# Memorandum

**Date:** March 18, 2025

**To:** Colin Stokes, Groveland Water & Sewer Superintendent

**From:** Ryan Allgrove, P.E.

**CC:** Robert Ward, Haverhill DPW Director
John D'Aoust, Haverhill Water Treatment Plant Manager

**Subject:** Haverhill Permanent Water Supply to Groveland

## Background

Groveland's groundwater supplies face water quality challenges related to iron, manganese, and PFAS that will require a new treatment facility. As an alternative to treatment, the Town requested a preliminary evaluation of a permanent interconnection with the City of Haverhill to supplement or replace local water supplies. The proposed interconnection location is on Salem Street in Groveland on the Haverhill City line. Historically, the Salem Street interconnection was used to supply Groveland from Haverhill prior to the establishment of Groveland's own supplies. The Salem Street interconnection is now severed and a hydrant to hydrant connection is available for emergency supply.

Apex completed an update and recalibration of Groveland's hydraulic model in December 2024. The model was updated to reflect all system improvements that have been implemented since the previous calibration (approximately 2010). Upon completion of this update, the model was calibrated using results from hydrant flow tests completed by Apex on October 18, 2024. Static and dynamic system conditions were recorded at various locations throughout the distribution system and compared with model simulation results. The model was adjusted until simulations reasonably converged with flow test pressures and flow rates. In general, static and dynamic simulation results were within 1-3 psi of actual field readings. In total, 12 hydrant flow tests were utilized to recalibrate the Groveland model.

Figure 1 shows the distribution system and proposed interconnection location.

## Hydraulic Analysis

### Baseline Assumptions

Apex assumed the following baseline conditions under the various simulation scenarios:

- Groveland static pressures and hydraulic grade line (HGL) ranges include average day demand (ADD) and maximum day demand (MDD) usage within the normal tank operating range of 262 – 279 ft (NAVD88).

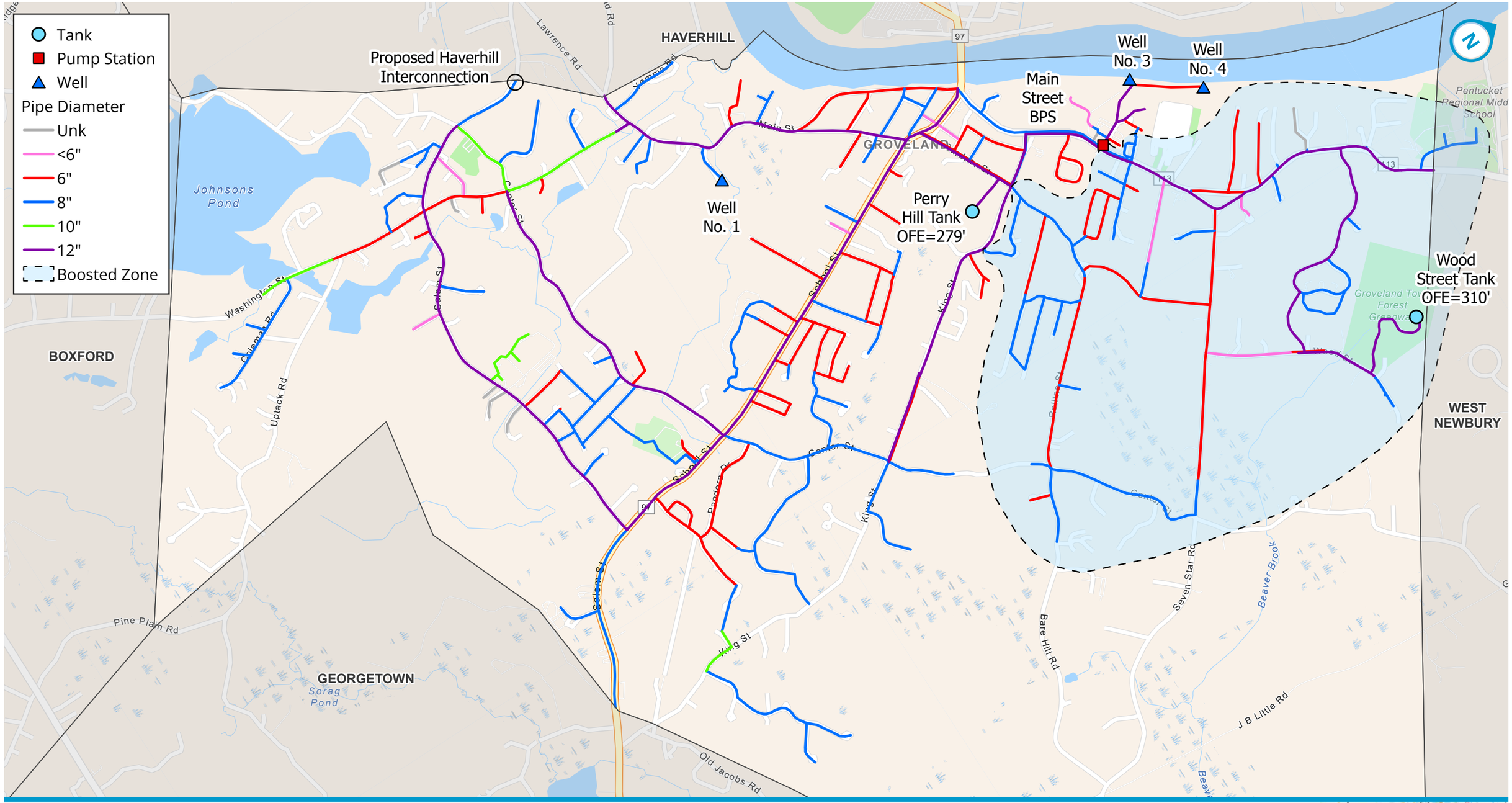


**Figure 1**

## Groveland Water Distribution System and Proposed Haverhill Interconnection

Groveland, MA

March 2025

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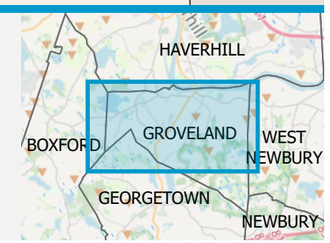
1:1,600 Feet




I:\Groveland.318\Water System\00 - Groveland Hydraulic Model\GIS\Jan-2025 System Map

Disclaimer: This map is intended for planning purposes

- Available fire flow scenarios are simulated under MDD with supply from the proposed interconnection or groundwater sources as noted. Available flows are calculated to maintain 20 psi throughout the distribution system.
- All simulations assume a projected 2044 ADD and MDD in Groveland of 0.45 MGD and 1.05 MGD, respectively. For comparison, average day demand from 2021 – 2023 ranged from 0.325 - 0.334 MGD.
- Two Haverhill supply scenarios were simulated as follows:
    - Full Supply – Groveland's three groundwater supply wells (Well No. 1, Well No. 3 and Well No. 4) would be inactivated.
    - Partial Supply – Groveland's Well No. 1 and Well No. 3 would be inactivated due to their more immediate water quality concerns. Well No. 4 would remain active.

## Static Conditions

Prior to simulating an interconnection between Haverhill and Groveland, Apex examined hydraulic information for both water systems. In order for the interconnection to function so that Haverhill can supply Groveland without pumping, the HGL in Haverhill must exceed Groveland's HGL at the main service zone's Perry Hill tank. Table 1 summarizes simulated HGLs at the extents of each water system and pressures at a ground level elevation of 39 ft.

**Table 1: Simulated Baseline System Hydraulics**

| Location | Future (2044) MDD HGL Range (ft)[1] | Static Pressure range (psi) |
|---|---|---|
| **Haverhill Side of Interconnection (Haverhill Main Service Zone)** | 276-325[2] | 103-124 |
| **Groveland Main Service Zone Tank Operating Range** | 262-279 | 97-104 |

1. Vertical datum = NAVD88.
2. HGL range provided by Woodard and Curran

Review of HGLs between the two water systems shows that under future Haverhill MDD, Haverhill's minimum HGL at the proposed interconnection point is approximately equal to the maximum elevation of Groveland's main service zone tank's operating HGL range, before accounting for additional headloss due to any additional demand from Groveland. This indicates that under high demand conditions in Haverhill, pumping at the interconnection would be required to fill the Perry Hill tank. However, during lower demand periods where Haverhill's HGL is sufficiently higher than the Perry Hill tank HGL, pumping may not be required to fill the tank.

## Pressure Analysis

### Required HGLs and Pressures

Apex utilized the hydraulic model in the most recent version of WaterGEMS V8i to simulate adequate HGLs and pressures from Haverhill at the proposed interconnection point under the two interconnection demand scenarios (100% Haverhill Supply and Partial Haverhill Supply). Simulations assumed the normal operating range of the Perry Hill tank. Apex defined adequate hydraulic conditions as the ability to fill the Perry Hill tank within its normal operating range at a rate equal to the replaced groundwater supply discharge rates. Both supply options assume approximately 2,800 LF of 12" DI pipe upgrades required on Salem Street and Center Street in Groveland, as described below in the recommended improvements.

**Table 2: Required Hydraulic Conditions for Interconnection Gravity Feed**

| Interconnection Scenario | Required HGL (ft) | Required Pressure (psi) |
|---|---|---|
| Full Supply (1,120 gpm) | 284-300 | 106-113 |
| Partial Supply (905 gpm) | 277-293 | 103-110 |

**Available HGLs and Pressures**

Available HGLs and pressures from Haverhill at the proposed interconnection point under the two interconnection demand scenarios were provided by the City of Haverhill's consultant, Woodard and Curran, and are summarized in Table 3. Haverhill demand was modeled to be 2044 MDD for both demand scenarios. The lowest HGL elevations represent peak hour (PH) during MDD demand period.

**Table 3: Available Hydraulic Conditions for Interconnection**

| Interconnection Scenario | Available HGL (ft) | Available Pressure (psi) |
|---|---|---|
| Full Supply (1,120 gpm) | 256-296 | 94-111 |
| Partial Supply (905 gpm) | 263-304 | 97-115 |

As shown above, available pressures in Haverhill will not always be adequate under either the full or the partial supply scenarios. Therefore, a pump station will be required to operate at times when the Haverhill HGL is insufficient to fill the Groveland main pressure zone Perry Hill Tank at a rate equal to the current fill rate provided by Groveland's groundwater supplies.

**Available Fire Flow Analysis**

Relocating Groveland's supplies from their current location will impact fire flow availability. Apex simulated available fire flows at select locations based on the most recently available ISO requirements and proximity to the Groveland wells. Available flows while maintaining 20 psi throughout the distribution system increased with the interconnection PS, as presented in Table 4. This is increase is attributed to stabilization of the HGL in the western part of the system due to the interconnection. The Perry Hill tank continues to stabilize the HGL in central Groveland.

**Table 4: Available Fire Flow at Select ISO Locations**

| Location | Required Flow (gpm at 20 psi) | Existing Available Flow (gpm at 20 psi) | Available Flow w/ Full Haverhill Supply (gpm at 20 psi) | Available Flow w/ partial Haverhill Supply (gpm at 20 psi) |
|---|---|---|---|---|
| School Street at Main Street | 3,000 | 4,725 | > 5,000 | > 5,000 |
| Main Street at Manor Drive | 2,250 | > 5,000 | > 5,000 | > 5,000 |

### Hydraulic Analysis Conclusions

Haverhill cannot supply Groveland adequately under all anticipated operating conditions without pumping. Model simulations show that in order to adequately fill Groveland's Perry Hill tank when Haverhill's HGL is on the lower end of its range, pumping will increase Groveland's pressure in the area of the interconnection by approximately 15 psi – 30 psi without any pipe upgrades. In order to avoid excessive pressures in the Salem Street area, approximately 2,800 linear feet of water 8-inch and 10-inch water mains should be replaced with new 12-inch main.

## Water Quality

Introducing Haverhill supply into Groveland's system would result in the introduction of completely new water quality parameters into Groveland's distribution system (full Haverhill supply) or mixing of Haverhill's surface water supply and Groveland's groundwater supply. If Haverhill supply is pursued, water quality will be assessed as part of a pilot study for approval by the MassDEP Drinking Water Program. The pilot study will focus on the Lead and Copper Rule (LCR), Revised Total Coliform Rule (RTCR), Disinfection Byproduct Rule (DBPR) and Aesthetic concerns.

### Lead and Copper Rule

Haverhill provides corrosion control through a combination of increasing the pH level to 7.8 and dosing with zinc orthophosphate as a corrosion inhibitor. Groveland's corrosion control processes include pH adjustment to approximately 7.7. Alkalinity is also important relative to the lead and copper rule, as adequate alkalinity maintains a stable pH and can prevent corrosion of metal pipes. Alkalinity levels for both Groveland and Haverhill are within the recommended range of 20 – 200 mg/L (as calcium carbonate). However, Groveland's alkalinity is typically 70 – 90 mg/L which is more than double Haverhill's which typically ranges from 30 – 40 mg/L. Introducing lower alkalinity into the Groveland distribution system could potentially increase the risk of corrosion.

Apex anticipates that the addition of zinc orthophosphate will be required in Groveland's sources under the partial supply scenario to maintain a consistent corrosion control strategy throughout the distribution system.

### Revised Total Coliform Rule

Both Haverhill and Groveland use free chlorine to maintain residual disinfection (chlorinated). Haverhill utilizes sodium hypochlorite to achieve a finished water free chlorine residual of 1.0 – 1.2 mg/L leaving the water treatment plant. Groveland doses with calcium hypochlorite and has target free chlorine residual of 0.5 to 0.75 mg/L. Free chlorine residual is monitored weekly at Haverhill's Sherwood Pump Station (approximately 2 miles from the proposed interconnection location) and 2025 data shows that the free chlorine residual ranged from 0.59 – 1.09 mg/L. Although Haverhill's residuals in the proposed interconnection area are consistent with Groveland's target, Apex anticipates that chlorine residual monitoring and chlorine dosing equipment would be required to safeguard against a low chlorine residual event from Haverhill.

### Stage 1 & 2 Disinfectants/Disinfection Byproducts Rules (DBPRs)

The reaction of disinfectants with natural organic matter (NOM) creates disinfection byproducts. NOM is typically greater in surface water sources, such as Haverhill. As a result, DBPs are anticipated to increase in Groveland with the introduction of Haverhill supply. However, review of recent DBP results on Salem Street in Haverhill (approximately 0.6 miles from proposed interconnection location) shows that DBP levels in this area are consistently well below Maximum Contaminant Levels (MCLs).

### Aesthetics (Taste & Odor)

There are inherent aesthetic differences between surface water supplies (Haverhill) and groundwater supplies (Groveland). Generally, groundwater has lower turbidity and has less noticeable odors than surface water. Surface water is also more prone to seasonal fluctuations that can affect taste and odor.

Water hardness is a measure of water's mineral content and also has an effect on taste. Generally, groundwater has a higher mineral content and is harder than surface water. Groveland's existing groundwater supplies have

hardness averaging approximately 60 – 100 mg/L (as calcium carbonate). Haverhill's water is softer and typically ranges from 30 – 40 mg/L as calcium carbonate.

## Haverhill Supply Permitting Considerations

### Water Management Act

Currently all of Groveland's water sources are registered under the Water Management Act (WMA). Under the WMA, the Town may withdraw a total annual volume of 149.65 MG or an average of 0.41 MGD throughout the year. If the Town abandons or inactivates one or more of their groundwater sources, Groveland's WMA registration would be forfeited and the status of each well would need to be modified through approval of a BRP WS 36 Permit (Abandonment of a Water Source) and BRP WS 32 Permit (Distribution System Modification).

Haverhill currently has a combined registered and permitted authorized withdrawal of 7.10 MGD, which is equal to the safe yield of their primary surface water source, Kenoza Lake. In 2023, Haverhill used 5.38 MGD of water, resulting in a surplus of 1.72 MGD that could be allocated to Groveland. Haverhill's projected 2044 ADD of 6.6 MGD would provide a marginal surplus of 0.05 MGD after allocation of Groveland's 2044 projected ADD of 0.45 MGD.

Water suppliers in the Merrimack River basin, including Haverhill and Groveland, anticipate that their WMA authorizations will begin the WMA permit renewal process within approximately 1 year and the authorized withdrawals listed above are subject to change.

### Interbasin Transfer Act (ITA)

The Massachusetts Interbasin Transfer Act grants the Massachusetts Water Resources Commission (WRC) authority to approve or deny transfers of water or wastewater outside their river basin of origin. Groveland's water supplies are in the Merrimack River Basin and a portion of the water is distributed to customers and discharged via septic system in the Parker River basin. A town with land area in multiple basins can supply itself with water without triggering review under the ITA under the intra-town exemption. However, under the proposed Haverhill interconnection, supply from the Merrimack Basin would cross a municipal boundary and the ITA would apply to the portion of water to be used in and discharged to the Parker River Basin in Groveland.

## Recommended Improvements for Groveland

The Haverhill distribution system cannot provide sufficient pressure at the proposed interconnection location to Groveland under all operating conditions without pumping. Additionally, relocating the supply in Groveland to the western extents of the system in an area of existing high pressure requires water main upgrades to avoid excessive pressures on the discharge side of the pump station. The following improvements are recommended in Groveland:

- Install new pump station and chemical feed facility
- Replace 1,300 lf of 8-inch water main on Salem Street between the Town line and Center Street with new 12-inch main.
- Replace 1,500 lf of 10-inch water main on Center Street between Salem Street and Washington Street with new 12-inch main.
- Install 2,400 lf of new 12-inch main on Lawrence Road in Haverhill for redundant gravity feed.

Recommended improvements are shown in Figure 2. Apex recommends that under the partial supply scenario, the Town implement the same improvements required for full supply, in order to safeguard against future decline of water quality at Well No. 4.

## Haverhill Improvements

Woodard and Curran performed a hydraulic analysis on Haverhill's distribution system to analyze the impacts of the proposed interconnection. Results showed that water main improvements were not required. However, the additional demand would affect the Water Treatment Plant's ability to maintain adequate storage levels during future high demand periods. As a result, Haverhill will require pump upgrades at the WTP in the future, as projected demands are realized.

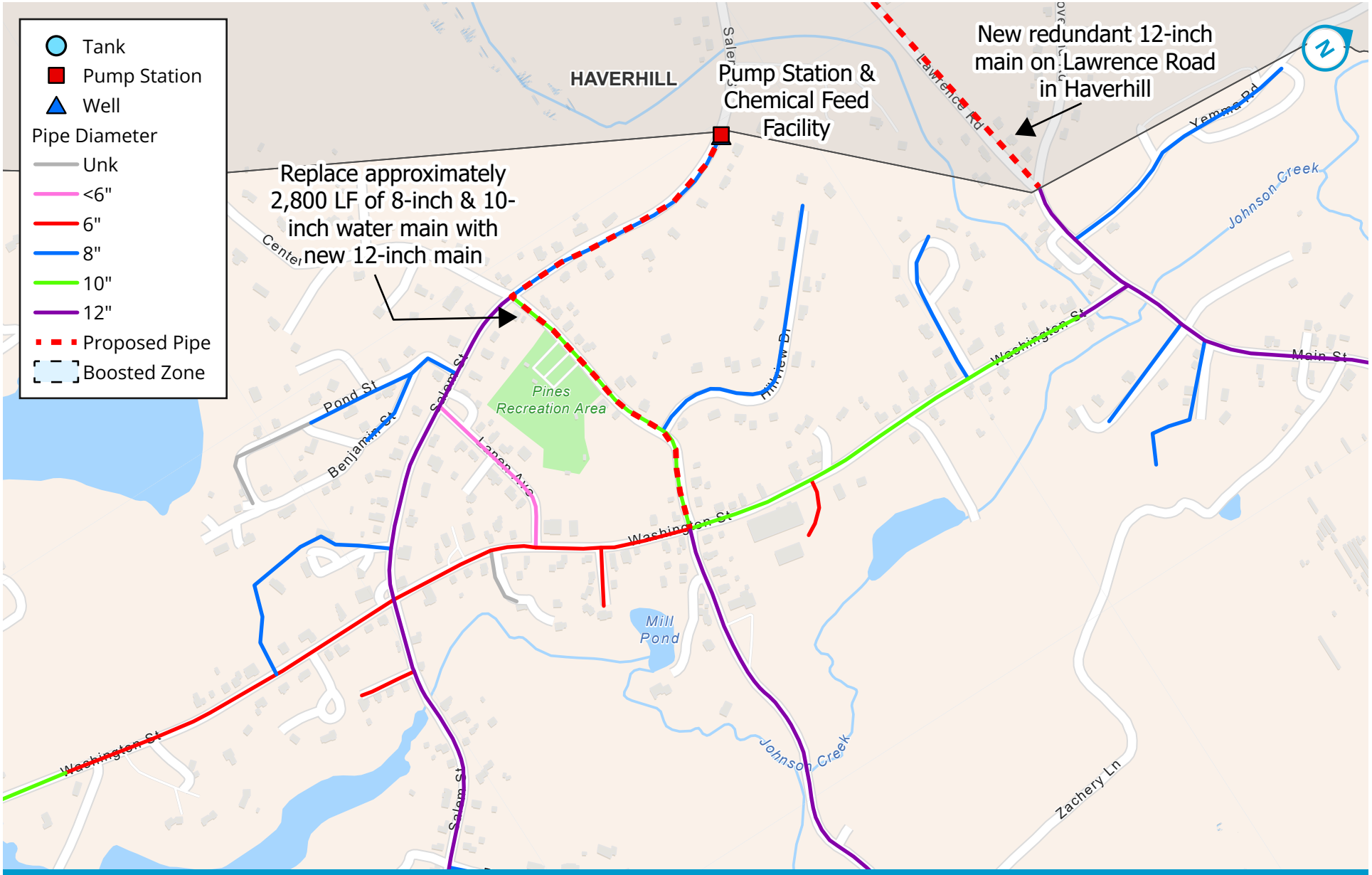



**Figure 2**

**Groveland Recommended Improvements for Haverhill Interconnection**

Groveland, MA

March 2025

0 325 650 1,300

1:650 Feet

APEX

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Disclaimer: This map is intended for planning purposes

## Cost Analysis

Apex evaluated the costs for the WTP and Haverhill interconnection option based on initial capital costs, water purchasing costs, and long-term operations and maintenance costs to compare the total lifecycle costs, assuming a 40-year design life. Capital costs are presented at an ENR index of 13900, approximately mid-2025.

### Capital Costs

Apex developed an opinion of probable project cost for the water treatment plant as part of the 2021 Water Treatment Facility Feasibility Study and updated the cost most recently in August 2024. Table 5 presents the opinion of probable project cost assuming the water treatment plant will be constructed adjacent to Well No. 3, at the rear of the Pines Recreation Area.

**Table 5: Water Treatment Plant Capital Cost**

| **Opinion of Probable Project Cost** | | |
|---|---|---|
| Item # | Description | Cost |
| 1 | Wells No. 1, 3 and 4 Pumps/VFDs | $ 260,000.00 |
| 2 | Wells No. 1, 3 and 4 Equipment Demo | $ 330,000.00 |
| 3 | Raw Water Piping | $ 2,500,000.00 |
| 4 | Main Street Finished Water Replacement | $ 750,000.00 |
| 5 | Pressure Filtration System Equipment | $ 1,850,000.00 |
| 6 | Process Mechanical Piping & Equipment | $ 3,950,000.00 |
| 7 | SCADA/Instrumentation & Control | $ 1,200,000.00 |
| 8 | Electrical/HVAC/Plumbing | $ 3,450,000.00 |
| 9 | Pre-Engineered Building | $ 5,800,000.00 |
| 10 | PFAS Filtration Equipment | $ 4,200,000.00 |
| 11 | Site Work & Utilities | $ 3,800,000.00 |
| 12 | Build American, Buy American (BABA) / American Iron and Steel (AIS) Markup | $ 2,809,000.00 |
| 13 | Police Details | $ 250,000.00 |
| 14 | Engineering News Report (ENR) Index Adjustment | $ 730,000.00 |
| | **Construction Subtotal** | **$ 31,879,000.00** |
| | Engineering & Contingencies (40%) | $ 12,752,000.00 |
| | **Opinion of Probable Program Cost (Rounded)** | **$ 44,600,000.00** |

Capital Costs to complete the recommended improvements for Haverhill supply are summarized in Table 6.

**Table 6: Haverhill Interconnection Capital Cost**

| Opinion of Probable Project Cost | | |
|---|---|---|
| Item # | Description | Cost |
| 1 | Haverhill WTP Pump Upgrades[1] | $ 3,000,000.00 |
| 2 | Interconnection Pump Station / Chemical Feed Facility[2] | $ 4,500,000.00 |
| 3 | Pump Station Land Acquisition | $ 500,000.00 |
| 4 | Groveland Water Main Improvements[3] | $ 2,080,000.00 |
| 5 | Police Details | $ 75,000.00 |
| 6 | Engineering News Report (ENR) Index Adjustment | $ 140,000.00 |
| | **Construction Subtotal** | $ 10,295,000.00 |
| | Engineering and Contingencies (40%) | $ 4,118,000.00 |
| | **Connection Fee[4]** | $ 4,700,000.00 |
| | **Opinion of Probable Program Cost** | **$ 19,113,000.00** |

1. Cost shown in March 2025 dollars. Upgrade implemented in 2046 in lifecycle cost analysis.
2. Estimated 1,800 SF @ $2,500 / SF
3. 5,200 LF @ $400/LF
4. Average of range estimated at $2.6M - $6.8M. This range is preliminary and subject to negotiation and change.

### Lifecycle Cost Analysis

Apex conducted a life cycle cost analysis over a 40-year assumed asset life for the water treatment plant. System variables and financial assumptions used in the analysis are found in Table 7. All assumptions for costs related to Haverhill supply are preliminary and subject to negotiation and change.

**Table 7: Lifecycle Cost Analysis Variables & Assumptions**

| Description | Amount |
|---|---|
| WTP & Interconnection Loan Term & Interest Rate | 30 Yrs @ 0.5%[1] |
| Haverhill WTP Pump Upgrades (2045) | 20 Yrs @ 5.0% |
| Annual Inflation on Expenses | 3.0% |
| Haverhill Purchased Water Rate (Low) | Standard City Rate |
| Haverhill Purchased Water Rate (High) | Standard City Rate + 30% |
| Haverhill Purchased Water Rate Annual Increase | 3.75% |
| Average Annual Water Usage Increase in Groveland | 1.1 MG per year |
| Average Annual Water Supply from Well No. 4 in Partial Supply Scenario | 69.3 MG[2] |

1. 0% SRF Loan for project components qualified as PFAS mitigation.
2. Assumes approximately 200 gpm pumping rate for 16 hours per day, 355 days per year.

Additional annual expenses in 2025 dollars assumed for the WTP include the following and were assumed to increase in cost by 3% annually.:

- Additional power usage - $20,000
- Additional chemical usage - $5,000
- Annual Replacement of Parts and Materials - $25,000
- Residuals Disposal to Sewer - $7,000
- Filter Media Replacement - $100,000
- Additional Water Department Personnel (1 additional full-time) - $100,000

In addition to purchasing water from Haverhill, Groveland would contribute to Haverhill's WTP capital improvement costs. Similar to Groveland's intermunicipal agreement with Haverhill for wastewater, Apex assumed that Groveland's CIP cost contribution would be proportional to the Town's "allocable share" of the water supply, estimated at 6.5%. Groveland's initial contribution to the Haverhill CIP was estimated at $200,000 based on review of Haverhill's 5-year capital plan and remaining debt service on the Kenoza Lake WTP upgrades completed in 2020. Table 8 summarizes the results of the lifecycle costs analysis.

**Table 8: 40-Yr Lifecycle Cost Analysis**

| | **WTP** | **Full Supply Haverhill Interconnection (Low - High)** | **Partial Supply Haverhill Interconnection (Low - High)** |
|---|---|---|---|
| Present Discounted Value | $42M | $74M - $90M | $55M - $66M |
| $ Differential | - | $32M – $48M | $13M - $24M |
| Payback Period[1] | - | 0 – 8 Years | 24 – 31 Years |

1. Payback period = Number of years to recover the initial higher cost of the WTP.

The life cycle cost analysis shows that the WTP has the lowest 40-yr lifecycle cost. Figures 3 and 4 compare the anticipated Haverhill supply expenses against WTP expenses for full supply and partial supply, respectively. The WTP payback period for full supply is estimated to take up to 8 years while the partial supply payback period ranges from 24 – 31 years.

**Figure 3 - WTP vs. 100% Haverhill Supply Additional Annual Expenses**

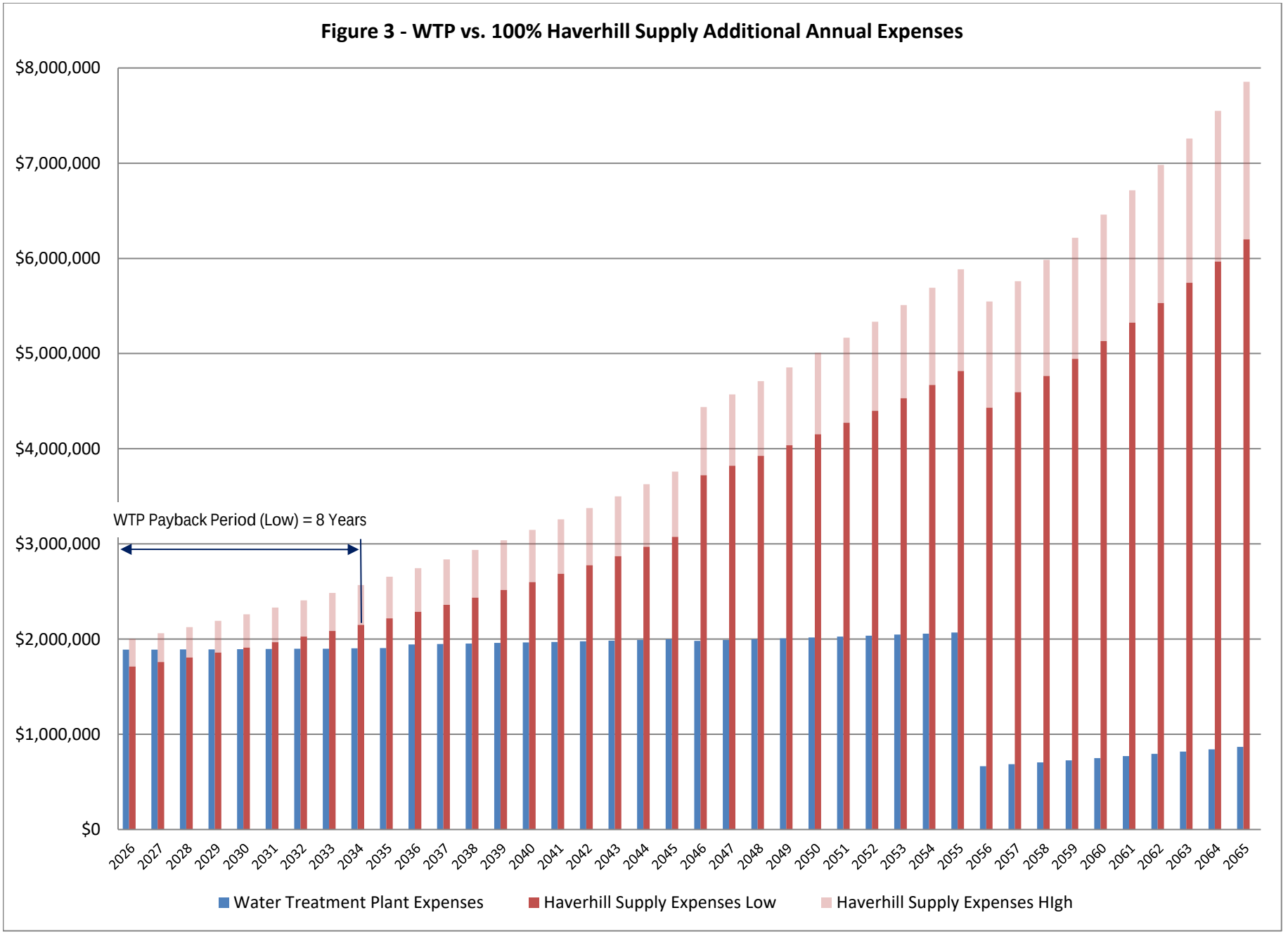
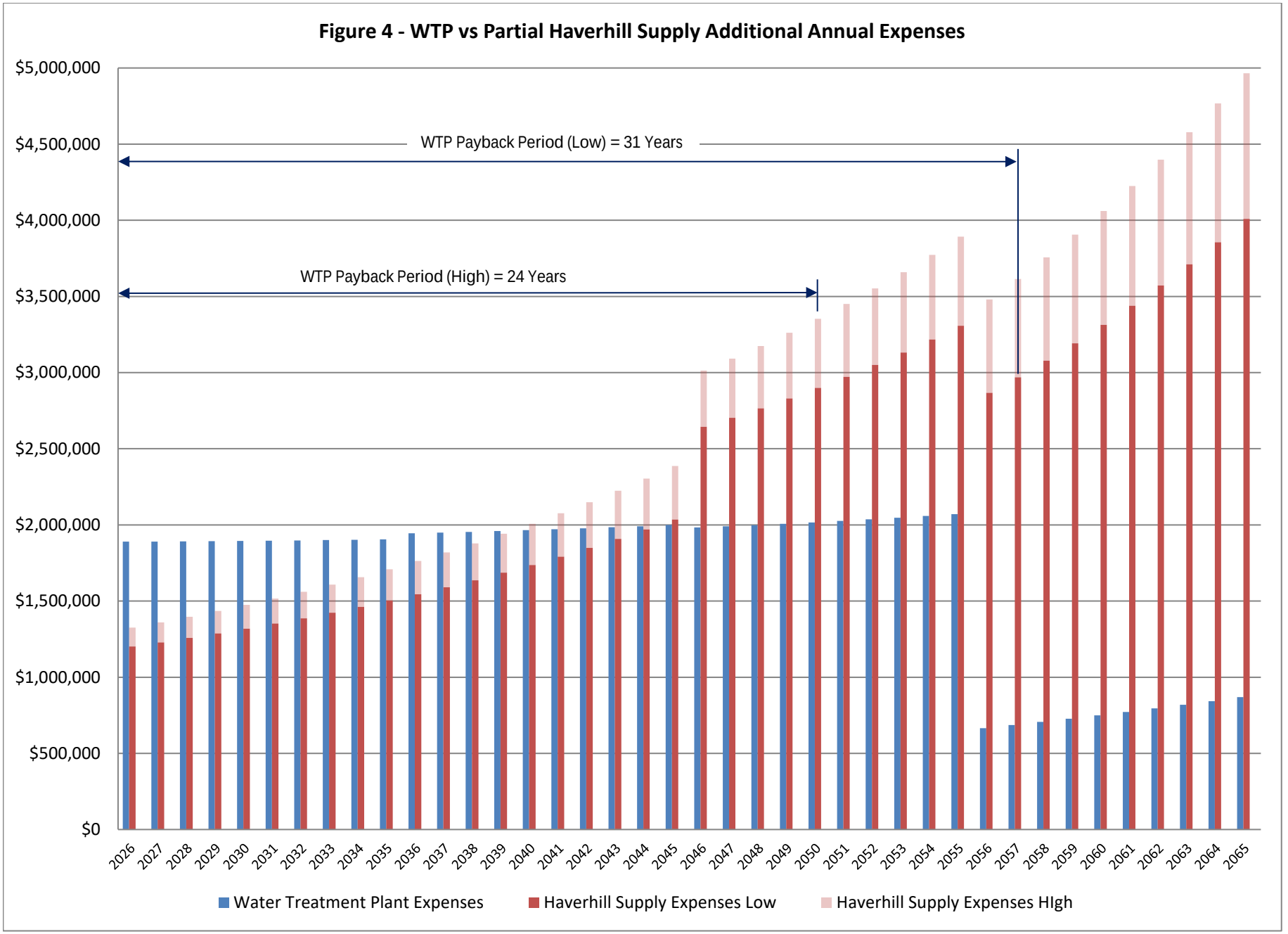


**Figure 4 - WTP vs Partial Haverhill Supply Additional Annual Expenses**



## Summary and Additional Considerations

In the next 5 years, Groveland will make what will likely be its largest investment in the Town's water system. Construction of a WTP is the highest capital cost alternative but offers the lowest life cycle cost when considering the 40-year life of the facility. Due to the costs of purchasing water from Haverhill and the improvements needed to facilitate a permanent interconnection, annual costs for full supply from Haverhill are estimated to exceed the additional estimated annual costs for the WTP within 5 years.

Water quality at Groveland's Well No. 4 currently meets existing secondary standards for iron and manganese. Limited testing at Well No. 4 suggests that per- and polyfluoroalkyl substances (PFAS) levels at this supply are also below enforceable limits recently announced by the EPA. As a result, Apex evaluated the alternative of mixing Haverhill supply with Well No. 4, to minimize water purchasing costs. This alternative extends the WTP payback period significantly to an estimated range of 24 – 31 years. If the Town intends to pursue this option, additional PFAS sampling at Well No. 4 should be conducted to confirm that levels are below the EPA enforceable limits. Additionally, future water quality decline at Well No. 4 could require the Town to transition to 100% Haverhill supply, which over the 40- year lifecycle cost analysis, is approximately twice the cost of the WTP.

Land availability to locate the required interconnection pump station is unknown at this time. If the Town elects to pursue the interconnection with Haverhill, Apex recommends that a separate alternatives analysis be performed to determine potential sites for the pump station. Additionally, the ITA approval process may take multiple years to complete and may require additional studies for approval. Apex recommends that Groveland/Haverhill request a determination of significance by the WRC at the project onset in order to fully understand the schedule impacts of the ITA approval process.