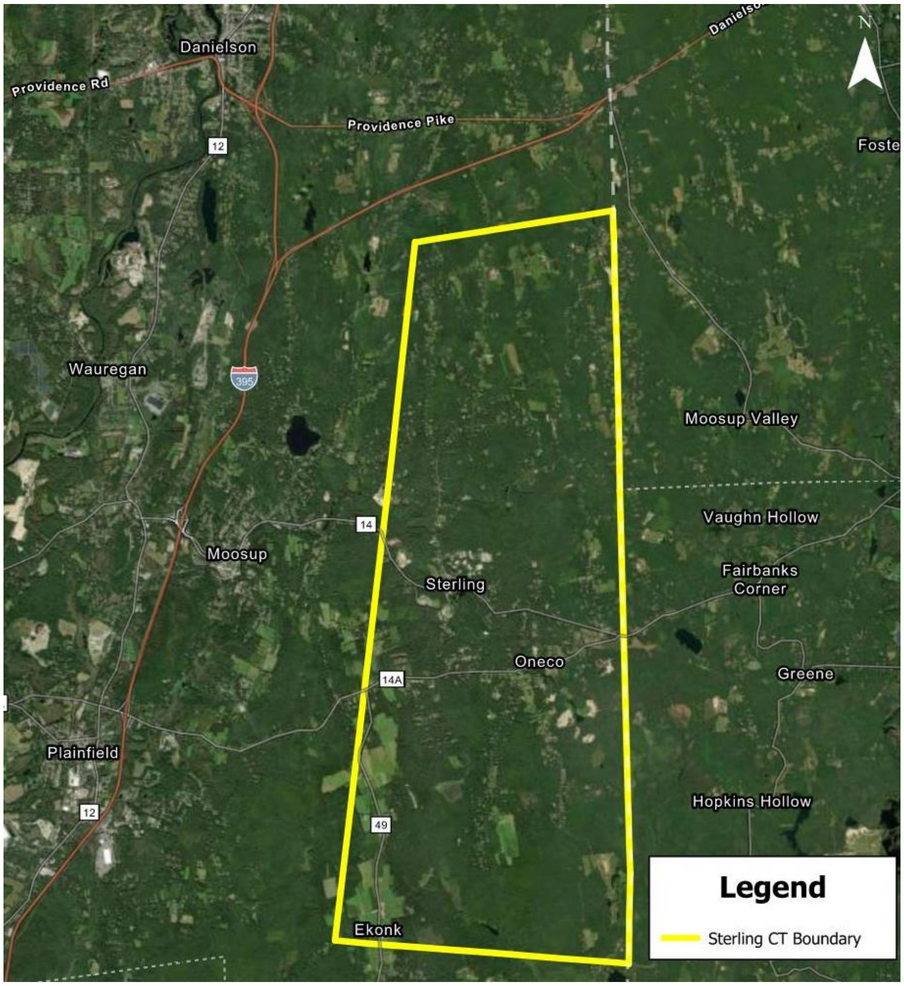


Table 2-1. Service Connection Types

Zoning Classification	Property Type	Quantity
Residential	Single Family	15
	Duplex	27
	Four Family	5
	Seven Family	1
	Single-Family Condo	33
Mixed Use	Single Family/Commercial	1
	Five Family/Office Space	1
Church		2
Commercial	Restaurant/Pub	1
	Post Office	1
	Social Club	1
Industrial		10
Municipal	Pre-K through 8th Grade School	1 (Approx. 375 students)

2.2 History

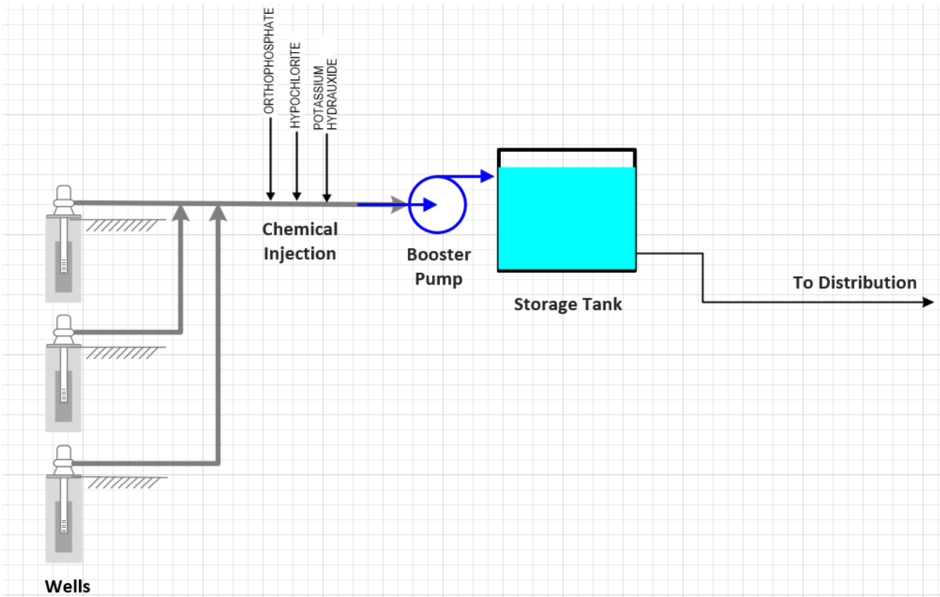
Sterling's water system was originally constructed in 1987. It was designed to serve the Sterling's industrial park as well as nearby municipal and residential buildings. In 2014, the largest industrial user, a tire-burning facility, shut down their facilities. This facility used a considerable amount of the Sterling's average daily water demand. As a result, the Sterling's average daily water consumption decreased dramatically upon closure of the facility. The water system continues to function to-date with the lower demand; however, the system continues to struggle with high levels of iron and manganese.

2.3 Condition of Existing Facilities

Sterling's water system is composed of three gravel-packed groundwater wells. Well #1A is the primary source, while wells #2 and #3 serve as backups. Well #1A has a life expectancy of 37 years and both backup wells have over 10 years of life expectancy. The water treatment system, upgraded in 2023, is in good condition and utilizes potassium hydroxide, chlorine, and phosphate for pH adjustment, disinfection and corrosion control. The system also includes one 400,000-gallon water storage tank, and water distribution piping ranging in size from 8- to 12-inch diameter. The distribution piping consists of primarily dead-end segments. The limited looping of the piping, combined with lower demand than the system was designed for, is resulting in water age issues. Residents have raised concerns about discolored water, especially towards the end of distribution system mains. Sterling's water system is currently operated by White Water.

Figure 2-2 is a schematic of the treatment process.

Figure 2-2. Process Flow Diagram for Sterling System



2.4 Financial Status of any Existing Facilities

Sterling's water system is owned and maintained by the Town of Sterling. The Town has contracted White Water, a contract operator, for maintenance and operation of the system.

2.5 Water / Energy / Waste Audits

Sterling has not conducted any formal audits on the water system; however, a Consumptive Diversion Water Use Reporting Form was submitted for the 2024 calendar year documenting daily water consumption for the entire system. The data confirms that the system is withdrawing an average daily demand of 0.046 million gallons per day (MGD) and a maximum daily demand of 0.095 MGD, which are both significantly less than the maximum authorized daily volume of 0.149 MGD.

3 Need for Project

This section describes the needs that the project will address, including health, sanitation and security, aging infrastructure, and reasonable growth needs.

3.1 Health, Sanitation, and Security

Sterling produces water from three wells; Well 1A is the primary well, while Wells 2 and 3 are backup wells. Additionally, Sterling operates a 400,000-gallon storage tank that provides storage for both peak domestic demands and fire protection.

In October 2020, Sterling hired Haley Ward, Inc. (previously known as Lenard Engineering, Inc.) to conduct raw water sampling at the three wells. Table 3-1 provides the results. Note that the EPA set the secondary maximum contaminant level for iron at 0.3 milligrams per liter (mg/L), and manganese at 0.05 mg/L. The Connecticut Department of Public Health (CT DPH) set the action level of manganese at 0.3 mg/L.

Table 3-1. Iron and Magnesium Levels in Sterling Wells (2020)

Well	Iron (mg/L)	Manganese (mg/L)
1A	0.056	1.95
2	1.25	1.03
3	1.1	0.62

mg/L = milligrams per liter

While the system was able to address the discolored water by flushing the system (which is now done twice a year), the sampling information indicates that the manganese levels in all three wells exceeded the CT DPH action level of 0.3 mg/L. In addition to the aesthetics of these levels of manganese (e.g., metallic-tasting water, black stains on tubs and toilets), such levels can also lead to serious health effects. According to CT DPH, high concentrations of manganese in drinking water may or may not cause harm to the nervous system (Connecticut Department of Public Health, n.d.d.)

In addition, the data also indicates that the iron levels in Wells 2 and 3 exceeded the CT DPH Secondary Goal of 0.3 mg/L. While concentrations above this level are not linked to health effects, higher iron levels may cause discoloration. Sterling plans to address these levels of manganese and iron to provide residents with safe drinking water and protect public health.

3.2 Aging Infrastructure

Sterling has three 12-inch gravel pack wells (i.e., Well 1A, Well 2, and Well 3). Well 1A was originally installed in 1990, and the pump is original, but the well was rehabilitated in 2022 and has an estimated 37 years of remaining service life. The Well 1A lineshaft turbine pump was installed in 1990 and is in good condition, but it is 15 years past its estimated service life expectancy and is likely to fail. Wells 2 and 3, the backup wells, were both built in 1987 and have an estimated two years of remaining service life. If Wells 2 and 3 were to fail, the Sterling would not have a backup to Well 1A. The 30-horsepower submersible pumps for Wells 2 and 3 were installed in 2017 and 2021 and have an estimated 12 and 16 years of remaining service life expectancy, accordingly. Most of the distribution system is reported to be ductile iron piping, installed in the 1980s.

3.3 Reasonable Growth

Growth and future demand are not drivers for this project, but to ensure the residents that currently live there can stay and prosper, Sterling needs to address the water quality to provide safe drinking water.

4 Alternatives Considered

In this evaluation, three alternatives were considered to identify the most favorable solution to meet Sterling's drinking water quality needs, including the following:

- Alternative 0: No action
  - This Preliminary Engineering Report does not include a "No Action" option, as the project is to evaluate options that resolve the discolored water issue and provide safe drinking water to the community. Alternative 1 is a simple adjustment without land disturbance, and Alternatives 2 and 3 both involve modifications or upgrades to the current water treatment system.
- Alternative 1: New Treatment – Sequestration
  - Install on top of current treatment process. This is a common method to address drinking water with elevated concentrations of iron and manganese. Iron and manganese levels must not exceed established concentrations in order for the sequestering agent to be effective. EPA identifies the effective concentration limits as twice the Secondary Maximum Contaminant Levels.
- Alternative 2: New Treatment – Oxidation and Filtration
  - Install oxidation and filtration to the existing treatment process for iron and manganese removal. A waste holding tank also needs to be installed.
- Alternative 3: Regionalization
  - Install an interconnection and transmission main from Connecticut Water's distribution system in Moosup to the central point of Sterling's water system; purchase wholesale treated water from Connecticut Water.

4.1 Alternative 1 – New Treatment – Sequestration

Sequestration is a treatment method commonly used for addressing elevated iron and manganese by adding sequestering agents to the water source. These agents bind metals and keep them in a soluble state, preventing precipitation and oxidation. A common sequestering agent is a polyphosphate or a blended ortho/polyphosphate. Typically, water systems can use a sequestering agent for manganese levels up to twice the Secondary MCL. The EPA Secondary MCL for manganese is 0.05 mg/L, and a sequestering agent would be effective for manganese levels up to 0.1 mg/L. Since manganese concentrations in Sterling's raw water samples exceed 0.6 mg/L, a sequestering agent would most likely be ineffective. Therefore, Alternative 0 is determined to be technically infeasible.

The most recent sampling report, dated May 22, 2025, and included in Appendix C, indicated that the total iron for the active well (Well 1) is 0.471 mg/L and the manganese is 1.89 mg/L. The other two backup wells have similar or higher values. While the iron present in Well 1 is lower than the sequestration effective limit, the two inactive wells show a total iron concentration above 1 mg/L. Additionally, the manganese value in Well 1 is significantly above the 0.1 mg/L sequestration limit, hindering the efficacy of the agent. Therefore, a full evaluation was not conducted for this alternative.

4.2 Alternative 2 – New Treatment – Oxidation and Filtration

4.2.1 Description

To meet the EPA Secondary Maximum Contaminant Levels for iron and manganese, as well as CT DPH action levels for manganese, oxidation and filtration treatment is proposed as an alternative. The proposed treatment includes upstream oxidant injection and filter vessels with Greensand Plus, to be placed near the existing well houses in a new building. A waste-holding tank will also be included in this treatment alternative for equalizing the wastewater from filter backwashing before it gets discharged into the municipal sewer.

4.2.2 Design Criteria

In this alternative, design criteria were developed and compared to two different flow rates listed in Table 4-1 and Table 4-2.

Well #1A has the highest instantaneous flow rate of 350 gpm, which is typically considered as the designed flow.

However, based on the 2024 daily water consumption mentioned in section 2.5, the system is withdrawing an average daily demand of 0.046 million gallons per day (MGD) and a maximum daily demand of 0.095 MGD. The maximum authorized daily volume is 0.149 MGD.

To meet the daily demand, the treatment design can either size a larger flowrate running for a short period time of time or a smaller rate with longer running time per day. The two designed flowrates are:

1. 350 gpm (roughly 0.5 MGD) running for 5hrs, this would produce 105,000 gpd, covering the maximum daily demand.
2. 100 gpm (roughly 0.149 MGD) running for 18hrs, which produces 108,000 gpd, also covering the maximum daily demand.

Table 4-1. Flow Rate at the Maximum Pump Draw Rate (350 gpm) Running for 5 Hours Daily

Design Criteria	Value
Maximum design flow rate	350 gpm or 0.5 MGD
Vessel dimensions (D x H)	8-foot diameter, 11-foot height
Number of filters	1 active filter + 1 standby filter
Filter Run Time	5 hours
Media Type	Greensand Plus
Total Media Depth	42 inches

Design Criteria	Value
Oxidation chemical	12.5% hypo @ 2 mg/L
Backwash Supply Hydraulic Loading Rate	15.0 gpm/square foot
Backwash Duration (per filter)	15 minutes
Filter to Waste	Yes
Filter to Waste Duration	10 minutes

gpm = gallons per minute

Table 4-2. Flow Rate at the Average Pump Draw Rate (100 gpm) Running for 18 hours daily

Design Criteria	Value
Maximum design flow rate	100 gpm or 0.15 MGD
Vessel dimensions	6-foot diameter, 9-foot height
Number of filters	1 active filter + 1 standby filter
Filter Run Time	18 hours
Media Type	Greensand Plus
Total Media Depth	42 inches
Oxidation chemical	12.5% hypo @ 2 mg/L
Backwash Supply Hydraulic Loading Rate	15.0 gpm/square foot
Backwash Duration (per filter)	15 minutes
Filter to Waste	Yes
Filter to Waste Duration	10 minutes

4.2.3 Map

The new treatment would be constructed at the existing well site as shown in Figure 4-1.

Figure 4-1. Alternative 2 Map

4.2.4 Environmental Impacts

The proposed location for the treatment building is adjacent to the well houses. The site is within the flood plain, and flooding has been reported in recent years. Similar to the well houses, the treatment building construction will be located on the mound that is above the floodplain elevation.
No environmental impacts are anticipated for the construction.

4.2.5 Land Requirements

The new treatment building is proposed to be constructed within the existing well house area that the Sterling, and limited piping is needed. No additional land acquisition is required for this treatment alternative.

4.2.6 Potential Construction Problems

At this stage of conceptual planning, there are no anticipated construction problems for this alternative. As detailed design progresses, a constructability assessment will be conducted to ensure the design can be feasibly implemented.

4.2.7 Sustainability Considerations

This project will promote sustainability by implementing efficient technology in the proposed treatment plan. Specific sustainability measures would be identified as the project progresses to detailed design.

4.2.7.1 Water and Energy Efficiency

At this conceptual level, water and energy efficiency measures have not been incorporated into the project. As the project progresses, energy efficiency measures will be applied to the design of individual components where applicable, such as filter vessels.

4.2.7.2 Green Infrastructure

At this conceptual level, green infrastructure has not been incorporated into the project. As design progresses, green infrastructure concepts will be applied for stormwater management if needed.

4.2.7.3 Other

Not applicable.

4.2.8 Cost Estimates

Commented [EL3]: Jacobs is updating this section using information from the March 2025 costs from Haley Ward.

Table 4-3 and Table 4-4 show the estimated construction cost for Alternative 2 at a design flow rate of 350 gallons per minute (gpm) and 100 gpm. These costs include a new filtration system, new chemical feed system, and new backwash waste holding tank.

Table 4-3. Construction Cost – Design Flow Rate @ 350 gpm

Project Component	Cost	
New Filtration System	$1,525,000	
New Chemical Feed system	$630,000	
Backwash Waste Holding Tank	$90,000	
SUBTOTAL - PROJECT COST	**$2,245,000**	
ADDITIONAL PROJECT COSTS:		
Demolition	1%	$30,000
Overall Sitework:	2%	$50,000
Plant Computer System[a]:	2%	$50,000
Yard Electrical and piping[b]:	6%	$140,000
SUBTOTAL w/o Markups	**$2,515,000**	
CONTRACTOR COSTS:		
Mobilization/Demobilization	5%	$130,000
Overhead and General Admin	10%	$260,000
Profit	10%	$260,000

Project Component	Cost	
Bond & Insurance	2%	$60,000
TOTAL CONSTRUCTION COST w/ MARKUPS	**$3,225,000**	
Local Adjustment Factor	106	$3,420,000
Design Contingency	30%	$1,026,000
TOTAL ESTIMATED CONSTRUCTION COST	**$4,446,000**	

Table 4-4. Construction Cost – Design Flow Rate @ 100 gpm

Project Component	Cost	
New Filtration System	$1,223,000	
New Chemical Feed system	$630,000	
Backwash Waste Holding Tank	$90,000	
SUBTOTAL - PROJECT COST	**$1,943,000**	
ADDITIONAL PROJECT COSTS:		
Demolition	1%	$20,000
Overall Sitework:	2%	$40,000
Plant Computer System[a]:	2%	$40,000
Yard Electrical and piping[b]:	6%	$120,000
SUBTOTAL w/o Markups	**$2,163,000**	
CONTRACTOR COSTS:		
Mobilization/Demobilization	5%	$110,000
Overhead and General Admin	10%	$220,000
Profit	10%	$220,000
Bond & Insurance	2%	$50,000
TOTAL CONSTRUCTION COST w/ MARKUPS	**$2,763,000**	
Local Adjustment Factor	106	$2,930,000
Design Contingency	30%	$879,000
TOTAL ESTIMATED CONSTRUCTION COST	**$3,809,000**	

4.3 Alternative 3 – Regionalization

4.3.1 Description

In this alternative, Sterling's wells would be decommissioned. A new interconnection would be installed to tie the distribution system into the Connecticut Water distribution system in the neighboring town of Moosup. A new transmission main would be installed from the interconnection point in Moosup to a new booster pump station located at the well site in Sterling. The booster pump station would be located at the existing well site to pump the water up the hill to fill the existing water storage tank. The distribution system would continue to operate off the existing water storage tank. Discussions between Sterling, the Town of Moosup, and Connecticut Water would be needed before implementing this alternative.

4.3.2 Design Criteria

Table 4-5 summarizes the construction components.

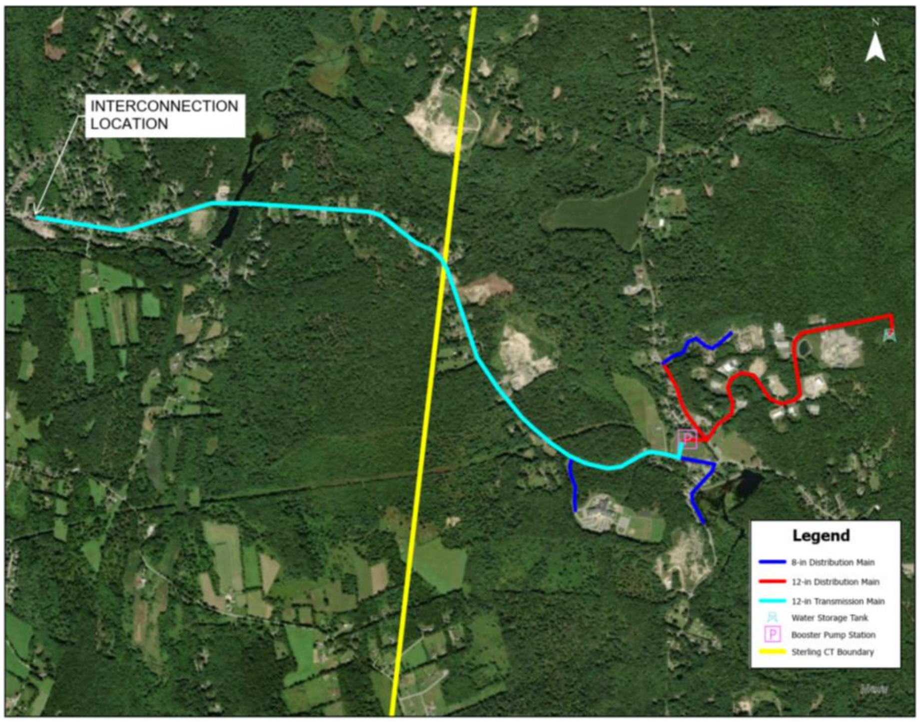
Table 4-5. Alternative 3 Construction Components

Item	Unit	Quantity
Furnish and Install new 12-inch Transmission Main	Linear Feet	13,000
Furnish and Install Interconnection Meter	Each	1
Furnish and Install a 0.5 MGD Booster Pump Station	Each	1

4.3.3 Map

Figure 4-2 represents the map for Alternative 3 illustrating a proposed interconnection with Moosup**,** including a preliminary route for a 12-inch transmission main with connection to Sterling's existing 12-inch transmission main.

Figure 4-2. Alternative 3 Construction Components



Commented [EL4]: Jacobs to add booster station to Figure 4-2

4.3.4 Environmental Impact

The proposed location for the pump station is within the flood plain, however similar to the existing well site, the pump station would be located on the mound above floodplain elevation. It is not anticipated that the construction of the transmission main would have environmental impacts, as it would be located entirely within the right-of-way.

4.3.5 Land Requirements

The land requirements for this alternative are minimal since all piping would be located within the right-of-way underneath the road. The new pumping station would be located on the existing well site; therefore, no additional land would need to be acquired by Sterling.

4.3.6 Potential Construction Problems

At this stage of conceptual planning, there are no anticipated construction problems for this alternative. As detailed design progresses, a constructability assessment will be conducted to ensure the design can feasibly be implemented.

4.3.7 Sustainability Considerations

This project will promote sustainability by implementing efficient technology in the proposed pump station. Specific sustainability measures would be identified as the project progresses to detailed design.

4.3.7.1 Water and Energy Efficiency

At this conceptual level, water and energy efficiency measures have not been incorporated into the project. As the project progresses, energy efficiency measures will be applied to the design of individual components where applicable, such as the booster pump station.

4.3.7.2 Green Infrastructure

At this conceptual level, green infrastructure has not been incorporated into the project. As design progresses, green infrastructure concepts will be applied for stormwater management if needed.

4.3.7.3 Other

Not applicable.

4.3.8 Cost Estimate

Table 4-6 shows the estimated construction cost for Alternative 3. In this alternative, the interconnection and the transmission main would be installed along with all appurtenances. These costs include all fittings, hydrants, valves, trenching, paving, and surface restoration associated with the transmission main installation.

Table 4-6. Alternative 3 Construction Costs

Project Component	Cost
Furnish and Install 12-in Transmission Main (Including Interconnection)[a]	$3,775,000
Furnish and Install Booster Pump Station	$1,639,000
SUBTOTAL - PROJECT COST	**$5,414,000**

Project Component	Cost	
ADDITIONAL PROJECT COSTS:		
Demolition	1%	$60,000
Overall Sitework	2%	$110,000
Yard Electrical and piping	6%	$330,000
SUBTOTAL w/o Markups	**$5,914,000**	
CONTRACTOR COSTS:		
Mobilization/Demobilization	5%	$300,000
Overhead and General Admin	10%	$600,000
Profit	10%	$600,000
Bond & Insurance	2%	$120,000
TOTAL CONSTRUCTION COST w/ MARKUPS	**$7,534,000**	
Local Adjustment Factor	106	$7,990,000
Design Contingency	30%	$2,397,000
TOTAL ESTIMATED CONSTRUCTION COST	**$10,387,000**	

[a] Cost includes all valving, fittings, trenching, paving, and surface restoration

5 Selection of an Alternative

The selection of an alternative is the process by which data from Section 4 are evaluated in a systematic manner to identify a recommended alternative. The evaluation includes consideration of both life cycle costs and non-monetary factors that are described in this section.

5.1 Life Cycle Cost Analysis

Commented [EL5]: Jacobs to update cost information.

A life cycle cost analysis was conducted for Alternatives 2 and 3. The analysis is based on the Net Present Value (NPV) calculated with capital cost, annual operations and maintenance (O&M) cost, salvage value assuming an annual discount rate (d) is 2.2%, and annual inflation rate (i) is 4.4% in a 20-year life cycle. Table 5-1 shows the Alternative 2 cost components with the total 20-year life cycle cost (NPV) of **$4,660,465**. Table 5-2 shows the Alternative 3 cost components with the total 20-year life cycle cost (NPV) of **$8,570,136.**

The capital cost and year one O&M cost is calculated based on each individual project element.
The salvage value is based on the assumed total years of life, which are listed in the table. The formulas for the calculations are provided in Equations 5.1, 5.2, and 5.3.

Table 5-1. Life Cycle Cost (NPV) for Alternative 2 – Treatment @ 100-gpm Flowrate

Description	Total Estimated Capital Cost	Annual O&M Cost (Year 1)	Present Worth of Uniform Series of Annual O&M (USPW(O&M))	20-Year SPPW(S)	Life-Cycle Cost (NPV)(20yrs)	Asset Life Value (yrs) (t)
New Filtration System	$3,140,000	$22,732	$298,275	$677,315	$2,760,961	30
New Chemical Feed system	$1,590,000	$8,047	$105,588	$0	$1,705,588	20
Backwash Waste Holding Tank	$260,000	$0	$0	$56,083	$203,917	30
Total	**$4,990,000**	**$30,779**	**$403,863**	**$733,398**	**$4,660,465**	

Table 5-2. Life-Cycle Cost (NPV) for Alternative 3 – Regionalization

Description	Total Estimated Capital Cost	Annual O&M Cost (Year 1)	Present Worth of Uniform Series of Annual O&M (USPW(O&M))	20-Year SPPW(S)	Life-Cycle Cost (NPV)(20yrs)	Asset Life Value (yrs) (t)
Furnish and Install 12-in Transmission Main (Including Interconnection)	$9,503,000	$36,000	$472,370	$4,919,634	$5,055,736	100
Furnish and Install Booster Pump Station	$4,138,000	$20,500	$268,988	$892,589	$3,514,400	30
Total	**$13,641,000**	**$56,500**	**$741,358**	**$5,812,223**	**$8,570,136**	

The NPV is calculated per EPA's guideline formula:

$$NPV = C + USPW(O\&M) - SPPW(S)$$ (Equation 5.1)

$$USPW\ (O\&M) = O\&M\ yr\ 1 * \left(\frac{(1+i)^n - 1}{i(1+i)^n}\right)$$ (Equation 5.2)

$$SPPW(S) = C * \left(1 - \frac{n}{t}\right) * \left(\frac{1}{(1+d)^n}\right)$$ (Equation 5.3)

Where:
NPV = Net Present Value
C = Capital Cost
USPW(O&M) = Present Worth of Uniform Series of annual O&M costs
SPPW(S) = the Single Payment Present Worth of the salvage value

n = number of lifecycle years - 20 years
t = Asset Life Value – defined in Table 5-1 and Table 5-2
i = inflation rate – 4.4%
d = discount rate – 2.2%

5.2 Non-Monetary Factors

The main assessment drivers for evaluating the three alternatives are quantity, quality, and reliability. The project team collaborated to identify four non-monetary evaluation criteria to assess the three alternatives:

1) Ability to Meet Current and Future Regulatory Requirements
2) Ease of Operation
3) Residual Management
4) Long-term System Operation

Each criterion is scored on a scale from 1 to 5, with 1 being the lowest score and 5 being the highest score. The higher the score, the better the alternative meets Sterling's need for that specific criterion. Table 5-3 defined the low and high score for each criterion.

The Ability to Meet Current and Future Regulatory Requirements criterion assesses the ability of each alternative to resolve the high levels of iron and manganese in the water system. Alternative 2 would implement new treatment to reduce the iron and manganese concentration in the water, and Alternative 3 would introduce a new source water to the system which does not exceed the acceptable levels for iron and manganese. Alternative 1 would implement new treatment that would not fully reduce the levels of iron and manganese in the water.

The Ease of Operation criterion identifies the level of effort required to operate the system for each alternative. Connecting to Connecticut Water is generally considered to be a much easier operation because the only facilities that Sterling, or its contractor White Water, need to operate are the booster pump station, water storage tank, and the distribution system piping. The treatment alternatives would require operation of the groundwater wells and chemical equipment in addition to the booster pump station, water storage tank, and the distribution system piping.

The Residuals Management criterion identifies the level of effort required to manage the residuals for each alternative. The treatment alternatives would require disposal of residuals, whereas the regionalization alternative would not have any source water treatment and therefore no residual disposal.

The Long-term System Operation criterion assesses the future costs anticipated for each alternative. Alternative 1 would not fully resolve the issues the utility is facing, and additional capital expenditures would be necessary to maintain the system. Alternative 2 would reduce the levels of iron and manganese in the water and should not require additional improvements in the near future. Alternative 3 is subject to Connecticut Water's decisions to implement capital improvements in their system, which will ultimately be recouped via customers' rates.

Table 5-3. Scoring Criteria for Non-Monetary Factors

Evaluation Criterion (EC)		1 (Low Score)	3 (Medium Score)	5 (High Score)
EC 1	**Ability to Meet Current and Future Regulatory Requirements**	Meets the current requirements, but modification may be needed for future regulatory requirements	N/A	Meets the current requirements and future requirements
EC 2	**Ease of Operation**	Complex operation in terms of mechanical complexity or additional operator required	Simple operation in terms of mechanical complexity	Requires minimal work by operator to maintain system
EC 3	**Residual Management**	Waste generated; residual disposal required	N/A	No waste generated; residual disposal not required
EC 4	**Long-term System Operation**	Town is not in control of future rate increases, near term capital expenditures expected	N/A	Town is in control of future rate increases, minimal capital expenditures expected

Four criteria were identified to capture Sterling's goals for the project. The evaluation criteria provided in Table 5-3 were considered for Alternatives 1, 2, and 3, and ratings were applied according to the conditions of each alternative. The ratings are shown in Table 5-4. The rating is multiplied by the weight factor to provide a weighted score for each criterion. The weighted score is then summed for each alternative to provide a total score. For this assessment, the highest possible score is 500, if each criterion was rated at a 5. The weighted score of each alternative is divided by the highest possible score to identify the percentage of project goals that are met by the alternative. The resulting ranking of the alternatives is shown in Table 5-4. As shown in the table, Alternative 3 meets 84% of the project goals, and Alternative 2 new treatment meets 64% of the project goals, while Alternative 1 sequestration only meets 48% of the project goals. Based on non-monetary factors for this technical review, Alternative 3 regionalization ranks the highest.

Table 5-4. Scoring Results for Non-Monetary Factors

Evaluation Criteria		Weight	Alternative 1 – Sequestration		Alternative 2 – Oxidation & Filtration		Alternative 3 – Regionalization	
			Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
EC 1	Ability to Meet Current and Future Regulatory Requirements	40	1	40	4	**160**	5	**200**
EC 2	Ease of Operation	20	4	80	2	**40**	4	**80**
EC 3	Residual Management	20	5	100	1	**20**	5	**100**
EC 4	Long-term System Operation	20	1	20	5	**100**	2	**40**
TOTAL SCORE			240		320		420	
Percent of Project Goals Met			48%		64%		84%	

A cost benefit value analysis is provided in Table 5-5. This analysis demonstrates that Alternative 2 (treatment at 100 gpm design flow rate) offers the most benefit for the investment, making it the recommended alternative based on non-monetary factors and total construction cost estimates.

Table 5-5. Cost Benefit for Alternatives

Commented [EL6]: Jacobs to update cost

Alternative	Alternative 2 – Treatment		Alternative 3 – Regionalization
Description	Hypo + Greensand Plus Flow rate @350 gpm	Hypo + Greensand Plus Flow rate @100 gpm	Connected to Connecticut Water
Non-Monetary Score	320	320	420
Total Construction Cost (in $ million)	$4.4	$3.8	$10.4
Benefit/Cost	73	84	40
Ranking per Benefit/Cost	2	1	3

6 Proposed Project (Recommended Alternative)

This section describes the recommended alternative with a fully developed description of the proposed project based on the preliminary descriptions developed during the evaluation of alternatives. This section includes descriptions of the preliminary project design, project schedule, permit requirements, sustainability considerations, a total project cost estimate, and an estimated annual operating budget.

Alternative 2 (New Oxidation and Filtration Treatment at 100 gpm Design Flowrate) has been identified as the recommended alternative. While both the treatment and regionalization alternatives aim to provide customers in Sterling with safe, reliable drinking water, Alternative 2 achieves these goals by providing the most benefit for the cost.

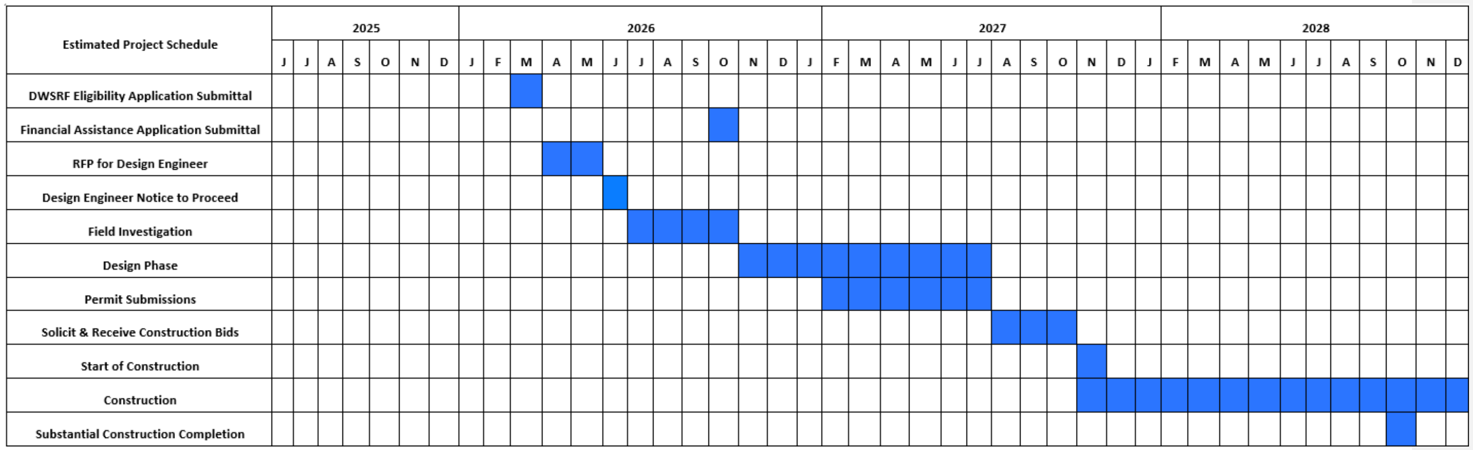
6.1 Preliminary Project Design

Preliminary Project design criteria are included in Section 4.2.2.

6.2 Project Schedule

The actual project schedule will depend on the award date of funds. An estimated project schedule is shown in Figure 6-1.

Figure 6-1. Proposed Project Schedule



DWSRF = Drinking Water State Revolving Fund

6.3 Permit Requirements

The following permits may be required prior to the application of the Public Water System Construction Permit. This list should be reviewed and updated as needed based upon the final design.

- Public Water System General Application for Approval or Permit
- Water Treatment Plant Classification Form
- Chemical Feed System Project Application
- Certification of Completed Water or Treatment Works Construction/Installation
- Natural Diversity Database Review Request

For the Public Water System General Application for Approval or Permit, a general application form will need to be submitted to the Drinking Water Section along with any specific project applications that require an approval or permit from the Department (Connecticut Department of Public Health, n.d.b.).

Water treatment plants in Connecticut must be classified based on points assigned according to the Association of Boards of Certification system, as per Section 25-32-8 of the Connecticut State Agencies Regulations Department (Connecticut Department of Public Health, n.d.b.). The Water Treatment Plant Classification Form is required by CT DPH. The classifications determine the class of the certified operator required to operate the plant. Points are assigned based on:

- Plant Size
- Water Supply Source
- Treatment Unit Processes
- Residual Disposal
- Facility Characteristics

This classification ensures that the treatment plant is operated by appropriately certified personnel.

The Chemical Feed System Project Application is provided in the interest of facilitating the approval process for chemical feed system projects and must be submitted to the CT DPH along with a General Application Form.

Upon completion of the construction or installation, a Certification of Completed Water or Treatment Works Construction/Installation letter must be completed and signed by the Public Water System's administrative official, designated representative, or certified operator. The letter must be submitted to the Drinking Water Section (Connecticut Department of Public Health, n.d.a.).

As noted in Section 1, CT DEEP’s NDDB for State Listed Species, shown in Figure 1-3, was reviewed for the project area. The project area is within NDDB areas. The need for an NDDB Review Request will be evaluated during detailed design phase.

6.4 Sustainability Considerations

Sustainability measures will be considered as the project progresses into detailed design.

6.4.1 Water and Energy Efficiency

At this conceptual level, water and energy efficiency measures have not been incorporated into the project. As the project progresses, energy efficiency measures will be applied to the design of individual components where applicable, such as the treatment building.

6.4.2 Green Infrastructure

At this conceptual level, green infrastructure has not been incorporated into the project. As design progresses, green infrastructure concepts will be applied for stormwater management if needed.

6.4.3 Other

Not applicable.

6.5 Total Project Cost Estimate (Engineer's Opinion of Probable Cost)

Commented [EL7]: Jacobs to update cost information

Table 6-1. Capital Cost Estimate for Recommended Alternative 2 – Treatment @ 100 gpm Flow Rate

Project Element	Capital Cost* ($)
New Filtration System	$3,140,000
New Chemical Feed system	$1,600,000
Backwash Waste Holding Tank	$260,000
Total	**$4,990,000**

* Includes Additional Project Costs percentage as follows:
Permitting 2%
Engineering 12%
Services During Construction 5%
Commissioning & Startup 2%
Land / Right-of-Way 5%
Legal / Admin 5%

6.6 Annual Operating Budget

Sterling's water system is owned by the Town and is funded through Town funds as well as water rates paid by the customers.

6.6.1 Income

The Water System runs at a significant deficit, with increasing management, facilities, and operational expenses. Due to the quality of the water, there has been a reluctance to increase rates, and Sterling has been funding the shortfall from its general fund. Sterling applied to the State of Connecticut for funding through the Drinking Water State Revolving Fund on March 13, 2025 to construct a Filtration/Oxidation Plant which would resolve the issues of high levels of manganese and iron. Appendix B includes the Fiscal Year 24-25 actual revenue and expenses for the Water System.

Water consumption and meter rates were increased effective January 1, 2025. It is anticipated that the rates will be increased each year to either gradually close the gap in the shortfall or fully meet the operating and management expenses in one increase, which includes regular reviews.

Appendix B also includes the income/expenses for 2024-2025.

6.6.2 Annual O&M Costs

Refer to Appendix B, Sterling Water System FYU 25-26 Budget.

6.6.3 Debt Repayments

If Sterling is unable to secure grants to finance a resolution to the water quality issue, the Board of Selectmen will pursue other funding. Sterling's request to the Drinking Water State Revolving Fund is for $3,225,000. Sterling is also a designated Disadvantaged Community, with an index of 0.3467. The annual town budget for FY 25-26 was approved on May 14, 2025, at the Annual Town Meeting; the portion of the budget for Town operations is $3,226,522, exclusive of any water expenses.

6.6.4 Reserves

Sterling does not maintain reserve funding for the water system. Any shortfall is funded through the Town's General Fund.

7 Conclusions and Recommendations

Both treatment and regionalization options aim to provide customers in Sterling with safe, reliable drinking water. While the regionalization alternative scores higher on non-economic factors such as ease of operations, residual management, and the ability to meet future regulatory requirements, the treatment option at a 100 gpm designed flow rate offers the most benefit while also considering cost. Therefore, the treatment option at 100 gpm design flow rate is recommended as the most cost-effective solution.

8 References

Connecticut Department of Public Health. n.d.a. Forms and Applications. Accessed May 6, 2025. https://portal.ct.gov/dph/drinking-water/dws/forms-and-applications.

Connecticut Department of Public Health. n.d.b. Water Treatment Plant Classification Form. Accessed May 8, 2025. https://portal.ct.gov/-/media/departments-and-agencies/dph/dph/drinking_water/pdf/wtpformpdf.pdf?rev=f82a5e0f3aba4322a12c8f98aaeb9119&hash=B6DCC051B506BE9748E326AF1A75601F.

Connecticut Department of Public Health. n.d.c. Drinking Water Section Chemical Feed System Project Application. Accessed May 8, 2025. https://portal.ct.gov/-/media/departments-and-agencies/dph/dph/drinking_water/pdf/chemicalfeedsystemprojectapplicationpdf.pdf?rev=68a3b3227a624833a0f380360685bd01&hash=8A991A74CA16DB708A8DC46E7A9F74EA.

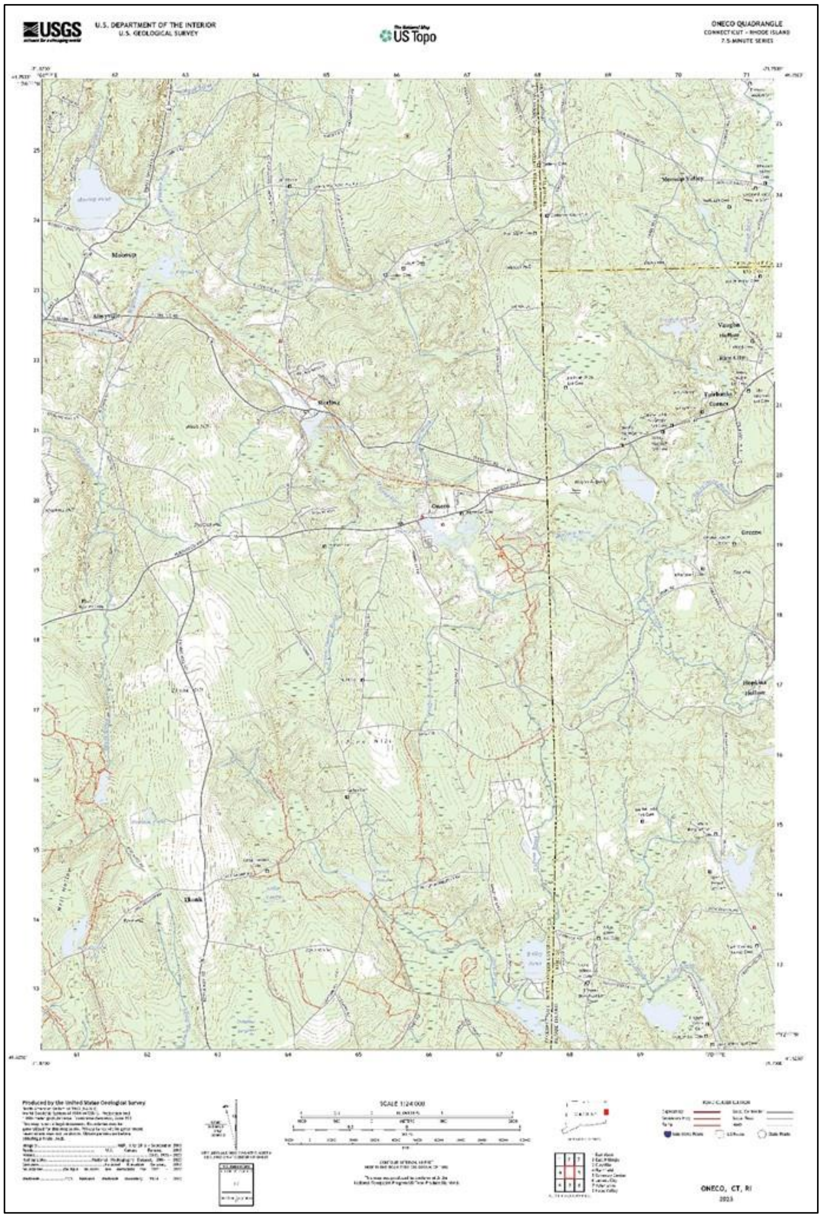
Connecticut Department of Public Health. n.d.d. Manganese in Drinking Water. Accessed June 18, 2025. https://portal.ct.gov/-/media/Departments-and-Agencies/DPH/dph/drinking_water/pdf/Manganese_Fact_Sheet.pdf.

Federal Emergency Management Agency, Flood Map Service Center. FIRMette: FIRM Panel 09015C0379F, effective 9/7/2023 (digital image). Retrieved from FEMA MSC May 2025.

U.S. Fish and Wildlife Service, National Wetlands Inventory Mapper. Accessed June 20, 2025. https://www.fws.gov/program/national-wetlands-inventory/wetlands-mapper.

U.S. Geological Survey. Oneco quadrangle, Connecticut and Rhode Island. Revised 2015. 1:24,000. 7.5 Minute Series. Reston, VA: U.S. Geological Survey.

Appendix A
Sterling, CT 7.5-Minute Topographical Map


U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
US Topo
ONECO QUADRANGLE
CONNECTICUT - RHODE ISLAND
7.5-MINUTE SERIES
ONECO, CT, RI

Appendix B
Sterling Water System FYU 25-26 Budget

Appendix C
May 2025 Fe and Mn Sampling Report