Water Storage Tank Concept Planning

Truro, MA

Prepared for:
Town of Truro, MA

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1 Executive Summary

This memorandum summarizes the development of a concept level design for a proposed water storage tank located in North Truro and evaluates the hydraulic implications of this water storage tank. This evaluation focuses on siting a water storage tank on the Town of Provincetown's well supply property, located at 247/245 Old Kings Highway, Truro, MA, which is adjacent to the Walsh Property. The Walsh Property was acquired by the Town of Truro in 2019 for municipal purposes such as housing, open space, and recreation.

The siting of a water storage tank at this location is feasible. The proposed future demands outlined in the previous Horsely Whitten Group (HWG) 2023 memorandum result in a recommended water storage tank volume of 600,000 gallons. Based on the ground elevations in the North Truro area, this water storage tank would be an elevated style water tank. This would create a new high service area in the water distribution system that would supply water to the areas of higher elevations in North Truro.

In order to fill this water storage tank, a new booster pump station should be constructed in tandem with the water storage tank. The existing South Hollow booster pump station is not adequately sized to fill the proposed water storage tank and the existing pump station does not have available space for expansion. In addition to the water storage tank and pump station, a pressure reducing valve vault would also be constructed to allow water from the newly created high service area to be reduced down to the main service area of Provincetown's water system. The booster pump station and pressure reducing valve vault concept design were outside of the scope of this study and therefore are captured from an overall recommendation standpoint, but future investigations and evaluations should be completed to advance the design concepts of these elements.

The proposed 600,000 gallon elevated tank is large for the current day water demand of North Truro. Only with increases in water demand, either through new development or new connections to the water system, will the tank fluctuate properly to maintain water quality. If timing of the water storage tank construction is prior to the completion of future development in North Truro, design elements of the water storage tank, booster pump station and pressure reducing valve vault should include provisions to force the turnover of the North Truro water storage tank to fill and drain on a frequent cycle.

Engineer's Opinion of Probable Construction Cost (EOPCC) has been developed as part of this project. The basis of the costs are RS Means, recent bids, published material prices, current labor costs and past projects. This EOPCC is based on using state wage rates for public construction, not utilizing Drinking Water State Revolving Loan Funds, and does not include costs for American Iron and Steel requirements. We caution that the accuracy of the EOPCC may vary greatly due to the current construction / infrastructure market conditions. The current market is very volatile, especially for materials due to delivery delays, scarcity of raw materials and limited production at manufacturing plants. At the present time this EOPCC should not be considered the actual construction cost, but as a relative cost the actual cost could be 15% less to 35% more than the EOPCC.

The table below shows the major items of work and expected costs. A 30% contingency has been added due to the design phase (conceptual).

Water Storge Tank Opinion of Probable Construction Cost

No.	Unit	Description	Estimated Quantity	Unit Price	Estimated Total Cost
1	LS	600,000 Gal ped. sphere tank, 145' height	1	$3,800,000	**$3,800,000**
2	LS	In-Tank Mixing System (1 tank)	1	$75,000	**$75,000**
3	LS	Piping and Valves at tank site only	1	$50,000	**$50,000**
4	LS	Site Improvements (overflow basin, fencing, etc.)	1	$150,000	**$150,000**
5	LS	Site Clearing	1	$80,000	**$80,000**
6	LS	Access Road	1	$100,000	**$100,000**
7	LS	Electrical Work/ Instrumentation Work	1	$100,000	**$100,000**
				ESTIMATED CONSTRUCTION COST	**$4,355,000**
				3.5% Mob, Demob, Bonds, Ins, etc.	**$152,425**
				30% CONTINGENCY	**$1,306,500**
				Subtotal Construction Costs	**$5,813,925**
				20% Design and Engineering Services During Construction	**$1,162,785**
				ESTIMATED TOTAL COST	**$6,976,710**

Notes:

1. Piping and valves only includes the work within the fenceline of the water storage tank and does not include any longer connecting mains beyond the site out to the distribution system.
2. Access Road only includes the work within the approach to the site
3. Does not include any land acquisition or easements

Booster Pump Station and Pressure Reducing Valve Opinion of Probable Construction Cost

No.	Unit	Description	Estimated Quantity	Unit Price	Estimated Total Cost
1	LS	Booster Pump Station 800 sq. ft. building, two (2) 50 HP split case pumps, associated piping and valves, electrical work, and site work	1	$1,500,000	**$1,500,000**
2	LS	Pressure Reducing Valve Vault Below grade vault including two pressure reducing valves along with power for monitoring and controlling valve operation	1	$200,000	**$200,000**
3	LS	Water Storage Tank Connecting Pipe 5,500 feet of new 16", 550 LF of new 12" and appurtenances to connect proposed water storge tank site to existing water distribution system.	1	$1,788,000	**$1,788,000**
4	LS	Water Distribution System Improvements If the new booster pump station is sited near the existing South Hollow pump station an additional 6,500 lf of 12-inch would be required to bring the Cloverleaf and Pond Street Areas to the high service area.	1	$1,950,000	**$1,950,000**
				ESTIMATED CONSTRUCTION COST	**$5,438,000**
				3.5% Mob, Demob, Bonds, Ins, etc.	**$190,330**
				40% CONTINGENCY	**$2,175,200**
				Subtotal Construction Cost	**$7,803,530**
				20% Design and Engineering Services During Construction	**$1,560,706**
				ESTIMATED TOTAL COST	**$9,364,236**

Notes:

1. Does not include any land acquisition or easements
2. Additional conceptual design for the booster pump station and pressure reducing valve vault is recommended prior to initiating design phase.
3. A higher contingency has been carried for these recommendations since the concepts are not as advanced as that of the water storage tank.
4. Item 4 is not required if Cloverleaf and Pond Street areas will remain in the low pressure service area.

2 Water Storage Tank Concept Design

Stantec has been retained to provide a conceptual level plan for the North Truro water storage tank including an evaluation and confirmation of the hydraulic operating parameters along with a water storage tank access road and site plan.

The basis of design for the storage tank includes:

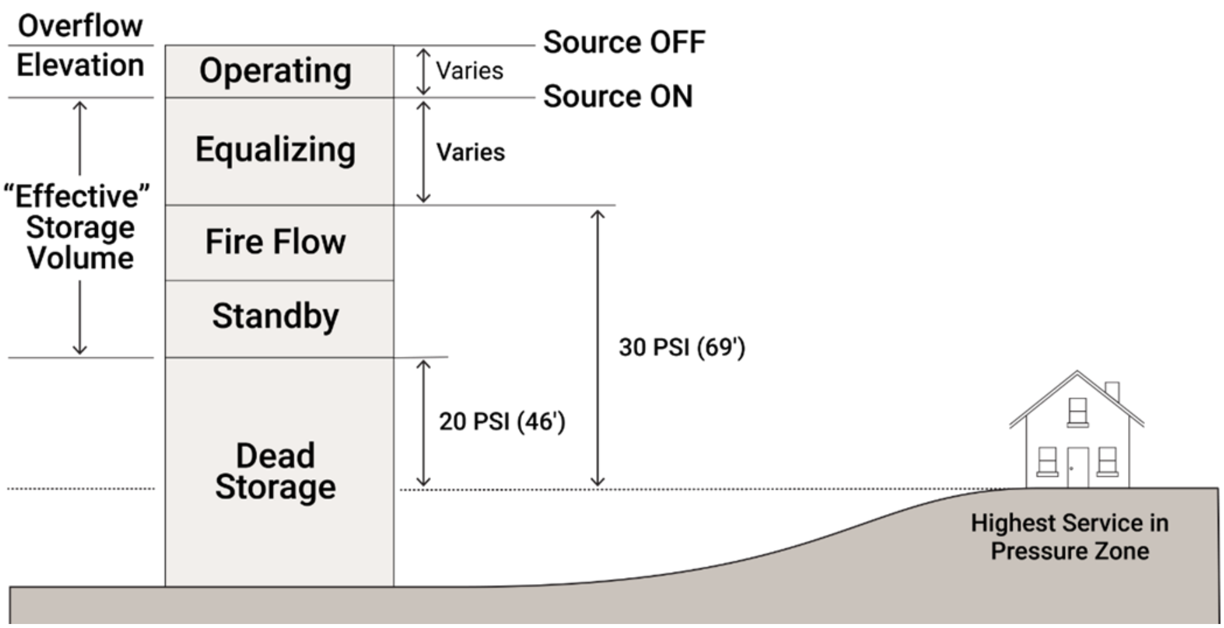
- Review of the Horsley Witten Group (HWG) April 2023 memorandum, noting any changes to the recommendations of the storage tank sizing.
- Review of the site and plans of existing surrounding areas.
- Inclusion of an active tank mixer.
- Instrumentation to provide temperature and level to SCADA systems.
- Review of FAA regulations to determine whether FAA lighting is required and to what level.
- Accessories – door and security light into the base of the pedestal. Other accessories include an overflow drainage basin (or rip rap basin), finial vent, roof handrails, interior ladders (including safety climb system) or stairs, platforms, access hatches, and manways.
- Foundation shall have a 10-foot-wide diameter ring of crushed stone with filter fabric around the base of the tank to maintain foundation integrity;
- Coatings shall meet NSF requirements on interior and exterior of tank, including mildew resistant coating on underside of tank bowl if a pedestal spheroid is selected;

2.1 Water Storage Tank Sizing Considerations

The Town of Truro's (Town) existing water supply is provided by the Town of Provincetown (Provincetown). The Town has recently acquired the Walsh Property, which is anticipated to hold up to 260 homes. This proposed development for the Town, along with other potential developments, would increase water demand, including the development at higher elevations, necessitating the need for additional water storage capacity. Provincetown currently has two water storage tanks, which service what will become the main or low-pressure system, and total 6.5 million gallons (MG). The proposed North Truro water storage tank would be in the high-pressure system. Based on the Horsely Whitten Group (HWG) report, the high-pressure system would have a Hydraulic Grade Line (HGL) of EL 220-feet.

Storage volume can be broken down into the following components: operating storage, equalization storage fire flow, standby storage, and dead (unusable) storage, as shown in Figure 2-1 below. Effective volume is equal to the total volume less any dead storage. Operational storage is the volume devoted to supplying the water system under normal operating conditions and while the sources of supply are in the "off" status. Equalization storage is the tank volume which stores water during periods of low demand and releases the water under periods of high demands. This equalizing storage helps to prevent the need for filling the tanks during peak demand hours.

Figure 1: Usable Storage



2.1.1 Current North Truro Demands

Stantec reviewed the calculations that were performed by HWG regarding the volume of the proposed tank. Those calculations are based on a single year of data (2022), the max day demand peaking factor, and future development needs based on a residential gallons per capita per day (RGCPD) of 65 gallons per day per person, which is the maximum allowed by MassDEP and the EPA. Table 1 presents the historical data presented in the HWG report.

Table 1: Historical North Truro Water Demand Data – From HWG Report

Year	Yearly Consumption (MG)	Max Day Demand (MG)	20% Of Max Day Demand (MG)	Average Day Demand (MG)
2022	21	0.229	0.046	0.090

Ratio of ADD to MDD (peaking factor) is 2.54.

Stantec assumed that the basic fire flow is 2,000 gpm, for a three-hour duration, or a total of 360,000 gallons. This is based on the HWG report as the nature of the commercial building usage and fire requirements are unknown at this time. Equalization is typically accounted for as 20% of the MDD, or 46,000 gallons.

The total water storage requirement for the water system is the sum of the equalization storage and the fire flow requirement. To meet the more conservative US EPA vulnerability requirements[1], the water storage requirement is the sum of the ADD plus fire flow. Refer to Table 2,and Table 3 below.

Table 2: Quantity of Storage by Type – North Truro Current Requirements

Type of Storage Needs	Quantity
Fire Flow Needs[1]	360,000 gallons
Equalization[1]	46,000 gallons
Average Day Demand	90,000 gallons
Maximum Day Demand	229,000 gallons

Table 3: Quantity of Current Water Storage Requirements – High-Pressure System

Type of Storage Needs	Quantity
Fire Flow + Equalization	406,000 gallons
Average Day Demand	90,000 gallons
Fire Flow + Average Day	450,000 gallons

Note: This table includes the total storage required for the high-pressure system, but does not include future / potential development.

To address system vulnerability concerns, the minimum storage amount should be the Fire Flow plus Average Day (0.450 MG). In the event that the system is unavailable, this affords the North Truro area approximately 5 days' worth of ADD storage, and time to find another temporary source of water while the system is brought back online, by obtaining water from interconnections or other emergency supply pumping. As storage tanks come in standard capacities, the 0.450 MG figure should be rounded up to 0.5 MG. The following section evaluates water storage requirements of future demand (near term) and long term.

[1] The EPA Vulnerability assessment recommends at least 24 hours of storage (ADD) be on site, preferably more than one day should be available.

2.1.2 Future Demand Planning

A build-out analysis was completed to ensure that future water storage capacity would be adequate to meet anticipated residential and commercial growth in North Truro. The future demands come from four (4) separate projects as delineated in the HWG report;

- the Walsh Property projected to hold up to 260 homes,
- the Cloverleaf Development (Anticipated water use - 6,305 gallons per day)
- the Pond Road Extension (Anticipated water use - 10,238 gallons per day)
- An additional 250 homes as requested by the Town of Truro.

Stantec analyzed the two years of Provincetown Annual Statistical Reports (2022, and 2023), which indicate that the RGPCD was 58 in 2022, and only 49 in 2023. These are considered to be low RGPCD, so the conservative RGPCD of 65 has been used in Stantec's calculations. Stantec reviewed publicly available data for the current (2025) average number of people per house in Truro. The current estimate is 2.18 people per home, which is also used in Stantec's calculations. The HWG report assumed the 2022 average number of people per home, which was 1.87. Based on those assumptions, the usage of the future demands as indicated in Table 4. The formula used to calculate the demand of the Walsh Property and Additional Homes is:

$$Calculated\ Usage\ (gpd)\ =\ (\#\ of\ homes)\ x\ (65\ RGPCD)\ x\ (2.18\ residents\ /\ home)$$

Table 4: Estimated Demands for 2030

Development	From HWG Report (gpd)	Calculated (gpd)	MG/Year
Cloverleaf Development	6,305		**2.30**
Pond Road Extension	10,238		**3.74**
Walsh Property (260 homes)		36,842	**13.45**
Additional Homes requested (250 homes)		35,425	**12.93**
		Total Future Estimated Demands in MGY	**32.42**

MG/Year was calculated based on the gpd x 365 days.

This revises previously presented data in Table 2-1 as seen below in Table 2-5.

Table 5: Future and Historical North Truro Water Demand

Year	Yearly Consumption (MG)	Max Day Demand (MG)	20% of Max Day Demand (MG)	Average Day Demand (MG)
Future	32.42	0.225	0.045	0.089
2022	21.00	0.229	0.046	0.090

Ratio of ADD to MDD (peaking factor) is 2.54.

The fire flow needs do not change from prior calculations. With the revised data from Table 2-5 above, Tables 2-2 and 2-3 change as indicated below in Table 2-6 and 2-7.

Table 6: Quantity of Storage by Type – North Truro Future Requirements

Type of Storage Needs	Quantity w/out Future Buildout	Quantity with Future Buildout
Fire Flow Needs	360,000 gallons	360,000 gallons
Equalization	46,000 gallons	91,000 gallons
Average Day Demand	90,000 gallons	179,000 gallons
Maximum Day Demand	229,000 gallons	225,000 gallons

Table 7: Quantity of Future Water Storage Requirements – High-Pressure System

Type of Storage Needs	Quantity w/out Future Buildout	Quantity with Future Buildout
Fire Flow + Equalization	406,000 gallons	451,000 gallons
Average Day Demand	90,000 gallons	179,000 gallons
Fire Flow + Average Day	450,000 gallons	539,000 gallons

Based on standard tank sizes, while addressing vulnerability and redundancy, as well as potential for commercial and residential build-out, and water quality concerns, 0.5 MG, 0.6 MG or 0.75 MG could be used for the quantity of storage. These options all exceed one day of average day water usage in current day demands and exceed one day of water use in future day demands. Even though the projected average day in the future is slightly above 0.5 MG, storage requirements should be based on a range of data, not a single year. The HWG report concluded the total volume required was 680,000 gallons, which translated to a 750,000 gallon tank (rounding up for standard tank sizes). Based on available data, Stantec's knowledge of tank pricing related to standard sizing, it is recommended that Truro proceed with a 0.6 MG tank. This tank size is readily available in the pedestal spheroid or the composite style tanks. Of the two tank styles, the Pedestal Spheroid has a head[2] height of 40-feet, and the Composite Tank has a head height of 32.5-feet. For the purposes of this report, the 40-feet head height has been used as it is the worst-case scenario.

2.1.3 Detailed Tank Sizing

This report focuses on the high-pressure system in terms of the sizing of the new tank. The required elevation to maintain a system pressure of 20 psi is at elevation 164.2 feet, based on the highest house's

[2] Head: The vertical distance between the bottom of the bowl and the overflow in elevated tanks.

threshold which has an elevation of 118 feet (currently). The highest potential new homes (future buildout) are located at EL 140 (located within the Walsh property). Stantec has analyzed the new tank using multiple variables – the first of which is the highest threshold elevation for servicing homes/businesses, utilizing both the existing EL 118 and the proposed EL 140. Stantec also analyzed the new tank hydraulics based on the minimum usable storage elevation – the MassDEP and EPA require 20 psi as a service pressure at the threshold elevation, as indicated in Figure 2-1 above. However, Provincetown requires 40 psi as a threshold service elevation. The HWG report indicates that Provincetown may not require 40 psi for this high-pressure zone. As such, Stantec analyzed the tank at 20 psi, 30 psi, 35 psi and 40 psi at the threshold. This provides the amount of dead storage that could be in the tank. Our initial calculations were based on the HWG's report setting the overflow (hydraulic grade line) at EL 220. Dead storage should be minimized to 10% or less of the tank's total volume. The calculations are summarized in Table 2-8 below.

Table 8: Dead (Inactive) Storage Amounts – Overflow at EL 220

	Dead (Inactive) Storage Amount			
	Highest Threshold EL 118		Highest Threshold EL 140	
Minimum Threshold Pressure	Gallons	% of Tank	Gallons	% of Tank
20 psi	0	0.0	93,000	15.5
30 psi	109,500	18.3	439,500	73.3
35 psi	282,750	47.1	600,000	100
40 psi	456,000	76.0	600,000	100

Regardless of which highest threshold elevation (highest serviceable elevation) is desired to be used, to provide pressure for fire flow and maintain the lowest amount of dead water, the Provincetown minimum pressure at the threshold of 40 psi cannot be met if the overflow is set at EL 220. The potentially lower 35 psi pressure at the threshold cannot be met if the highest serviceable elevation is EL 140, and due to the high dead water amount at the current serviceable elevation of 118, it is not recommended to use that overflow elevation. Provided that the tank only needs to meet the EPA / MassDEP minimum threshold elevation of 20 psi and fire flow, and the service elevation remains at EL 118 (reducing the location of the potential homes on the Walsh property), the new tank will work with an overflow set at EL 220. The new tank will work with an overflow of EL 220 for the highest serviceable elevation of 140, with the realization that there is 93,000 gallons of dead storage which is slightly more than is considered acceptable within the tank industry. A visual representation of these elevations is shown in Figures 2-2 and 2-3 below.

If the desire to service the new high-pressure zone is to follow Provincetown's minimum service pressure of 40 psi, the overflow elevation would need to increase to EL 250 if the service elevation remains EL 118, and to EL 272 if the service elevation is 140. A visual representation of these elevations is shown in Figures 2and 3 below.

Adjusting the overflow elevation higher will have impacts on the lowest served elevation within the distribution system. Using an overflow of EL 272, and a lowest threshold elevation within the new pressure zone of 59, 68, or 78 (depending on where the limits of the new zone are), the service pressures at the lowest threshold elevation of EL 59 (worst case) become 92 psi, at EL 68 become 88 psi, and at EL 78 provides a service elevation of 84 psi. All of these are acceptable, and the lowest threshold elevation of 59 should be the lowest served.

Based on the minimum service pressure at the threshold elevation of 20 psi, dead water, and servicing all homes between EL 59 and EL 140, Stantec recommends the new tank be a 0.6 MG tank, with an overflow elevation set at EL 272. This is the scenario shown in Figure 5.

Figure 2: Dead Storage with Highest User at EL 118, Overflow EL 220

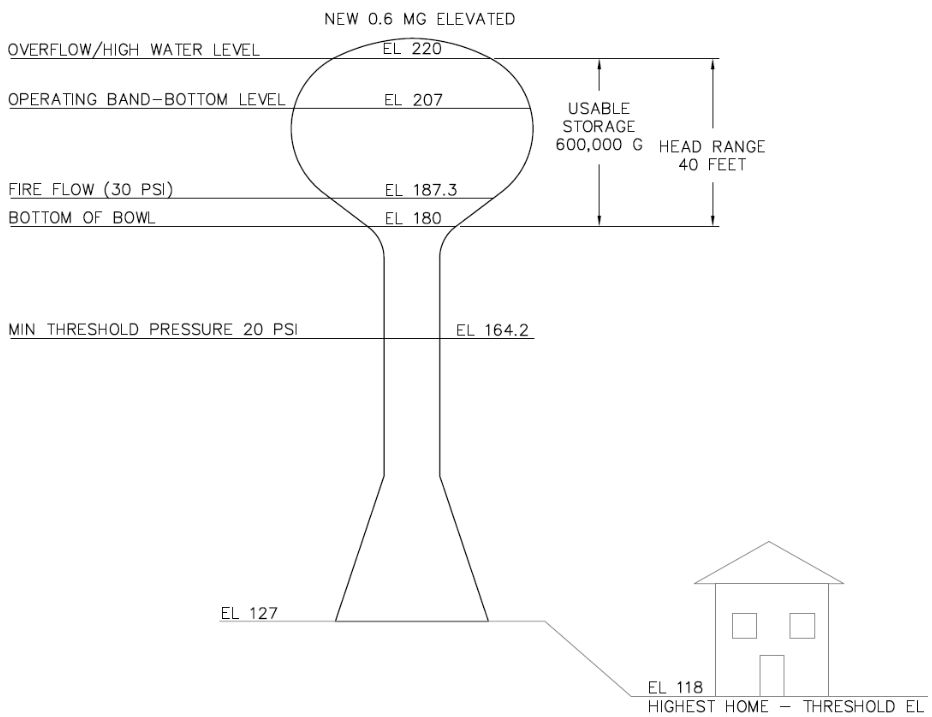


Figure 3: Dead Storage with Highest User at EL 140, Overflow EL 220

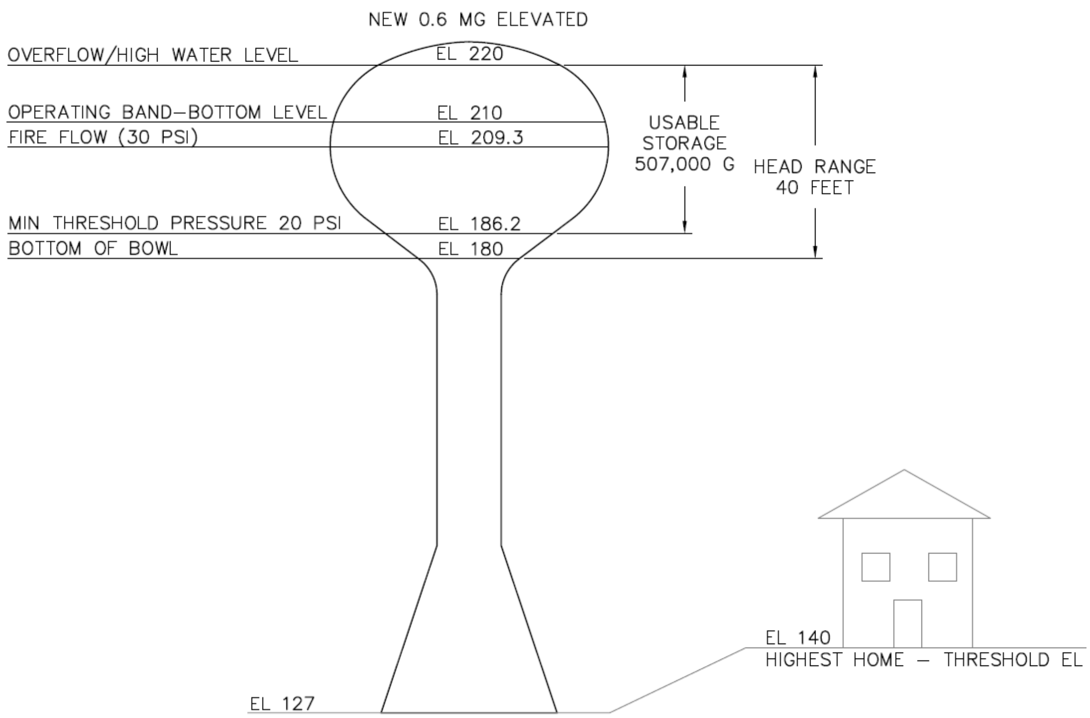


Figure 4: Dead Storage with Highest User at EL 118, Overflow EL 250

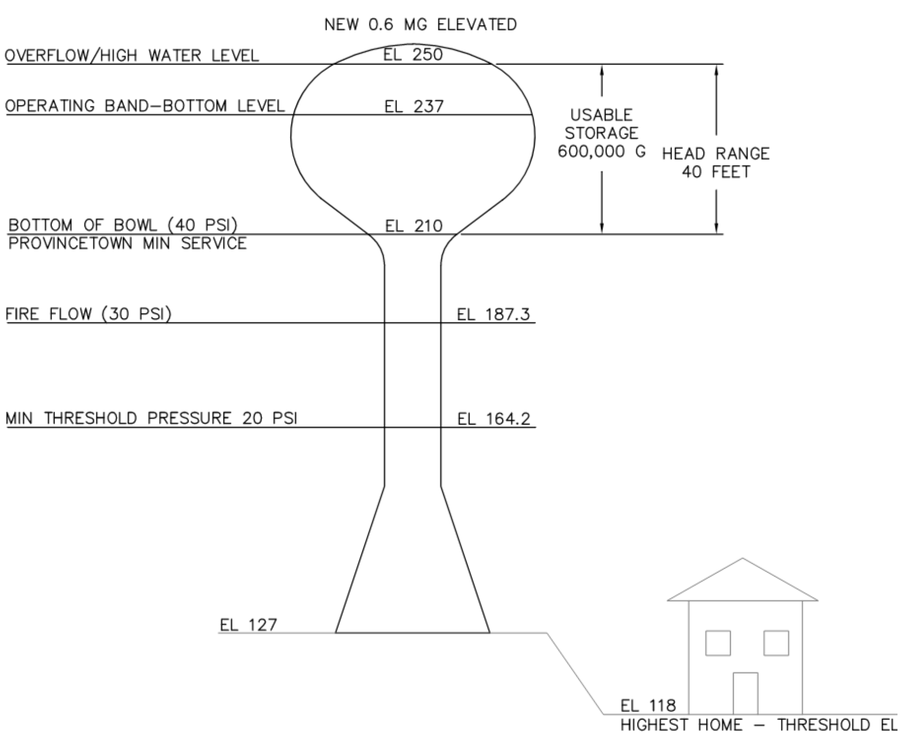
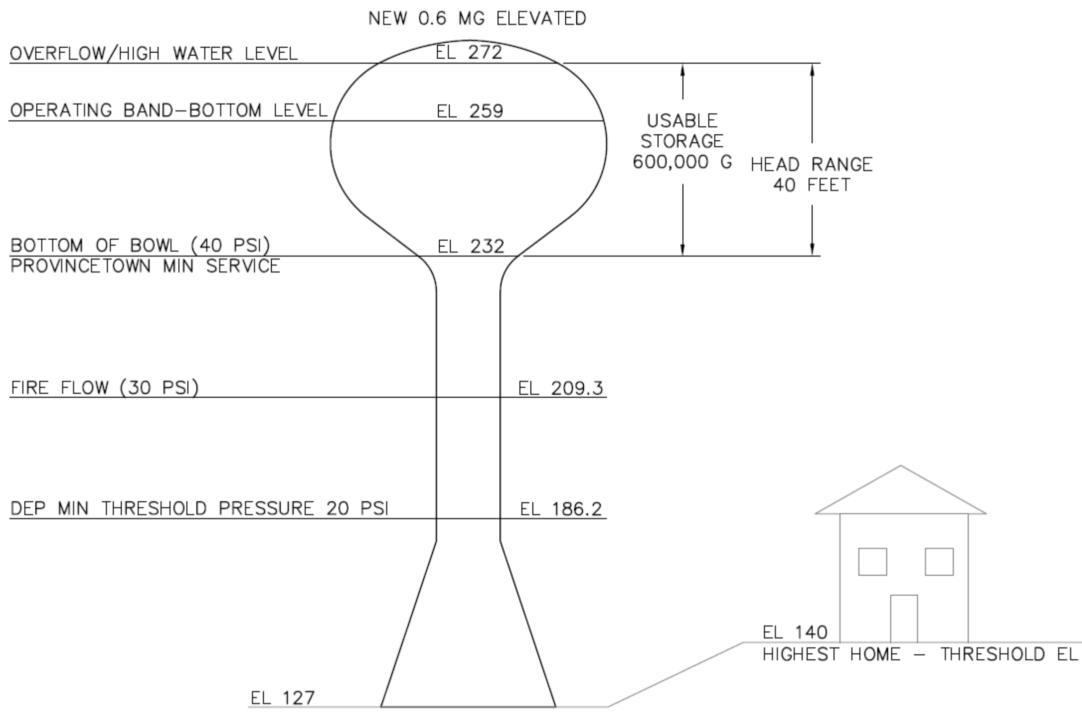


Figure 5: Dead Storage with Highest User at EL 140, Overflow EL 272



2.2 Water Storage Tank Site

The subsequent paragraphs discuss options about the site, including issues such as tree removal, fencing, lighting, and environmental concerns. Information on the access road (driveway) can be found in Section 4.0.

2.2.1 Environmental Concerns

The entire site is densely forested. Prior to any work being completed, the access road (driveway) should be cleared of all trees, brush, and vegetation, including stump removal. The tank site itself should be cleared of trees and stumps for the purposes of constructing and maintaining the tank. The minimum size for tank construction, is 100-feet by 100-feet. A perimeter fence will be located around the tank site, most likely at the 100-feet by 100-feet location. At a minimum, in order to design the site to a biddable point, the access road (driveway) to the tank site location, and the diameter of the tank foundation (estimated 30-foot for a pedestal spheroid) will need to be cleared for subsurface investigations to be completed.

MassMapper[3] was reviewed for GIS data in relationship to the tank parcel to determine if there are any areas of environmental concern. A review of the available data on February 12, 2025 has indicated that the property:

- is not of historical significance,
- does not fall under the community preservation act,
- is not in an area of critical environmental concern (ACEC),
- is considered to be part of a hiking trail (the existing road/driveway coming into the property; however, the portion of the property being looked at for the tank does not have a trail located through it),
- is within the habitat of a local rare species (PH 892), and
- is within the critical natural landscape,

Based on this review, it is anticipated that there will be environmental issues or concerns related to the priority habitat / rare species, and constraints related to the critical natural landscape that will require special attention, permitting and coordination during design. Typical environmental controls such as silt sacks, straw wattles / bales, and siltation fences will be required during construction to prevent surface runoff and erosion; however, depending on the findings related to the issues indicated above, these controls may need to be modified or there may be time of year restrictions for construction work.

2.2.2 Security

2.2.2.1 Lighting

Lighting on the access road/driveway should be provided for security, safety, and utility. Lighting in this area would be a deterrent to anyone attempting to access the site and provide ambient light during the darker hours of the day. The site lighting would also provide the operators needing access at night increased site visibility.

Several options for access road lighting are available to choose from. Traditional lighting choices include pole mounted lights (similar to those in parking lots) and streetlights (mounted on telephone poles). Commercial bollards[4] with LED lights can be seen in the image on the right. Bollards up the access road are the less traditional but recommended option.

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[3] https://maps.massgis.digital.mass.gov/MassMapper/MassMapper.html
[4] Image from https://www.eledlights.com/products/18w-color-adjustable-bollard-led-retrofit

Whether bollards or traditional lighting is selected for the site, photocell controls are recommended over timer controls. Photocell controls would decrease the energy consumption of the lights without reducing the utility of the lights or raising the system maintenance needs, as photocells do not require resetting throughout the year.

A pole-mounted light by the access gate is also recommended.

2.2.2.2 Fencing

Site security at the Truro tank site can be accomplished with an 8-foot-high chain link fence topped with optional barbed wire around the perimeter of the tank site. A double leaf vehicle gate will be included in the fence to allow maintenance access to the tank. A triangle gate will be located approximately 15-feet from the existing driveway to prevent unauthorized vehicles from traveling down the new access road. See image below for a triangle gate. If the existing site at 245 Old Kings Highway already has fencing and gates preventing unauthorized people from entering, the additional triangle gate would not be required.

Figure 6: Triangle Gate

2.2.2.3 Piping

The tank pipeline size shall be determined during more detailed design. A single inlet / outlet pipe will penetrate the tank foundation then head into the bowl. The tank pipeline will not reduce in size. The piping can be ductile iron pipe or steel pipe; however, it is recommended to use ductile iron up to the tank and then steel piping through the foundation until termination at the bowl – this makes coating and future maintenance easier within the tank structure.

Additional piping requirements include piping from the tank overflow basin to a detention basin, piping for a hydrant to drain the tank, and additional control valve piping near the tank. The hydrant will discharge into the overflow basin, travel through the basin and out to the detention basin. The detention basin is riprap lined, which dechlorinates water as it flows over the rocks, and allows for the water to slowly drain from the basin into the ground. It also dissipates the energy of the water and overflow the basin to reduce erosion. A typical overflow basin and detention basin detail are shown below. This basin will be customized based on tank inlet, outlet, and overflow piping size.

Figure 7: Detention Basin Elevation

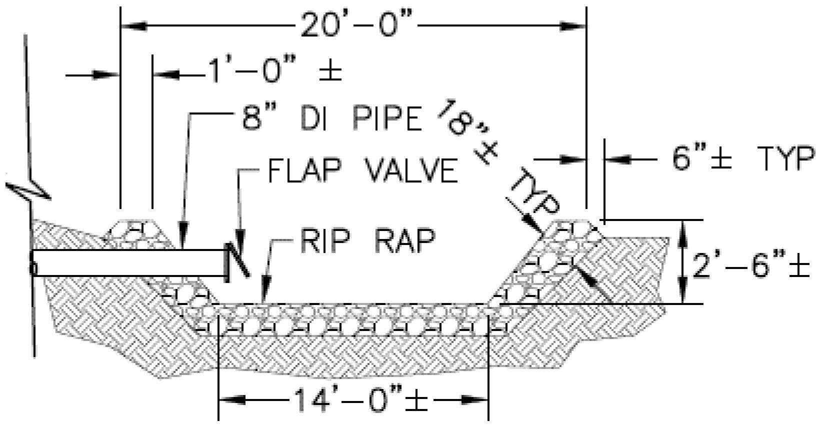
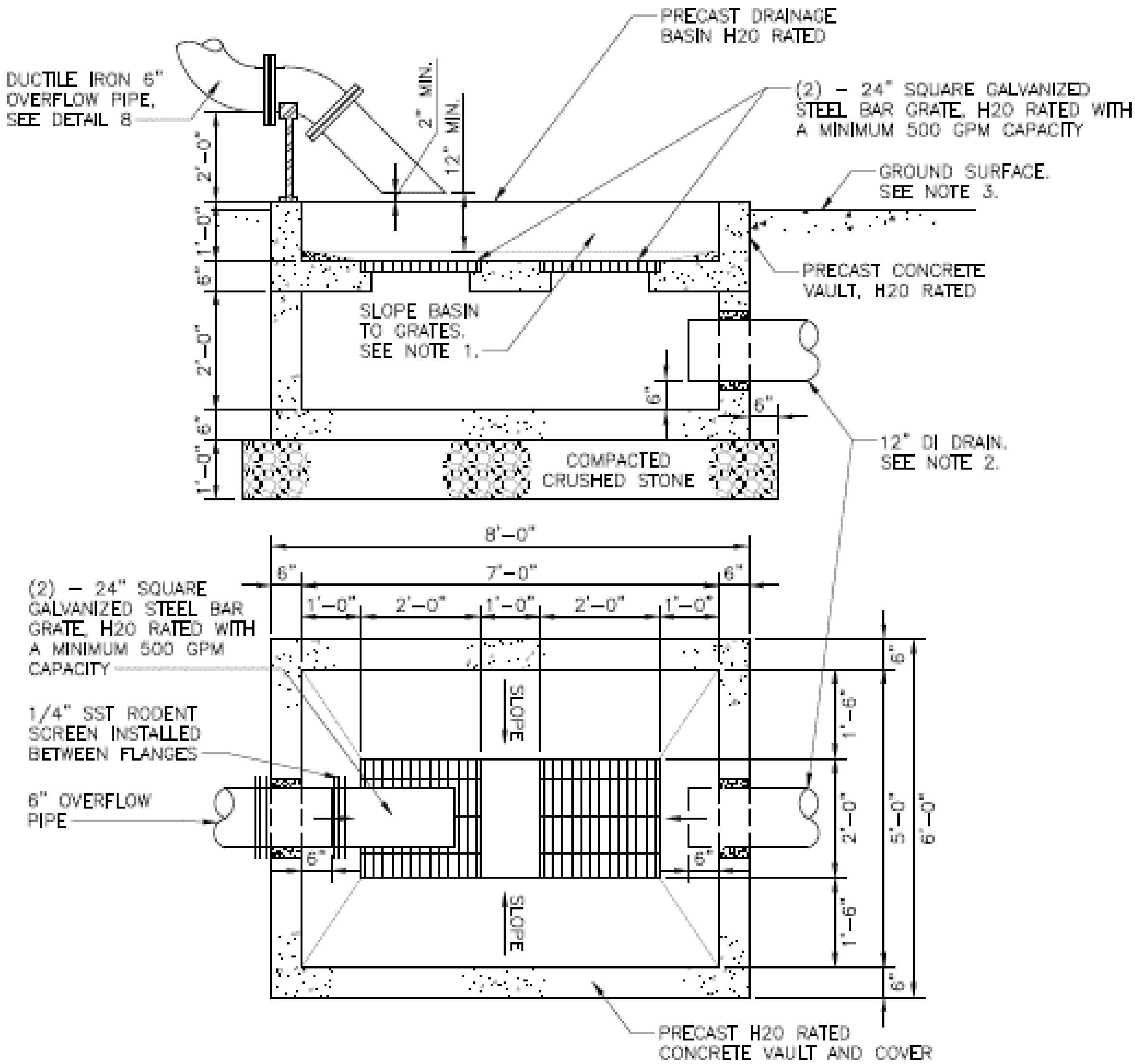


Figure 8: Overflow Basin



2.2.3 Access Road / driveway

The tank site and access road / driveway shall be designed to allow construction vehicles and crane access to the site for construction of the new water tank. The access roadway will be at least 15-feet wide, with sufficient corner radius as needed and have a maximum grade of 6%.

Roadbed materials for construction of the access road will comprise of 8-inch gravel borrow, 6-inch dense graded stone, and a 3-inch temporary paved driveway apron entrance/tracking pad, at a minimum 50-foot long. Upon completion of the new water tank, the temporary driveway will be removed and a 15-foot wide paved access road consisting of new 2.5-inch intermediate and 1.5-inch surface courses will be installed. A parking/turnaround area will be provided at the tank entrance.

2.3 Tank Styles

2.3.1 Elevated Tank Types

2.3.1.1 Pedestal Spheroid

(See brochure in Appendix A for more details)

Pedestal Spheroid tanks are constructed of welded steel with a flared base at the bottom with a straight column, and a rounded spheroid (ball) on top. All access to the top of the tank is through the (dry) interior of the tank. The flared base (pedestal) has a personnel-door and larger tanks can be equipped with a roll up door as well. A pedestal spheroid tank comes in capacities ranging from 50,000 gallons to 1.5 million gallons of storage. As with any new storage tank, using manufacturer's standard head ranges (the distance from the bottom of the bowl to the overflow/high water line) reduces costs. This style of tank has limited space for running cables from the bottom of the tank to the top of the tank. For a 600,000-gallon tank in this style, the diameter would be 58.167-feet and have an 8-foot diameter stem. The image on the right is a typical pedesphere elevated storage tank. The new elevated tank would have an overall tank height of approximately 103-feet with an overflow elevation of 272, and will maintain a system pressure of 20-psi.

2.3.1.2 Composite Tanks

(See brochure in Appendix B for more details)

Composite tanks consist of a steel bowl on top of a concrete pedestal. Composite tanks (photo to the right) come in capacities ranging from 500,000 gallons to 3.50 million gallons of storage. For a 600,000-gallon tank, the pedestal (the bottom portion of the tank, frequently called the column) diameter is 28-feet dependent on soil conditions, and the tank bowl diameter would be 62-feet. Pedestal diameters are determined by soil bearing capacities, total tank height, and tank size. All the tank dimensions will be determined by the manufacturer during design and construction. Regardless of the pedestal diameter, the site has the adequate space to construct this style of tank. Maintenance (cleaning and painting) of this style of tank does require a complete coating, from the top of the tank to the foundation on the pedestal. Like pedestal spheroid tanks, these tanks are equipped with a personnel-door at the base, and depending on the column diameter, it is often possible to add a roll-up door to the base.

The benefits to a composite tank over an all-steel tank is the insulative properties of the concrete, which assist with keeping the interior of the pedestal cooler in the summer and warmer in the winter, simply because the concrete is thicker walled.

2.3.1.3 Recommended Style of Tank

Cost is a factor. Traditionally, the pedestal spheroid tank is less expensive. However, if the tank requires a booster pump station, there may be a cost savings by using a composite tank and placing the booster pump station in the pedestal of the tank. It is recommended that the pedestal spheroid style tank be constructed.

2.4 Tank Appurtenances

2.4.1 Coatings

Coatings on the tank will consist of NSF 61 coatings for the interior surfaces in white. The exterior coatings are not required to be NSF 61, but for a pedestal spheroid style tank, the underside of the bowl, and the pedestal column and bell should receive a mildew resistant coating. Coatings are typically chosen from the manufacturer's standard color palette and most municipalities choose a single color. However, Sherwin Williams now has a "Water Tank Color Designer[5]" (design tool) that allow engineers

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[5] https://swcoloryourtank.com/

and owners to produce simple renderings of potential tanks in a variety of colors, patterns and logos. Additionally, Tnemec also has a "Tank 3D" tool that is similar to allow engineers and owners to produce simple renderings of tanks in a variety of colors, patterns, and logos. Neither design tool allows for exact configurations (size / height) to be coated but does provide for a number of tank styles in limited capacities. These tools are available to anyone and will be used during the next phase of design to provide some general visuals of the tank.

2.4.2 Piping / At and Below Grade Considerations

Piping for the tank shall consist of a single inlet/outlet pipe through the foundation. On the exterior of the tank, the overflow will drain to an overflow basin, which will then either daylight the flow or the flow can be piped to a sewer or storm drain system. The overflow basin provides the DEP-required air gap separation and prevents erosion near the tank. Other exterior piping features will include valving outside the tank foundation for taking the tank out of service, and a hydrant for draining the tank for maintenance. Refer to Paragraph 2.2.2.3 for more information on the piping.

2.4.3 Equipment

Tanks are sized such that they frequently hold more water than is used in any given 24-hour period. To provide the best water quality, the AWWA recommends that all potable water storage tanks turnover (completely empty and refill) at least once every three days. Although there are two categories of mixers on the market (passive and active mixers), passive mixers only work during a fill cycle. For the most part, passive mixers do best in clearwell tanks, or tanks that turnover multiple times per day. The MassDEP requires that all tanks are "homogenous", meaning a mixer is required. As such, it is recommended that an active mixer be installed in the tank. An active mixer is powered and runs 24 / 7, 365 days a year. The mixer prevents stratification resulting in better water quality and less ice build-up in the winter months. The mixing of the tank water makes it homogenous, providing a consistent water age and quality throughout the tank. The recommended submersible mixer for the North Truro water storage tank is a Gridbee® GS-12 Mixer as manufactured by Ixom Watercare[6] or a Pax PWM-400 impeller style submersible mixer by PAX Water Technologies.[7] It should be noted that these are the only two companies that produce water lubricated, no-maintenance mixers that are NSF 61 certified and for use in potable water storage tanks that meet the application requirements. Therefore, the specification will not list an "or equal" and a proprietary memo may be required. The GS-12 mixer is a sheet flow mixer, meaning it pulls water from the bottom of the tank bowl via the bottom of the mixer, and pushes the water out the top of the mixer in a sheet. The PWM-400 mixer is an impeller style mixer that has a spiral impeller located on a tripod. The impeller spins causing the water to swirl, which induces mixing. This is similar to the way a whirlpool works, but at much slower velocities.

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[6] https://www.ixomwatercare.com/equipment/gs-series-submersible-mixers
[7] https://www.paxwater.com/impeller-mixers

2.4.4 Lighting

The Town can choose from two tank lighting options: traditional lights (such as pole and/or fence lighting) or "uplighting" or "downlighting" – which light the tank. Either option would enhance the tank security.

Uplighting[8] is recommended for multiple reasons. Uplighting highlights the tank, potentially changing the perceived view of "eyesore" or "blight on landscape" to "art" or "signage." Uplighting can be put further up the tank to highlight the bowl (image on right) or be installed at ground level. In addition to improving the aesthetics of the tank, uplighting would reduce the ambient light levels that would reach housing adjacent to the site.

Security lighting above the tank door would come as standard with any tank type selected; however, it should be noted that this only lights a small portion of the base.

Interior tank lighting would be assessed with space usage in mind. Whatever primary end use the Town decides on for the interior of the tank, the light levels within the tank would be proposed to conform to recommended light levels for either the intended end use or typical tank interiors, whichever recommended light level is highest.

Lighting controls for the tank are recommended. The exterior lighting for the tank is recommended to be controlled via photocell to reduce the energy consumption of the lights without compromising the lights' utility. Lighting controls for the tank interior lighting would be assessed when the intended use of the tank interior space is finalized.

Should the proposed tank exceed 200-feet in height, the exterior tank lighting would be designed to meet FAA regulations[9]. Based on the available data, the tank will not exceed the height requirements, or any of the special conditions and FAA lighting will not be required.

2.4.5 Instrumentation

The tank will be equipped with instrumentation to monitor a few conditions including, level and temperature, of the water. In addition to the instrumentation signals, feedback from a tank mixer and security signals shall be integrated into a small local controller. The tank would be connected to Provincetown's existing SCADA system.

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[8] https://m.facebook.com/AvonLakeWater/photos/a.374024422630297/3157788717587173/?type=3
[9] FAA Regulations: https://www.faa.gov/faq/what-are-requirements-aircraft-warning-lights-tall-structures

2.4.6 Electrical

The tank and site will require new electrical service to feed the proposed loads including the site lighting, tank lighting, active mixer, instrumentation for the SCADA system, and any other electrical elements intended for the site.

The existing electrical site conditions will be assessed for any coordination requirements, including finding an appropriate location for an above ground cabinet with a meter and a small load center to feed the electrical loads intended for the site.

2.5 Storage Tank Design Summary

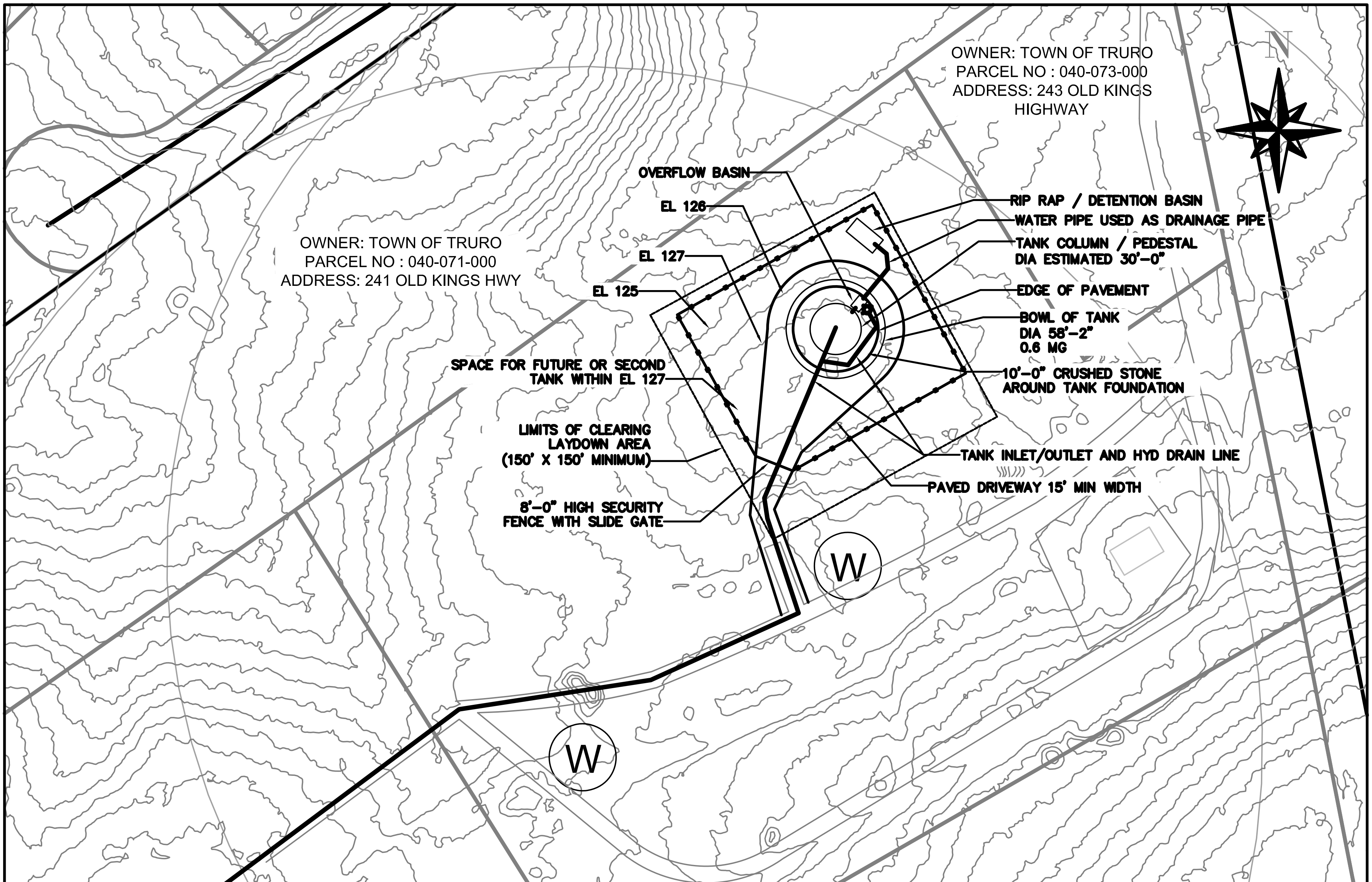
The design criteria are found throughout the various sections of the report are summarized below. These recommendations will be used as the basis of the Tank Design.

- The site requires tree removal, security, lighting, and piping. The site needs to be cleared of trees within the 100-foot square parcel. The site clearing is necessary for construction.
- The new tank requires 539,000 gallons of storage, which translates to a 0.6 MG tank size. This provides for 360,000 gallons of fire flow, plus the average day demand with future buildout of 179,000 gallons. Based on the ground elevation, and estimated highest served area from topographic maps, Stantec recommends the overflow elevation be set at EL 272. This allows for service of all structures with a threshold elevation between EL 59 and EL 140.
- The new tank would be located within the habitat of a local rare species and that may require special conditions in the tank design package. Security lighting and fencing are recommended, with the majority of site lighting being low level to reduce light pollution. Access roads / driveways should be 15 feet wide.
- The style of tank will be a pedestal spheroid style elevated tank. This tank has a steel pedestal base and a steel bowl.
- The tank is not expected to exceed 200-feet in height and does not require any special FAA lighting considerations.
- A mixer will be provided in the new tank.

2.6 Conceptual Tank Siting Plan

Drawing C-101 (next page) shows a conceptual tank siting plan for the new tank. The tank would be located on the existing well site parcel (No. 040-073-000) located at 243 Old Kings Highway. Drawing C-101 provides general dimensions based on Chicago Bridge and Iron's (CB&I's) standard dimensions. The dimensions do vary from manufacturer to manufacturer but tend to be similar. Other manufacturers include Caldwell Tanks, Phoenix Tanks, and Landmark Tanks. The pedestal diameter (at the widest spot at ground level) is estimated based on experience; however, the pedestal diameter is dependent on but not limited to the soil bearing pressure, the type of foundation, snow, wind and seismic loading, and each tank manufacturer's design.

Drawing C-101 ensures that in the future (approximately 75 years from construction completion) there is room for a replacement tank based on estimated useful life of steel tanks. By allocating space for this future tank now, when it is time to replace the current tank, there is room on site to install a new tank of similar design and size, while the existing tank remains in service. Once the replacement tank is online, the old tank can be removed from service and demolished. The alternating of tank sites is beneficial to always have room for a replacement tank on this site. This future tank site can also be used before 75-years to install a second tank at some point in the future if demand requires it (e.g. – storage needs are 1.5 times more than what is available, so a second duplicate sized tank is installed to provide the additional storage, or a larger tank is installed that will hold the complete storage needs, or redundancy is required).



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ED

Stantec

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www.stantec.com

Notes

0 80 160 Feet

Client/Project
TOWN OF TRURO, MA
NORTH TRURO TANK

Project No.
195151014

Title
CONCEPTUAL TANK SITING

Revision
0

Date
2025.03.27

Reference Sheet
C-101

Figure No.
1

2.7 Opinion of Probable Cost

The Engineer's Opinion of Probable Construction Cost (EOPCC) is based on costs from RS Means, recent bids, published material prices, current labor costs and past projects. This EOPCC is based on using state wage rates for public construction, not utilizing Drinking Water State Revolving Loan Funds, and does not include costs for American Iron and Steel requirements. We caution that the accuracy of the EOPCC may vary greatly due to the current construction / infrastructure market conditions. The current market is very volatile, especially for materials due to delivery delays, scarcity of raw materials and limited production at manufacturing plants. At the present time this EOPCC should not be considered the actual construction cost, but as a relative cost the actual cost could be 15% less to 35% more than the EOPCC.

The table below shows the major items of work and expected costs. A 30% contingency has been added due to the design phase (conceptual).

Table 9: Water Storge Tank EOPCC

No.	Unit	Description	Estimated Quantity	Unit Price	Estimated Total Cost
1	LS	600,000 Gal ped. sphere tank, 145' height	1	$3,800,000	**$3,800,000**
2	LS	In-Tank Mixing System (1 tank)	1	$75,000	**$75,000**
3	LS	Piping and Valves at tank site only	1	$50,000	**$50,000**
4	LS	Site Improvements (overflow basin, fencing, etc.)	1	$150,000	**$150,000**
5	LS	Site Clearing	1	$80,000	**$80,000**
6	LS	Access Road	1	$100,000	**$100,000**
7	LS	Electrical Work/ Instrumentation Work	1	$100,000	**$100,000**
				ESTIMATED CONSTRUCTION COST	**$4,355,000**
				3.5% Mob, Demob, Bonds, Ins, etc.	**$152,425**
				30% CONTINGENCY	**$1,306,500**
				Subtotal Construction Costs	**$5,813,925**
				20% Design and Engineering Services During Construction	**$1,162,785**
				ESTIMATED TOTAL COST	**$6,976,710**

Notes:

1. Piping and valves only includes the work within the fenceline of the water storage tank and does not include any longer connecting mains beyond the site.
2. Access Road only includes the work within the approach to the site
3. Does not include any land acquisition or easements

3 Water Storage Tank Hydraulic Analysis

Stantec performed a hydraulic analysis using and updating the existing Provincetown hydraulic water model that was provided by Apex Co. The analyses performed were under an extended period simulation with a duration of 24-hours, unless otherwise indicated.

3.1 Demand Scenarios

3.1.1 Average and Maximum Day Demands

The existing average and maximum day demands used for the hydraulic analysis were already inputted into the model from the previous Horsley Witten Group (HWG) memorandum complete in 2023. The following table provides a summary of the demands in the hydraulic model for the entire water distribution system.

Table 10. Existing Average and Maximum Day Demands

Description	Demand, gpd (gpm)
Average Day	169,920 gpd (118 gpm)
Maximum Day	626,400 gpd (435 gpm)

3.1.2 Future Average and Maximum Day Demands

The future average and maximum day conditions include the addition of the Clover Leaf Development, the Pond Road Extension, Walsh Property, and future buildout to the above demands. The demands were obtained from the previous Horsley Witten Group (HWG) Memorandum completed in 2023. Table 11 below provides a summary of the demands in the hydraulic model.

Table 11. Future Average and Maximum Day Demands

Description	Average Day Demand, gpd (gpm)	Maximum Day Demand, gpd (gpm)	Model Location
Clover Leaf Development	6,305 (4)	16,015 (11)	J-963
Pond Road Extension	10,239 (7)	26,005 (18)	J-962
Future Walsh Property	32,500 (23)	82,550 (57)	J-249
Future Buildout[1]	33,800 (23)	85,852 (60)	J-980 & J-982
1 – Assumes the addition of 250 homes			

3.1.3 Connection to Wellfleet

There has been discussion between the Town of Truro and the Town of Wellfleet about a potential interconnection location. The Wellfleet town boundary is approximately 4.5 miles from the end of the existing Truro water distribution system. This long distance may provide hydraulic challenges to sharing water. At this point in time, no further investigation has been conducted.

3.1.4 Future Maximum Day with Fire Flow

A fire flow analysis was conducted to evaluate impacts of fire flows. Three (3) locations were selected and evaluated for the hydraulic model simulations. The locations are shown in the following figure.

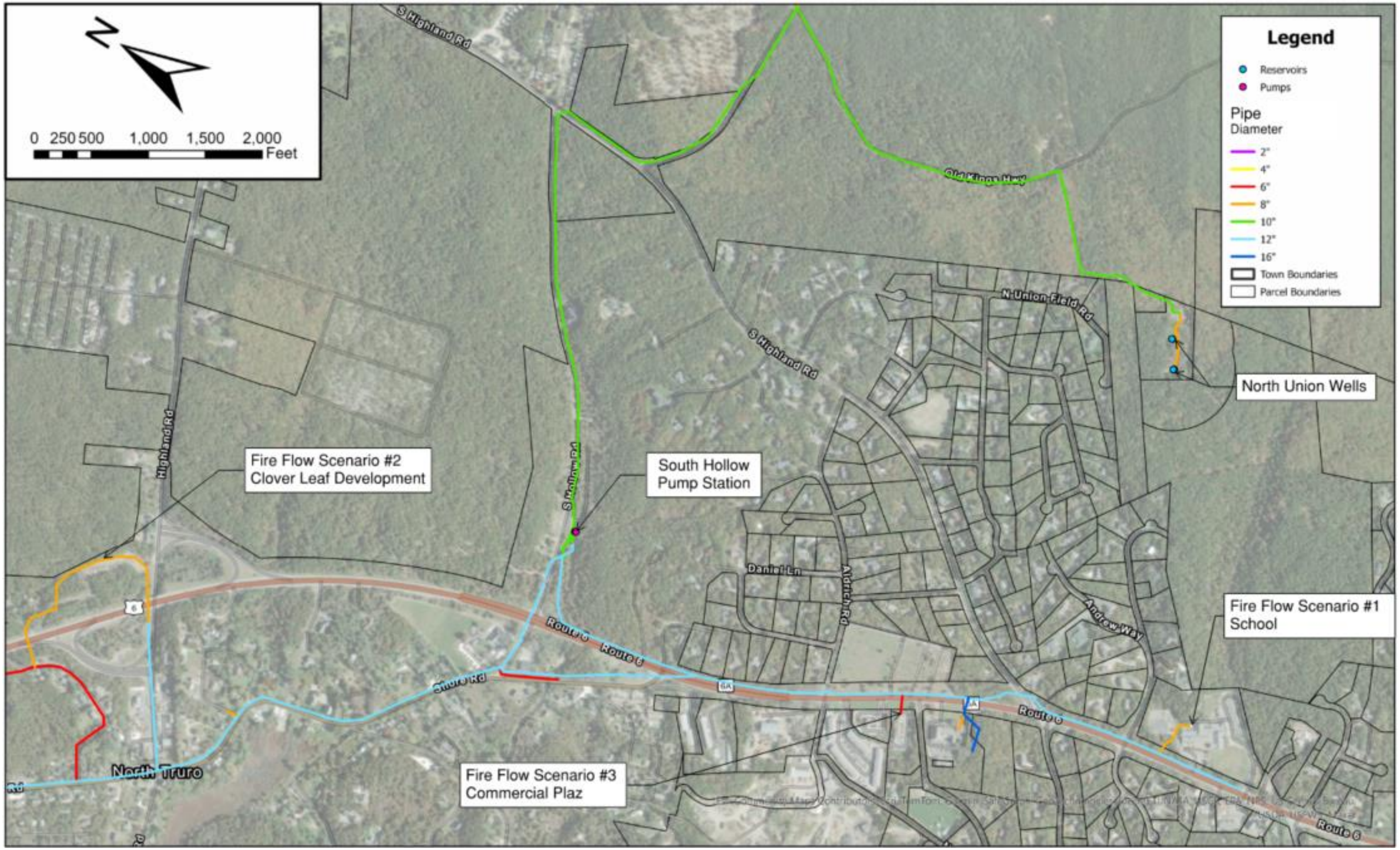


Figure 9: Fire Flow Locations

Stantec does not have the building types, square footage, or sprinkler information for the buildings in Truro. Therefore, a conservative fire demand of 2,000 gpm for a duration of 2-hours was used based on the 2024 International Fire Code (IFC). The fire demand occurs when the new Truro tank is full 2 p.m. and 4 p.m.

3.2 Existing Conditions Analysis

The existing hydraulic model consists of the Knowles Crossing Water Treatment Plant (KCWTP), two (2) storage tanks in Provincetown, North Union Field Wells and the existing South Hollow Booster Pump Station in North Truro. **Figure 10** provides a system map. Table 12 through Table 14 provide the existing asset information.

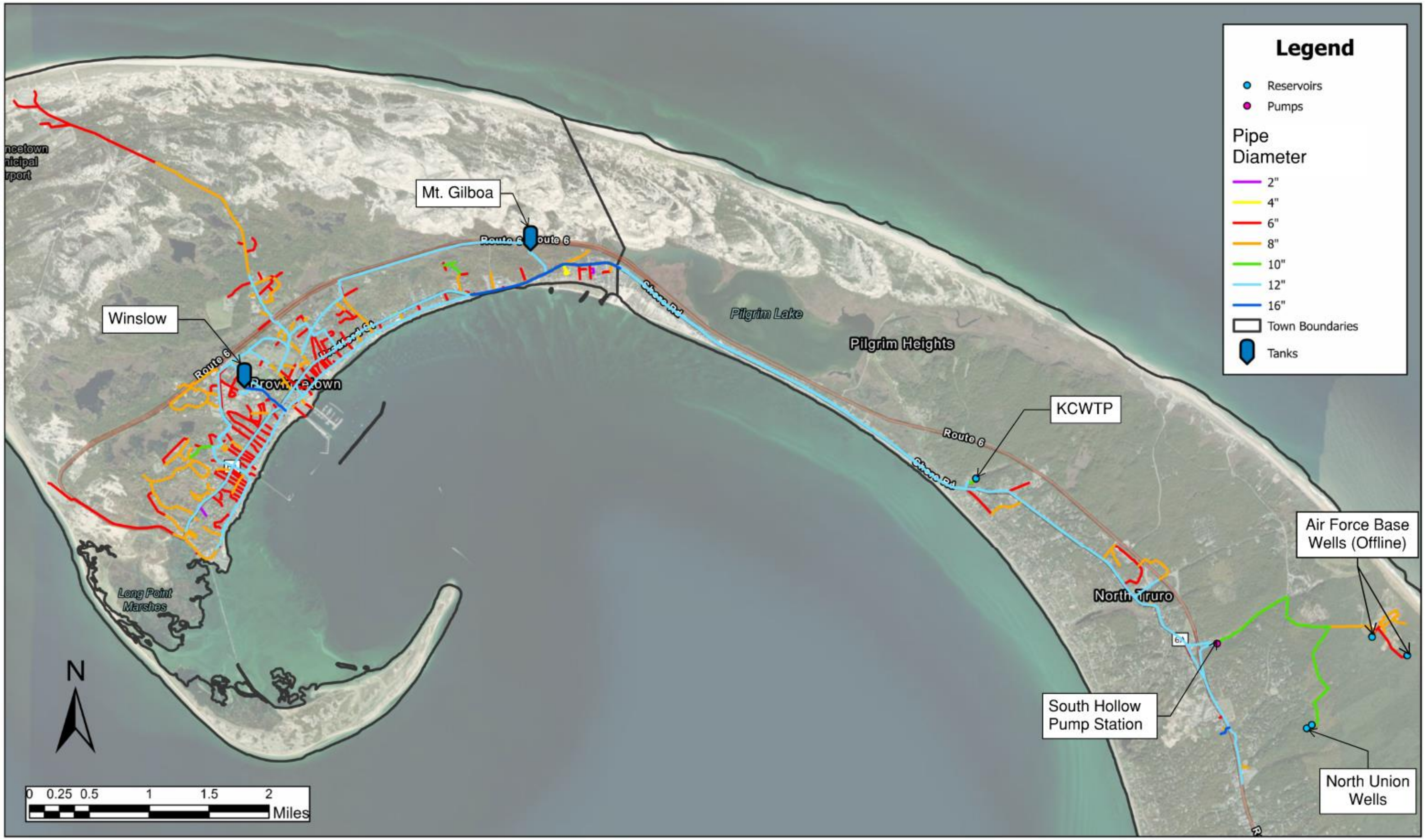


Figure 10: Existing Water Distribution System Ma

Table 12. Knowles Crossing Water Treatment Plant (KCWTP)

Description	Pump #1	Pump #2
Design Flow, gpm	560 gpm	560 gpm
Design Head, ft	273 ft	262 ft
Pump On, ft[1]	159.44 ft	--
Pump Off, ft[1]	169.30 ft	--
1 – Controlled off Winslow Tank Levels		

Table 13. Existing Storage Tank Data

Description	Winslow Tank[1]	Mt. Gilboa[2]
Base Elevation, ft	67.80	87.50
Minimum Elevation, ft	67.80	87.50
Maximum Elevation, ft	175.80	167.50
Diameter, ft	78	76
Total Volume, MG	3.8	2.7
Inlet / Outlet Pipe Diameter	16”	12”
1 – Primary tank that is filled by KCWTP and North Union Wells 2 – Operates off an altitude valve		

Table 14. North Union Field Wells

Description	North Union #1	North Union #2
Design Flow, gpm	372	375
Design Head, ft	96	91
Pump On, ft[1]	159.44	159.44
Pump Off, ft[1]	169.30	169.30
1 – Controlled off Winslow Tank Levels		

The existing model received from Apex Co. did not include controls for the existing South Hollow pump station. The model was updated based on information provided by the Town of Provincetown which included that the existing station maintains a discharge pressure of 90 psi and typically sees approximately 10 – 20 gpm depending on the demand. Table 15 provides the existing station properties.

Table 15. Existing South Hollow Pump Station Properties

Description	Lead Pump	Lag Pump	Fire Pump
Design Flow, gpm	30	30	150
Design Head, ft	90	90	1,100
Pump On, psi[1]	80	75	55
Pump Off, psi[1]	90	85	95
1 – Based on discharge pressure directly outside the station			

Since there is always demand in the system, the pump station should always be in operation. Stantec developed model controls for DP-1 so that the discharge pressure just outside the station (J-849) maintains 90 psi by adjusting the speed of the pump to replicate the field conditions. Therefore, the model controls that were implemented are shown in Table 16.

Table 16. Existing South Hollow Pump Station Controls

Condition	Pump Setting
J-849 <= 80 psi,	0.77
J-849 >= 90 psi,	0.60[1]
1 – Minimum pump speed to prevent motor overheating	

3.2.1 Existing Conditions Model Results

The North Truro area of the water system currently has no water storage tank and is served by the South Hollow Booster Pump Station which includes two domestic pumps and one fire pump. Operating pressures and available fire flows are limited based on the existing operating parameters of the existing pump station. Typically for this type of memo, we would compare existing conditions to future conditions. Since the existing conditions include no storage tank, the data is less relevant for comparison to future conditions with a new water storage tank online. Also, without actual SCADA operating data for the existing booster pump station, assumptions in the hydraulic model may not accurately represent existing conditions.

3.3 Future Conditions Analysis

The future conditions analysis includes the addition of the future North Truro 0.6 MG water storage tank located on the Town of Provincetown's Water Department property located at 247/245 Old Kings Highway, adjacent to the Walsh property, as shown in **Figure 11**. The parameters are as follows:

Table 17. Proposed North Truro Water Storage Tank

Description	
Base Elevation	122 ft
Minimum Elevation	232 ft
Maximum Elevation	272 ft
Operating Volume	Approx. 0.2 MG
Total Usable Volume	0.6 MG
Inlet / Outlet Pipe Diameter	16"
Inlet / Outlet Pipe Length	Approx. 5,500-LF

It is recommended to install the new tank inlet/outlet pipe along the proposed road of the Walsh property development. This will allow for easy access and minimize tree clearing.

Provincetown has an existing booster pump station located on South Hollow Rd. For the purpose of this technical memorandum, it is assumed that a new booster pump station will be required to fill the new storage tank. The preliminary pump design and controls are provided in Table 18.

Table 18. Preliminary Sizing of New North Truro Booster Pump Station

Description	
Design Flow	500 gpm
Design Head	260 ft
Pump On[1]	<= 259 ft
Pump Off[1]	>= 271 ft
1 – Based on the new North Truro Water Storage Tank Levels	

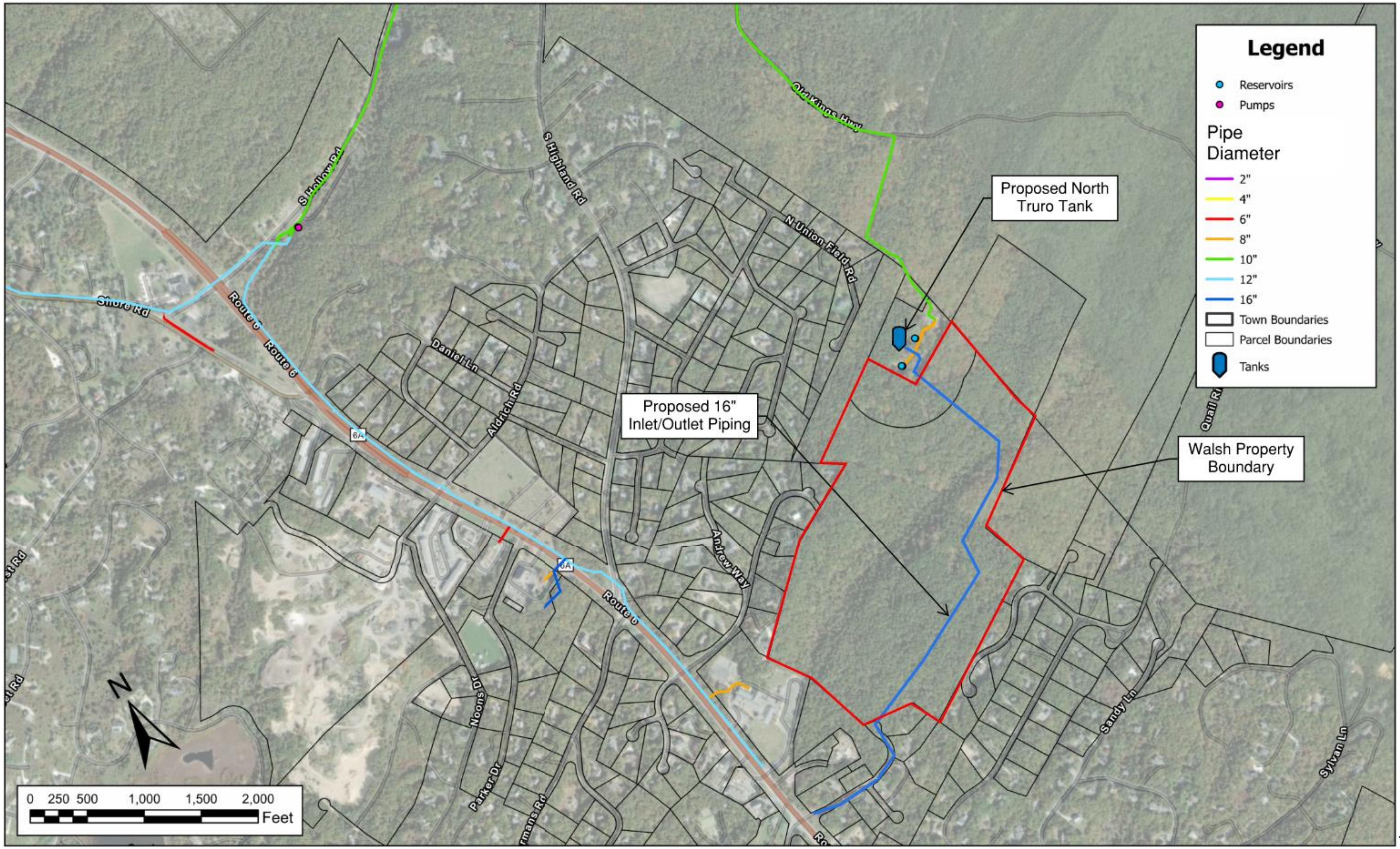


Figure 11: Proposed Water Storage Tank Location Map

3.3.1 Future Conditions Pressure Zones

The existing water distribution system currently has one (1) pressure zone. With the addition of the North Truro Tank, two (2) new pressure zones will be created. The new high-pressure zone is the area east of the new South Hollow Pump station and will be served by the new storage tank. The new low-pressure zone is the area west of the South Hollow Pump station, including the Cloverleaf development and the Pond Road Extension, and will be served by the existing Winslow and Mt. Gilboa storage tanks. However, with piping upgrades, the Cloverleaf and Pond Road Extension demands (shown in Table 11 and Table 19) could be met by the new storage tank in the high service area.

The different pressure zone boundaries described above are shown in **Figures 12 and 13**. **Figure 14** depicts the system improvements needed for Cloverleaf and Pond Road Extension to be in the high-pressure zone.

The demand breakdown for North Truro by pressure zone is shown in Table 19:

Table 19. North Truro Water Storage Tank Demands

Description	Low Pressure Zone	High Pressure Zone	Total Demand in North Truro
Existing Conditions			
Average Day, gpm	58	5	63
Maximum Day, gpm	146	12	159
Cloverleaf + Pond Road Extension in Low Pressure Zone (Figure 12)			
Average Day, gpm	69	51	120
Maximum Day, gpm	176	129	305
Cloverleaf + Pond Road Extension in High Pressure Zone (Figure 13)			
Average Day, gpm	58	62	120
Maximum Day, gpm	146	159	305

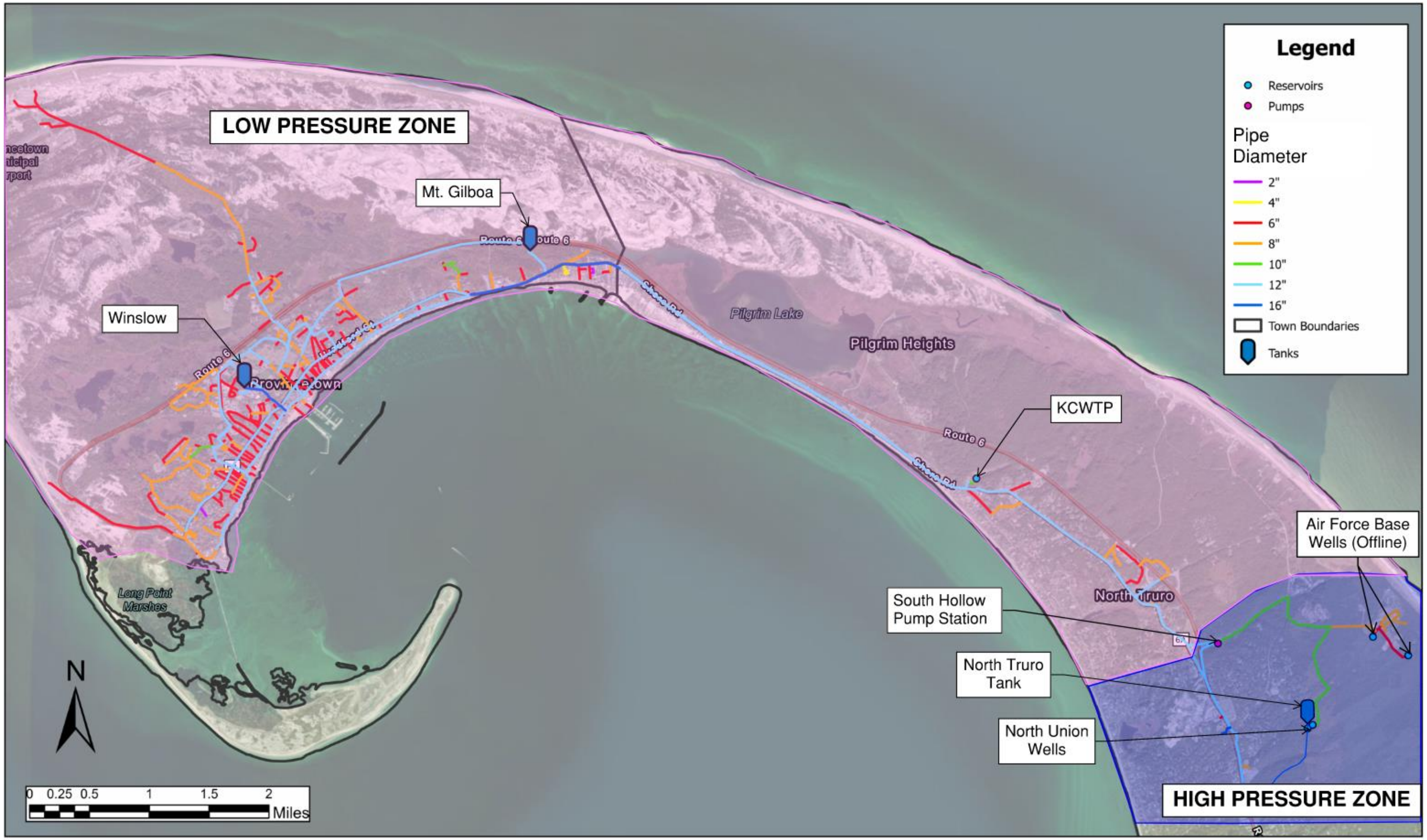


Figure 12: Future Conditions – Pressure Zones (Cloverleaf and Pond Rd. in Low Pressure Zone)

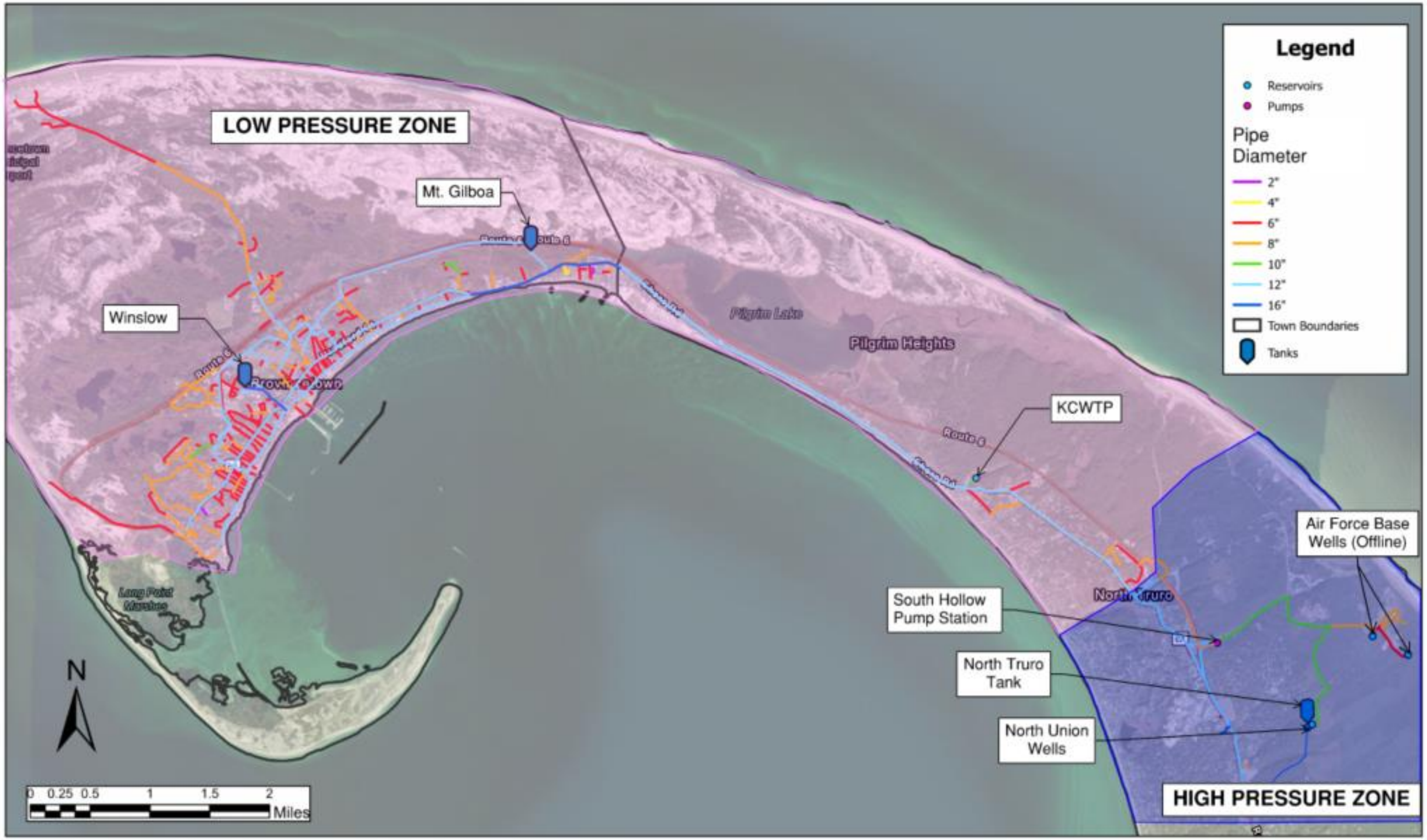


Figure 13: Future Conditions – Pressure Zones (Cloverleaf and Pond Rd. in High Pressure Zone)

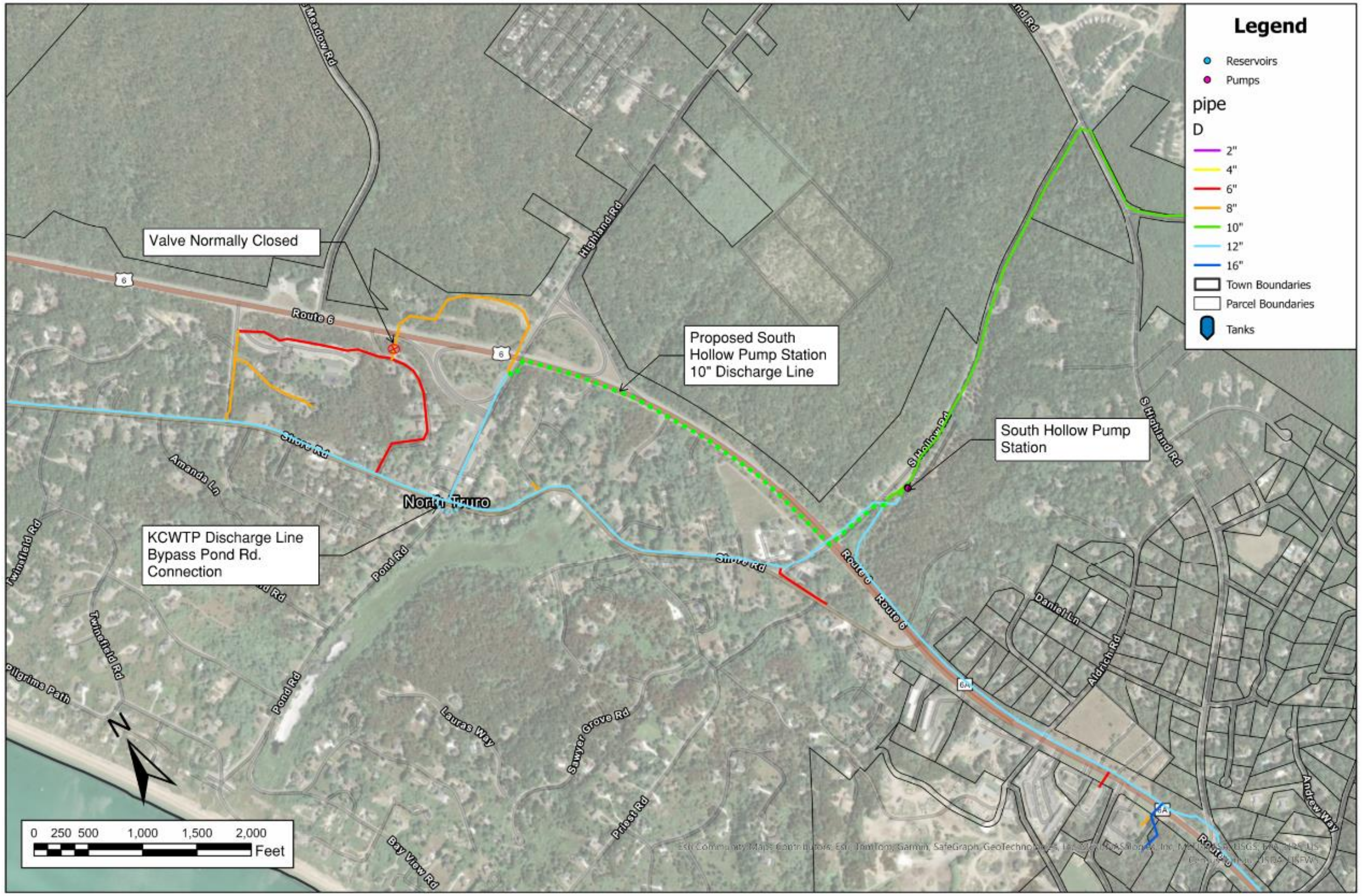


Figure 14: Future Conditions – Proposed Improvements (Cloverleaf and Pond Rd. in High Pressure Zone)

3.3.2 Future Conditions Model Results

Current Average Day Demand

Under this scenario, pressures range between 33 and 113 psi throughout the entire distribution system. The proposed high-pressure zone experiences pressures between 41 and 113 and the low pressure zone experiences pressures between 33 and 91 psi.

Under the existing average day demands and future demand conditions, the North Truro storage tank would slowly drain over the course of approximately 20 days due to the existing, low demands in North Truro. **Figure 15** provides the hydraulic grade of the tank under this scenario.

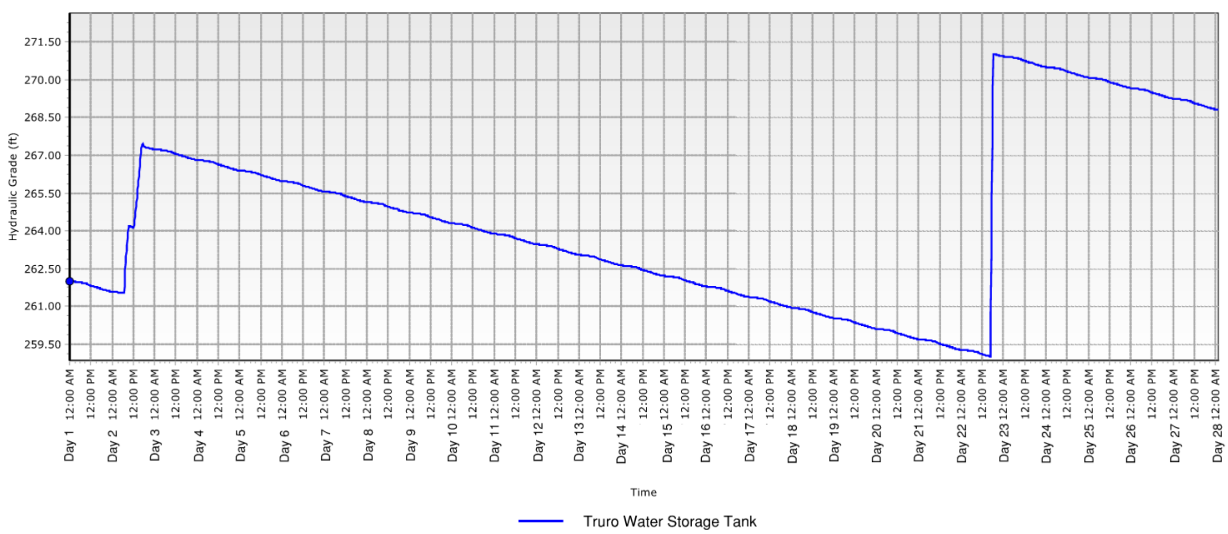


Figure 15: Existing ADD with New Tank – North Truro Tank Levels

This is a significantly long draw cycle for a water storage tank. This scenario demonstrates that more development and/or existing water users should be connected to the new high service area in order to support improved water storage tank operation and deliver a higher water quality.

Current Maximum Day Demand

Under this scenario, pressures range between 36 and 115 psi throughout the entire distribution system. The proposed high-pressure zone experiences pressures between 51 and 115 and the low pressure zone experiences pressures between 36 and 68 psi.

With existing maximum day demands, the North Truro tank quickly fills and slowly drains, over the course of approximately 4 days, as shown in **Figure 16**.

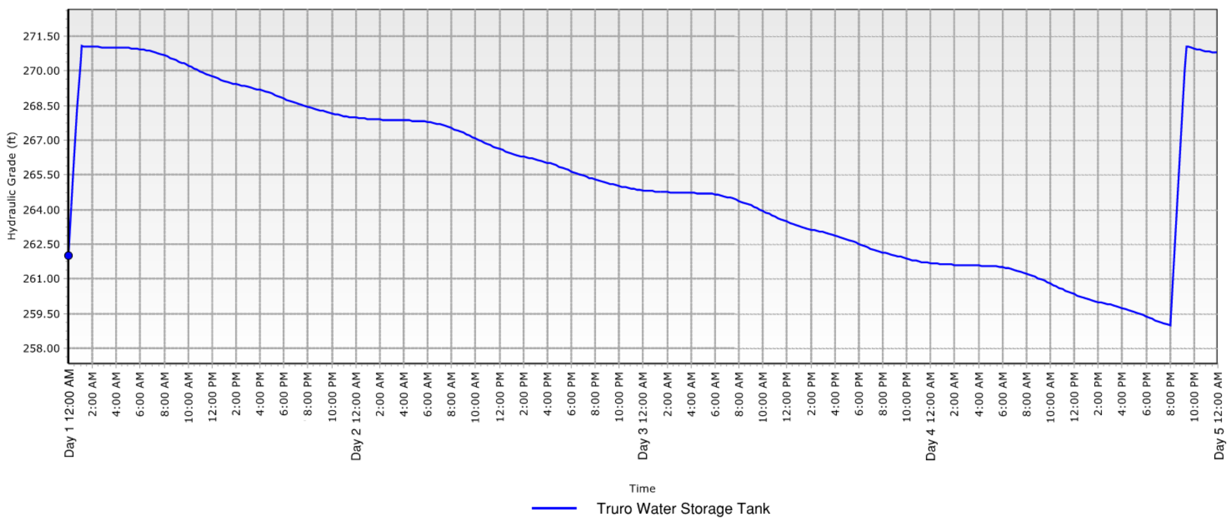


Figure 16: Existing MDD with New Tank – North Truro Tank Levels

Future Average Day Demand

Cloverleaf + Pond Road Extension – Low Pressure Zone

Under this scenario, pressures range between 33 and 113 psi throughout the entire distribution system when the Cloverleaf and Pond Rd. extension are located in the low-pressure zone. The high-pressure zone experiences pressures between 41 and 113 and the low-pressure zone experiences pressures between 33 and 91 psi.

As shown in **Figure 17**, the North Truro tank cycles over the course approximately 1.5 days (36 hours). This graphs shows a more desirable fill/draw cycle for tank operation as compared to the existing average day demand condition.

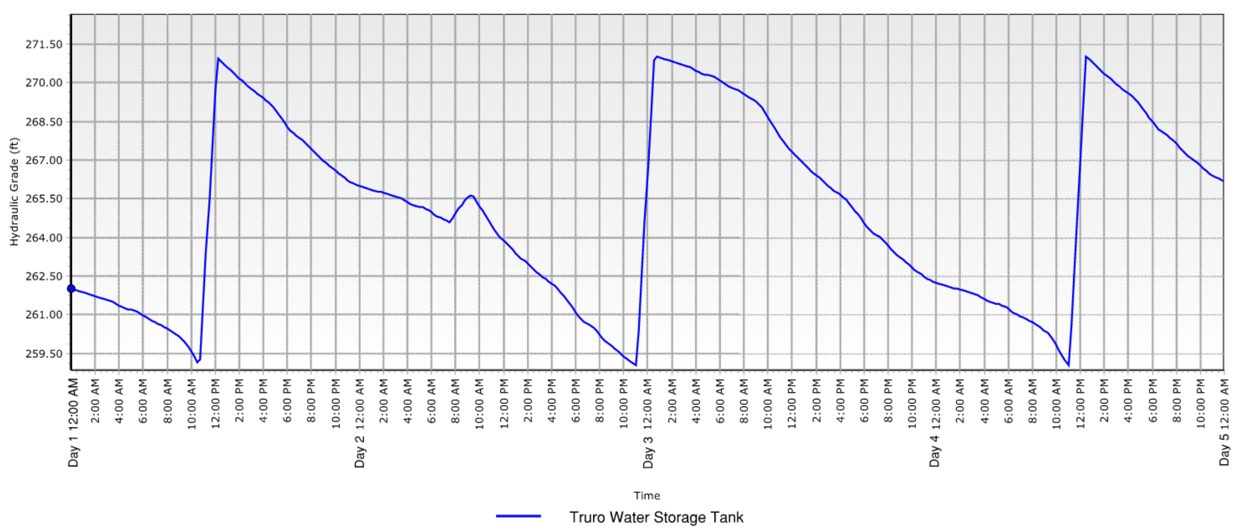


Figure 17: Future Conditions, Future ADD – North Truro Tank Levels

Cloverleaf + Pond Road Extension – High Pressure Zone

Under this scenario, pressures range between 33 and 113 psi throughout the entire distribution system when the Cloverleaf and Pond Rd. extension are located in the high pressure zone. The high-pressure zone experiences pressures between 41 and 113 and the low pressure zone experiences pressures between 33 and 91 psi.

Similar to when Cloverleaf and Pond Road are located in the low-pressure zone, the tank cycles over the course of about 1.5 days (36 hours) when in the high-pressure zone. This cycle is only slightly shorter with the tank cycle changing about 30-minutes earlier with the additional demand in the high service system.

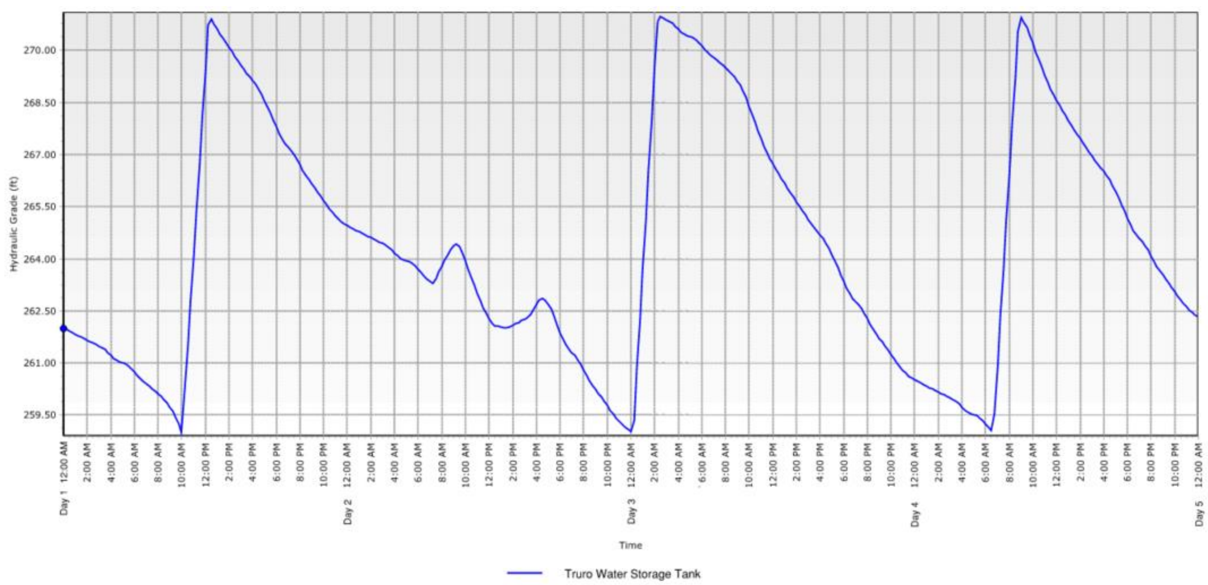


Figure 18: Future Conditions, Future ADD – North Truro Tank Levels

Future Maximum Day Demand

Cloverleaf + Pond Road Extension – Low Pressure Zone

Under this scenario, pressures range between 36 and 114 psi throughout the entire distribution system. The proposed high pressure zone experiences pressures between 51 and 115 psi and the low pressure zone experiences pressures between 36 and 68 psi.

With higher maximum day demand conditions in North Truro, the new storage tank cycles twice over the course of 1-day as shown in **Figure 19**.

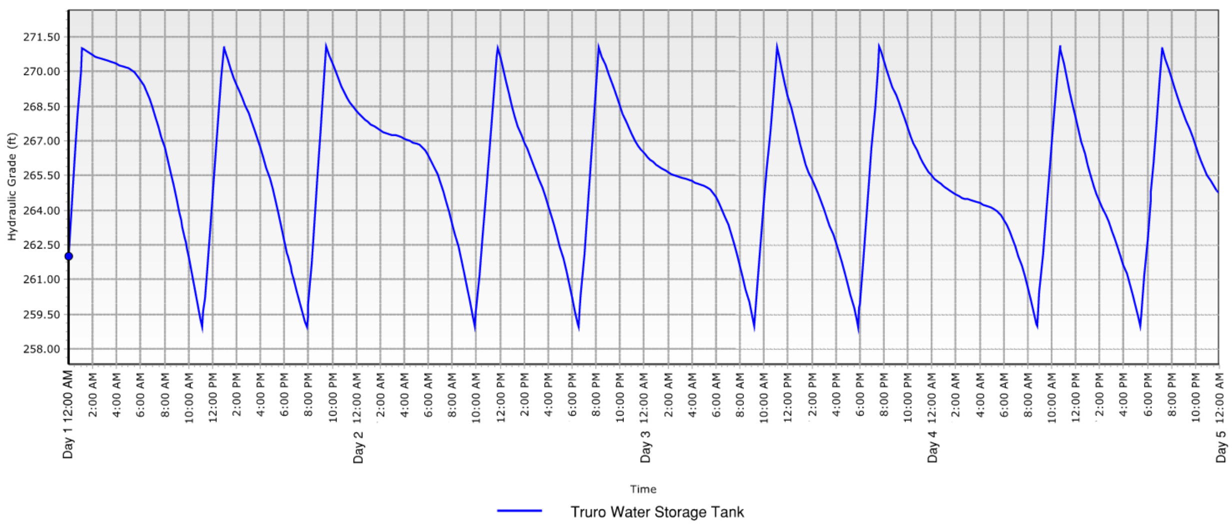


Figure 19: Future Conditions, Future MDD – North Truro Tank Levels

Cloverleaf + Pond Road Extension – High Pressure Zone

Under this scenario, pressures range between 36 and 115 psi throughout the entire distribution system. The proposed high pressure zone experiences pressures between 49 and 114 psi and the low-pressure zone experiences pressures between 36 and 67 psi.

The operation is similar when Cloverleaf and Pond Road extension are on the high-pressure zone with the new storage tank cycles twice over the course of 1-day as shown in **Figure 20**. The cycle is slightly shorter by about 15-minutes when the Cloverleaf and Pond Road Extension developments are in the high pressure zone.

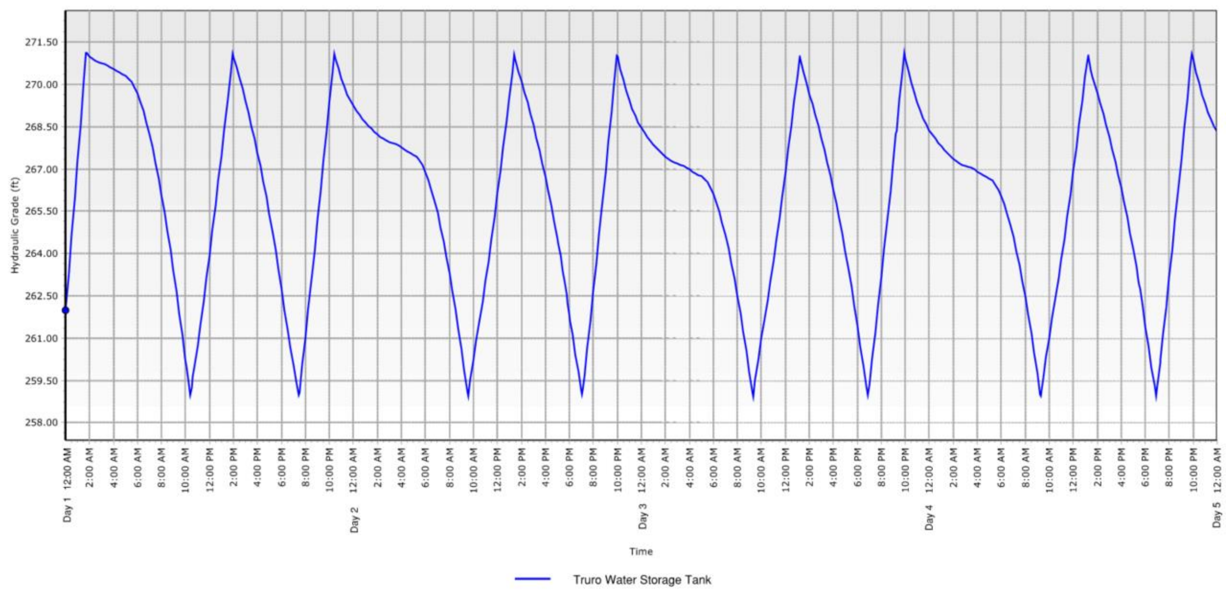


Figure 20: Future Conditions, Future MDD – North Truro Tank Levels

Future Maximum Day with Fire Flow

Three (3) fire flow simulations were run under future, maximum day demand conditions and with either the Cloverleaf and Pond Rd. extension located in the low pressure zone or high pressure zone. The fire flow used was 2,000 gpm for a 2-hour duration.

Fire flows with Cloverleaf and Pond Road on Low Pressure Zone

<u>Fire Demand at the Truro Central School (Cloverleaf and Pond Road Extension – Low Pressure Zone):</u> A fire flow of 2,000 gpm was simulated at the Truro Central School. During the simulated fire flow pressures ranged between 36 and 106 psi in the entire water system during the fire event (hours 2 p.m. – 4 p.m.).

The new North Truro storage tank is capable of supplying the 2,000 gpm fire and maximum day demands. As shown in the graph, the tank quickly drains for the 2-hour duration to a level of approximately 236-ft. This level is outside its typical operating level, but still part of its usable storage volume. The booster pump station would start up to help support the high demand when the tank level reaches 271-ft.

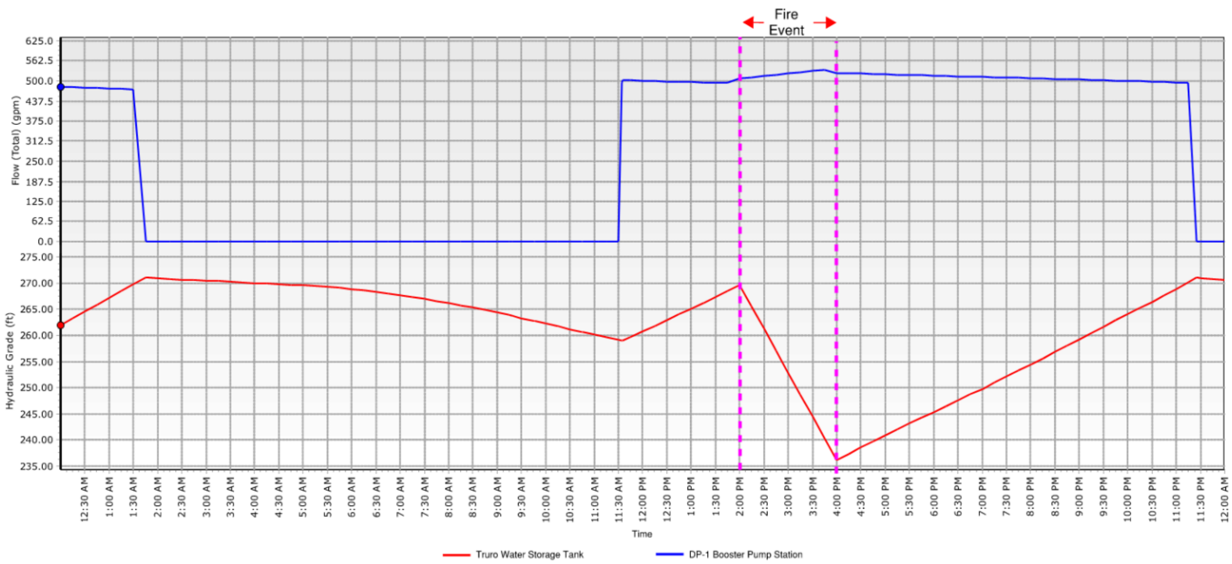


Figure 21: Fire Demand @ School (Cloverleaf and Pond Road in LPZ) – North Truro Tank Levels and Pump Flow

Fire Demand at Clover Leaf Development (Cloverleaf and Pond Road Extension – Low Pressure Zone): A fire flow of 2,000 gpm was simulated near the proposed Clover Leaf Development. Pressures ranged between 36 and 106 psi during the fire event.

For this analysis the new Clover Leaf Development is outside the new tank high service area. Therefore, the North Truro water storage tank does not support the fire flow demand. Winslow and Mt. Gilboa tank support the MDD and fire demand that occurs at the Clover Leaf Development.

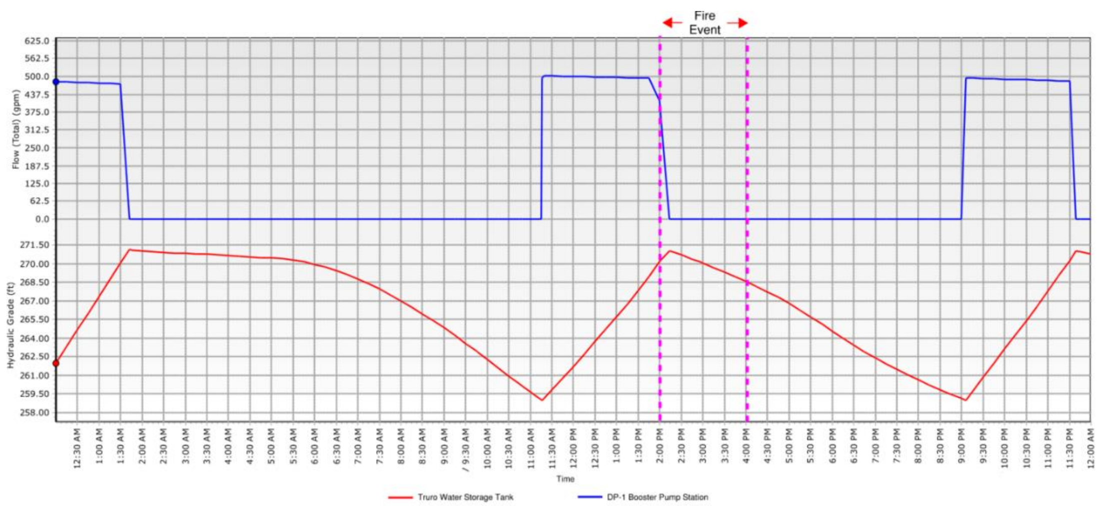


Figure 22: Fire Demand @ Clover Leaf (Cloverleaf and Pond Road Extension in LPZ) – North Truro Tank Levels and Pump Flow

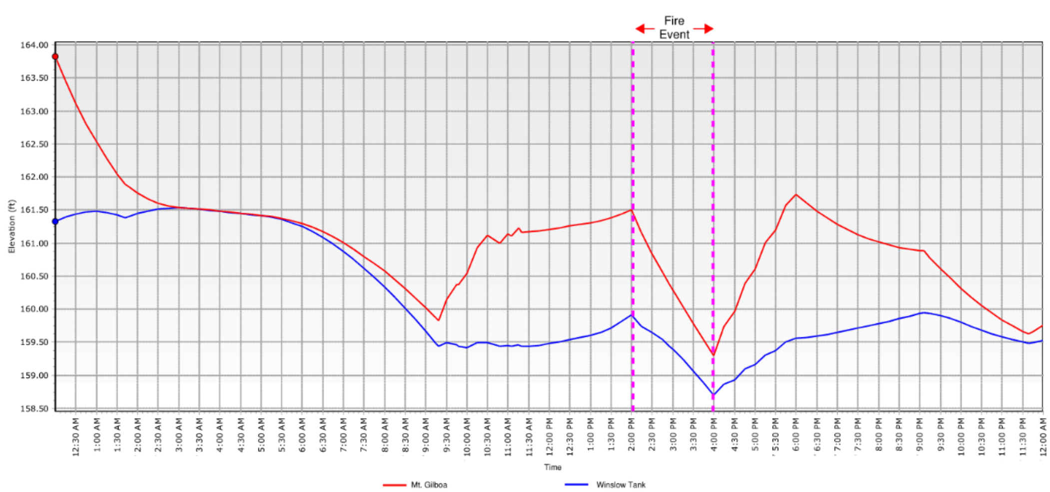


Figure 23: Fire Demand @ Clover Leaf – Winslow and Mt. Gilboa Tank Levels

<u>Fire Demand at Truro Trademen's Park (Cloverleaf and Pond Road Extension – Low Pressure Zone):</u>
Pressures ranged between 36 and 115 psi during the fire event.

The new storage tank is capable of supplying the 2,000 gpm fire and maximum day demands. As shown in the graph, the tank quickly drains for the 2-hour duration to a level of ~236-ft. This level is outside its typical operating level, but still part of its usable storage volume, dipping into the fire storage volume. The booster pump station would start up to help support the high demand when the tank level reaches 271-ft.

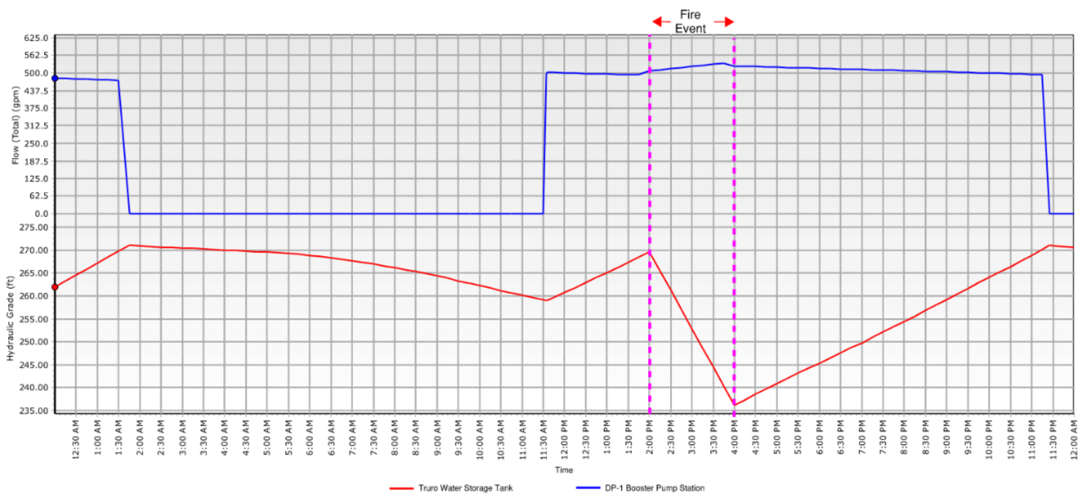


Figure 24: Fire Demand @ Commercial Plaza (Cloverleaf and Pond Road Extension in LPZ) – North Truro Tank Levels and Pump Flow

Fire flows with Cloverleaf and Pond Road on High Pressure Zone

<u>Fire Demand at the Truro Central School, Commercial Plaza, and Cloverleaf (Cloverleaf and Pond Road Extension – High Pressure Zone):</u> The new North Truro storage tank is able to supply the 2-hour fire duration of 2,000 gpm at maximum day demand when Cloverleaf and Pond Road Extension are in the high-pressure zone for all three (3) scenarios. As shown in **Figure 25**, the tank is full when the fire begins and then quickly empties to a level of 236-ft over the 2 hour duration. The booster pump would start up when the tank level reaches 270-ft and continues to run until the tank fills.

Pressures ranged between 34 – 96 psi in the entire system during the 2-hour fire duration.

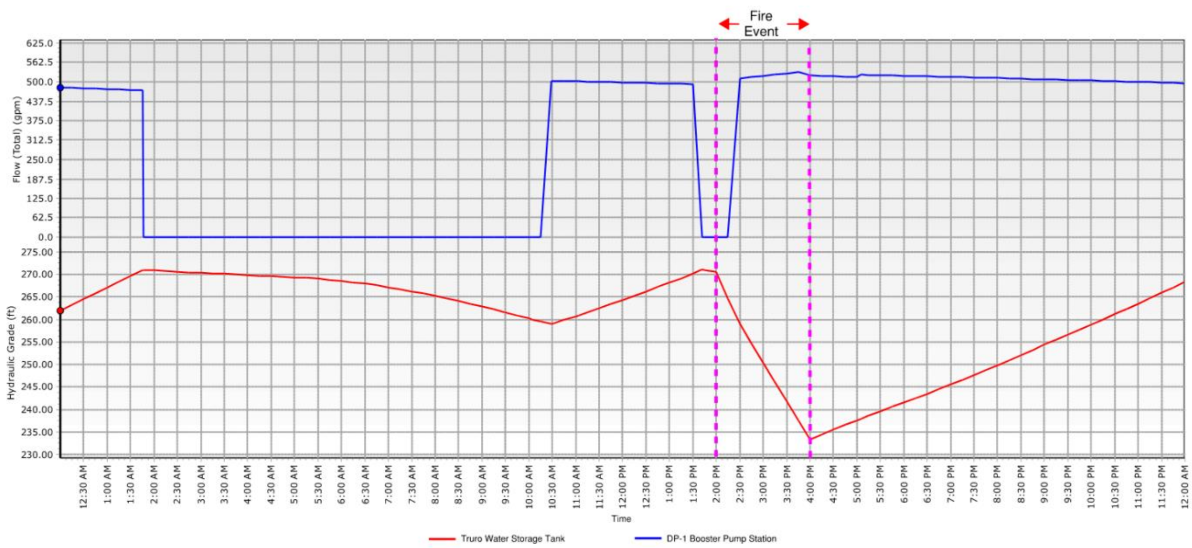


Figure 25: Fire Flow Analysis (Cloverleaf and Pond Road in HPZ) – North Truro Tank Levels and Pump Flow

3.3.3 Future Conditions Water Age

A water age analysis was performed to determine the average time water stays in the system prior to consumption. It is primarily a function of water demand, system operation, and system design. Water age can become a challenge when it is too high as it can lead to quality issues like taste and odor, color, sediment deposits and disinfection by-product (DBP) formation. The definition of "high" is system-specific, as the extent to which water age impacts water quality depends on numerous factors, including source water quality, treatment process efficacy, disinfectant type and dose, distribution system configuration, and system operation. Water age is typically elevated when water usage is low (most notable at dead end water mains) and is exacerbated when pipe sizes and storage tank volumes are large relative to demand. In general, the maximum acceptable water age will be defined for this (and any) system as the water age below which distribution system challenges, that directly or indirectly relate to reaction time (such as chlorine decay, disinfection by-product formation, microbial growth etc.) do not occur, as supported by the sampling data.

The purpose of this water age analysis was to determine the impacts of water age on the system with the new 0.6 MG water storage tank in North Truro. With the proposed North Truro Water Storage tank being filled by the proposed new pump station, the water storage tank has a strong fill/draw cycle encouraging tank turnover. The water age in the North Truro tank is approximately 7 days under a future maximum day demand condition discussed in Section 3.3.2.

Water age was also calculated for the water distribution system in the North Truro area. The following table summarizes this data.

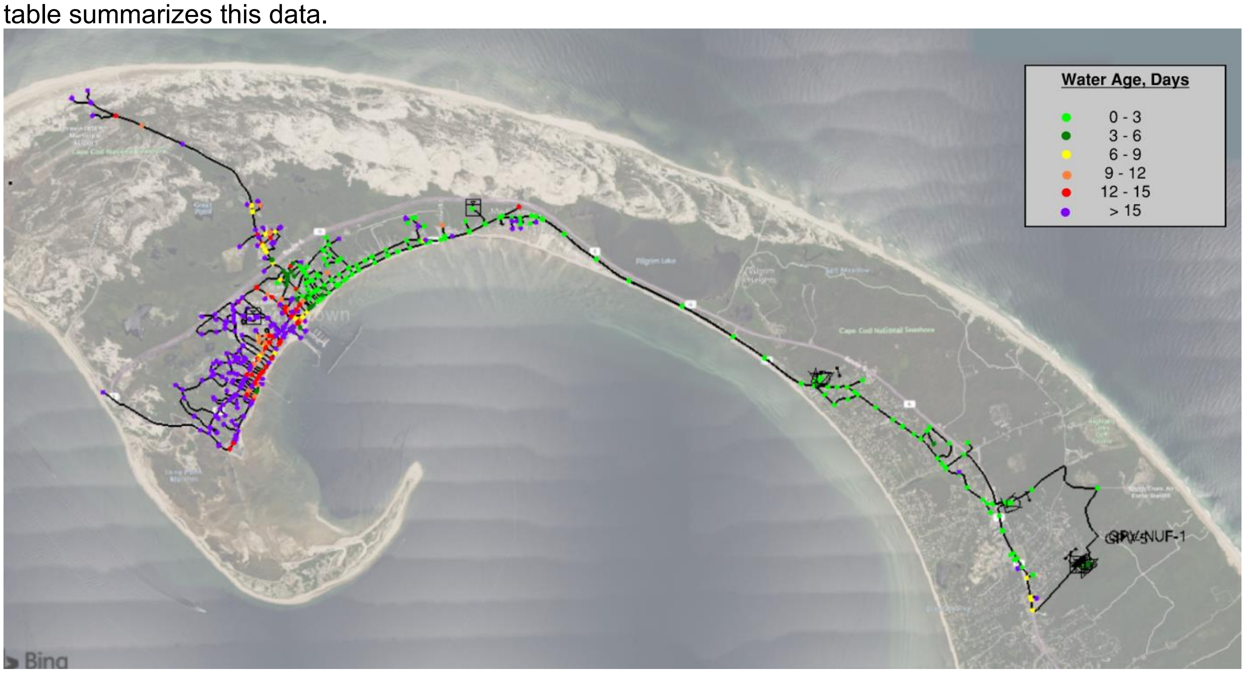


Figure 26: Future Conditions MDD –Water Age

Table 20. Future Conditions MDD – Water Age

Junction	Location	Avg. Water Age, Hrs	Avg. Water Age, Days
J-770	Shore Road	30	1.25
J-982	Route 6 – Commercial Plaza	31	1.3
J-980	Route 6 / S. Highland Road	30	1.25

The highest water age was experienced at locations of little to no water demand, or on dead end lines. Developing a routine flushing program or installing automatic flushing stations are a few ways to reduce a system’s water age.

3.3.4 Pressure Reducing Valve

The addition of the North Truro Tank creates two (2) pressure zones. A pressure reducing valve (PRV) vault can be installed to allow the high pressure zone to bleed water into the low pressure zone in instances of high demands in the Provincetown low service system (i.e. fire). The PRV vault should be located north of the proposed booster pump station. It is recommended that the siting and sizing of the PRV vault be investigated to identify an acceptable location. While PRV's can simply operate hydraulically based on pressures in the high service and low service system, it is recommended that electrical controls be added to the proposed PRVs so that these valves can assist with forcing turnover in the North Truro Water Storage Tank, if needed. The availability of an electrical service connection should be evaluated as part of the siting of the vault.

3.3.5 Budgetary Cost

A budgetary cost estimate for the new booster pump station, tank inlet/outlet pipe, installation of the PRV, and miscellaneous distribution system improvements is provided in Table 21. There is potential for cost savings if the existing booster pump station is retrofitted to accommodate the new pumps. The pump station cost assumes an approximate 800 sq. ft. building, two (2) 50 HP split case pumps, associated piping and valves, electrical work, and site work.

Table 21. Budgetary Distribution System Piping and Pump Station Cost

No.	Unit	Description	Estimated Quantity	Unit Price	Estimated Total Cost
1	LS	Booster Pump Station 800 sq. ft. building, two (2) 50 HP split case pumps, associated piping and valves, electrical work, and site work	1	$1,500,000	**$1,500,000**
2	LS	Pressure Reducing Valve Vault Below grade vault including two pressure reducing valves along with power for monitoring and controlling valve operation	1	$200,000	**$200,000**
3	LS	Water Storage Tank Connecting Pipe 5,500 feet of new 16”, 550 LF of new 12” and appurtenances to connect proposed water storge tank site to existing water distribution system.	1	$1,788,000	**$1,788,000**
4	LS	Water Distribution System Improvements If the new booster pump station is sited near the existing South Hollow pump station an additional 6,500 lf of 12-inch would be required to bring the Cloverleaf and Pond Street Areas to the high service area.	1	$1,950,000	**$1,950,000**
				ESTIMATED CONSTRUCTION COST	**$5,438,000**
				3.5% Mob, Demob, Bonds, Ins, etc.	**$190,330**
				40**%** CONTINGENCY	**$2,175,200**
				Subtotal Construction Cost	**$7,803,530**
				20% Design and Engineering Services During Construction	**$1,560,706**
				ESTIMATED TOTAL COST	**$9,364,236**

Notes:

1. Does not include any land acquisition or easements
2. Additional conceptual design for the booster pump station and pressure reducing valve vault is recommended prior to initiating design phase.
3. A higher contingency has been carried for these recommendations since the concepts are not as advanced as that of the water storage tank.

3.3.6 Conclusion

A new elevated water storage tank and associated booster pumping station are required to handle the anticipated increase in water demands in North Truro. Based on the hydraulic analysis, under future maximum day demands, the tank cycles over the course of 1 day and has a water age of approximately 7 days.

The addition of the new tank will split the Provincetown water distribution system into two (2) pressure zones with the division being at South Hollow Road. A PRV is recommended to be installed so that the high pressure zone could feed the low pressure zone in emergency situations.

Careful consideration is needed when constructing and putting the new 0.6 MG storage tank and booster pump into service. The existing average day and maximum day demands are too low to properly cycle the tank. For the new 0.6 MG tank to operate effectively without water quality issues, the proposed developments will need to occur, or operational changes will be required.

Appendix A Pedestal Spheroid Tank Brochure

Waterspheroid®

ELEVATED WATER STORAGE

www.cbi.com

Modern sleek design

Visually pleasing contours blend well with surroundings

Attractive graphics enhance community identity

Why choose a Waterspheroid® elevated tank?

Proven to be the most popular of all single pedestal elevated water storage tank styles, the Waterspheroid elevated tank is available in storage capacities from 150,000 to 2,000,000 gallons. It offers low capital and maintenance costs, enhanced safety/security, convenient storage, and a small footprint that minimizes land requirements.

With its sleek design and pleasing contours the Waterspheroid tank is well suited for high visibility locations such as school grounds, commercial developments, residential neighborhoods, parks and other prominent locations.

We invented the Waterspheroid tank design, and we have built more single pedestal steel spheroidal elevated tanks than any other company, including the tallest and largest capacity tanks in service. We have the most experience in the industry in the art of forming the ball. We use larger steel plates than our competitors which leads to a smoother ball shape with fewer weld seams, minimizes potential areas of paint failure and reduces long-term paint maintenance of the tank.

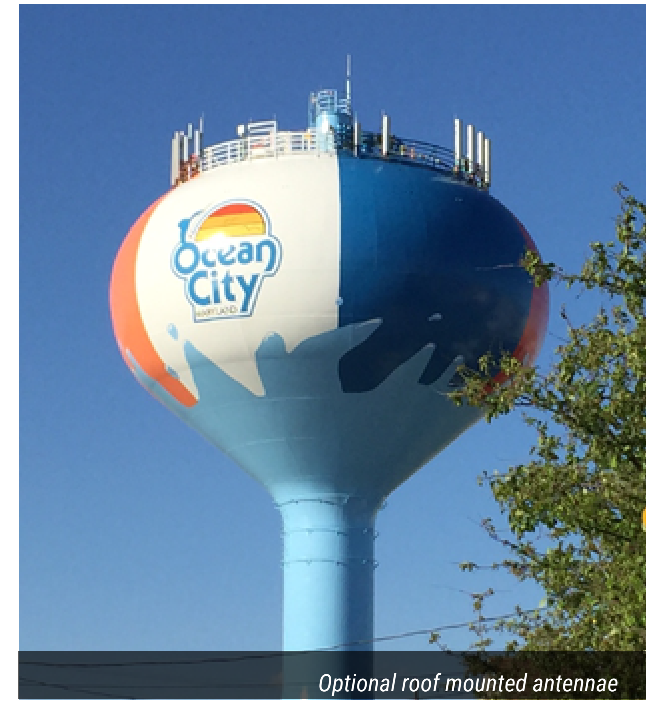
Additionally, we use double-curved, hot pressed knuckles between the bell and the shaft and between the shaft and the ball. Not only does this add to the smooth line aesthetics of the tank, it eliminates the potential lamellar tearing that could occur on tanks using dollar plates and coned sections in these areas.

Waterspheroid tanks are all-steel, all-welded structures that have proven reliability, serving thousands of municipalities and industries for decades. Properly maintained and operated, steel tanks offer an extremely long life, with some structures exceeding 100 years of service.

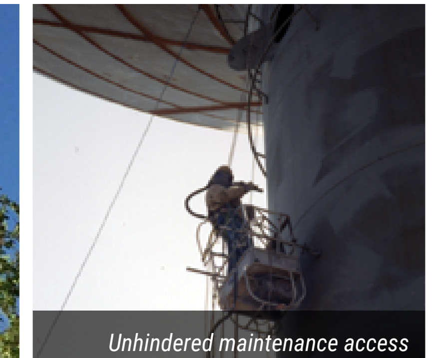
Since the construction of our first elevated tank in 1894, we have become a global leader in the design and construction of elevated water storage tanks. We pioneered the transition to welded steel tanks in the 1930s, invented the original Watersphere® tank in 1939, the larger Waterspheroid® tank in 1954, and have been improving the concept ever since. We also have been instrumental in the development of the AWWA standards, beginning with the first D100 Standard in 1941, continuing today through active organization and committee participation.

Taking the Lead with QHSES

McDermott is committed to setting a leading example in all areas of Quality, Health, Safety, Environment and Security, and encourages our partners, subcontractors and clients to join us in the pursuit of outstanding QHSES performance. Taking the Lead is a company-wide initiative that brings a single, united QHSES culture to our diverse workforce and organization, a culture where setting the right example in QHSES attitude and behavior is simply 'In our DNA.'



Optional roof mounted antennae


Unhindered maintenance access


Piping and valves in base

More pleasing appearance, lower maintenance and superior security than multi-column tanks

Selecting a Waterspheroid elevated tank

CB&I provides sample specifications and detail drawings for engineers and owners who are planning Waterspheroid projects. Contact our regional sales force to receive guidance on specifying your tank or visit **www.cbi.com/water** to view our standard specifications and drawings.

Aesthetic design

- Smooth contours
  - The most popular single pedestal style in use
  - Visually pleasing, modern design
- Blends well with surroundings
- Capitalizes on high visibility locations
  - Optional lettering and logos enhance community identity and pride
  - Custom ornamental and specialty paint designs available

Economics

- Low capital expenditure
- All-steel composition permits cost effective, year-round construction
- Small footprint permits "tight sites" and minimizes land cost
- Turnkey supply of foundation and painting offers cost and schedule savings
- Eliminates costly and unsightly fencing
- Height can be modified if pressure requirements change after installation
- At end of life cycle, tank can be demolished at minimal cost

Maintenance

- Style minimizes interior and exterior painted surface area and future maintenance
- Interior dry surfaces are weather protected and seldom need repainting
- Maintenance access to all exterior surfaces is unhindered

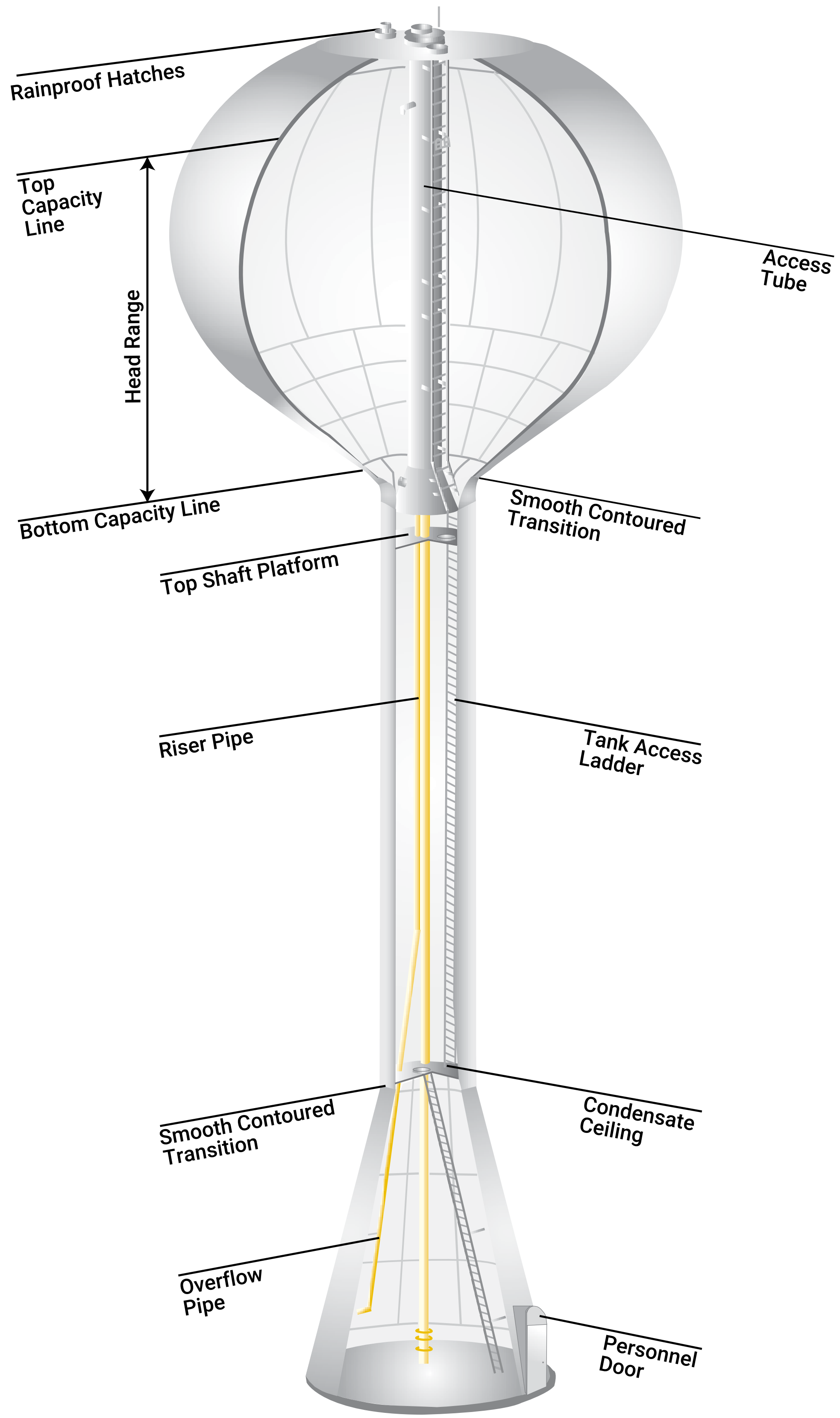
Safety and security

- Solid, flush threshold steel door with deadbolt lock restricts unauthorized entry
- Enclosed interior access ladders
  - Minimize vandalism and unsightly graffiti
  - Minimize unauthorized tank access
  - Facilitate climbing during inclement weather
- Proven performance in high wind events (tornadoes and hurricanes

Multi-purpose space inside bell

- Optionally insulated and heated
- Provides space for multiple uses, such as:
  - Tool and equipment storage
  - Pumps, valves, piping and controls
  - Telecommunication equipment
- Flush threshold personnel door allows easy access for storage

Standard features and options



Standard features

- One 36 in. wide by 80 in. high steel personnel door with flush threshold
- Concrete floor inside base
- Steel riser pipe with expansion joint
- Steel overflow pipe to grade with splash block
- Steel condensate ceiling with drain
- Ladders in pedestal and access tube
- Safety devices on ladders as required by state and federal regulations
- Steel top shaft platform with one 30 in. diameter manway in top shaft platform
- One 30 in. diameter manway in condensate ceiling
- One 42 in. diameter access tube
- Painter's rings at top of pedestal
- One 24 in. diameter painter's ring hatch
- Two 30 in. diameter roof hatches
- One 24 in. diameter painter's ventilation roof hatch
- Minimum 1/4" thick steel roof plates
- Seal welding underside of roof
- Fail-safe roof vent
- Interior lighting in pedestal and access tube

Options

- Lettering, logos and decorative graphics
- Alternative style as composite elevated tank or Hydropillar®
- Ornamental and specialty styling
- FreshMix™ circulation system
- Double personnel door
- Overhead door
- Valve vault inside base
- Control room in base
- Dual risers
- Stainless steel riser
- Stainless steel overflow
- Riser insulation and heat tracing
- Intermediate platforms
- Seal welding of pedestal appurtenances
- Upsized 48 in. diameter or 60 in. diameter access tube
- Tank drain
- Internal tank ladder on access tube
- Roof handrail
- External security or decorative lighting
- FAA lighting
- Instrumentation
- Telemetry
- Cathodic protection
- Lightning protection
- Antenna penetrations and supports

Standard capacities and dimensions

Capacity U.S. Gallons	Spheroid Diameter ft-in.	Head Range ft-in.
150,000	35 - 0	30 - 0
200,000	39 - 10	30 - 0
250,000	42 - 10	32 - 6
300,000	46 - 6	32 - 6
400,000	50 - 8	37 - 6
500,000	55 - 10	37 - 6
600,000	58 - 2	40 - 0
750,000	64 - 8	40 - 0
1,000,000	74 - 8	40 - 0
1,250,000	79 - 2	45 - 0
1,500,000	86 - 0	46 - 0
2,000,000	93 - 0	52 - 0

Northville, MI – 1,000,000 gallons

Gonzales, LA – 1,000,000 gallons

Batavia, IL – 750,000 gallons

Shorewood, IL – 1,500,000 gallons


Wentzville, MO – 2,000,000 gallons

Custom paint options

CB&I is the world's leading designer and builder of storage facilities, tanks and terminals. With more than 59,000 structures completed throughout our 130-year history, CB&I has the global expertise and strategically located operations to provide our customers world-class storage solutions for even the most complex energy infrastructure projects.

Headquarters

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Houston, TX 77079
USA
Tel: +1 832 513-4000

www.cbi.com

CB&I
A MCDERMOTT COMPANY

Appendix B Composite Tank Brochure

Composite Elevated Tank

WATER STORAGE

www.cbi.com

CB&I

Sizes range from 500,000 to 3,500,000 gallons. Above is a 1,500,000 gallon tank

Architectural lines blend well with surrounding structures and landscapes

Concrete support structure requires minimum maintenance on both inside and exterior

3,000,000 gallon tank in Souderton, PA

Why choose a composite elevated tank?

The tensile strength of steel has long been recognized as a characteristic most effective in producing leak-free water-retaining vessels. Reinforced concrete is one of the most efficient and economical materials to carry compressive loads. A composite elevated tank (CET) combines these materials to produce an efficient, long lasting structure.

A CET from CB&I can be a cost effective solution for large-capacity tanks. The low maintenance requirements of the interior and exterior of the support structure minimize long-term ownership costs.

We have designed and built hundreds of CETs of various capacities and heights since their introduction to the marketplace.

Our concrete forming system (forms, ties and bulkheads) minimizes pour lines and allows proper vibration of the concrete, reducing bug holes and honeycombing to obtain architectural grade concrete. We install a ¼ inch thick formed steel liner over the concrete dome, which minimizes voids between the concrete and steel and meets the AWWA D107 minimum thickness requirement for plates in contact with water.

The self-supporting dome roof minimizes interior structural supports in the vapor area of the tank where condensation occurs. Since this is the most corrosion-prone area in the tank, future maintenance requirements are reduced.

The concrete support structure exterior is enhanced by an architectural pattern that blends well with surrounding structures. In addition, the exterior coating and logo on the steel tank can be custom designed to identify your municipality, company or product.

Since the construction of our first elevated tank in 1894, we have become a global leader in the design and construction of elevated water storage tanks. We pioneered the transition to welded steel tanks in the 1930s and built our first Composite Elevated Tank in 1986. We also have been instrumental in the development of the AWWA D107 Standard for composite elevated tanks.

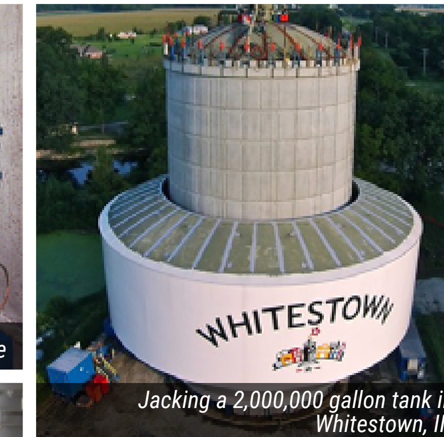
Taking the Lead with QHSES

CB&I is committed to setting a leading example in all areas of Quality, Health, Safety, Environment and Security, and encourages our partners, subcontractors and clients to join us in the pursuit of outstanding QHSES performance. Taking the Lead is a company-wide initiative that brings a single, united QHSES culture to our diverse workforce and organization, a culture where setting the right example in QHSES attitude and behavior is simply 'In our DNA.'

Standard designs provide efficient head ranges from 35–50 ft to minimize pumping costs and variations in water pressure


Piping and valves in support structure


Piping and valves in support structure



Jacking a 2,000,000 gallon tank in Whitestown, IN


Painting tank exterior prior to jacking

Selecting a composite elevated tank

CB&I sample specifications and detail drawings for engineers and owners who are planning elevated water storage projects. Contact our regional sales force to receive guidance on specifying your tank or visit **www.cbi.com/water** to view our standard specifications and drawings.

Maintenance

- Concrete support structure requires minimal maintenance
- Maintenance access to all exterior surfaces is unhindered
- Multi-purpose interior space
- Dual use as offices, meeting rooms, pump station, fire station, equipment and machinery storage, etc.
- Reinforced concrete support structure
  - Easily integrates with interior structural steel for multiple floors
  - Allows exterior windows
- Offset riser pipe maximizes available interior space

Economics

- Can be economical in larger capacities
- Effective cost is reduced when the value of the interior space is considered
- Turnkey supply of foundation and painting offers cost and schedule savings

Aesthetic design

- Clean modern appearance
- Vertical and horizontal architectural lines blend well with surrounding structures and landscapes
- Capitalizes on high visibility locations
  - Optional lettering and logos enhance community identity and pride
  - Optional custom architectural concrete support structure designs available

Safety and security

- Solid threshold steel door with deadbolt lock restricts unauthorized entry
- Overhead door
  - Quick entry and exit for trucks and large equipment
  - Easy access for larger storage items
- Enclosed interior access ladders
  - Minimizes vandalism and unsightly graffiti
  - Minimizes unauthorized tank access
  - Facilitates climbing during inclement weather

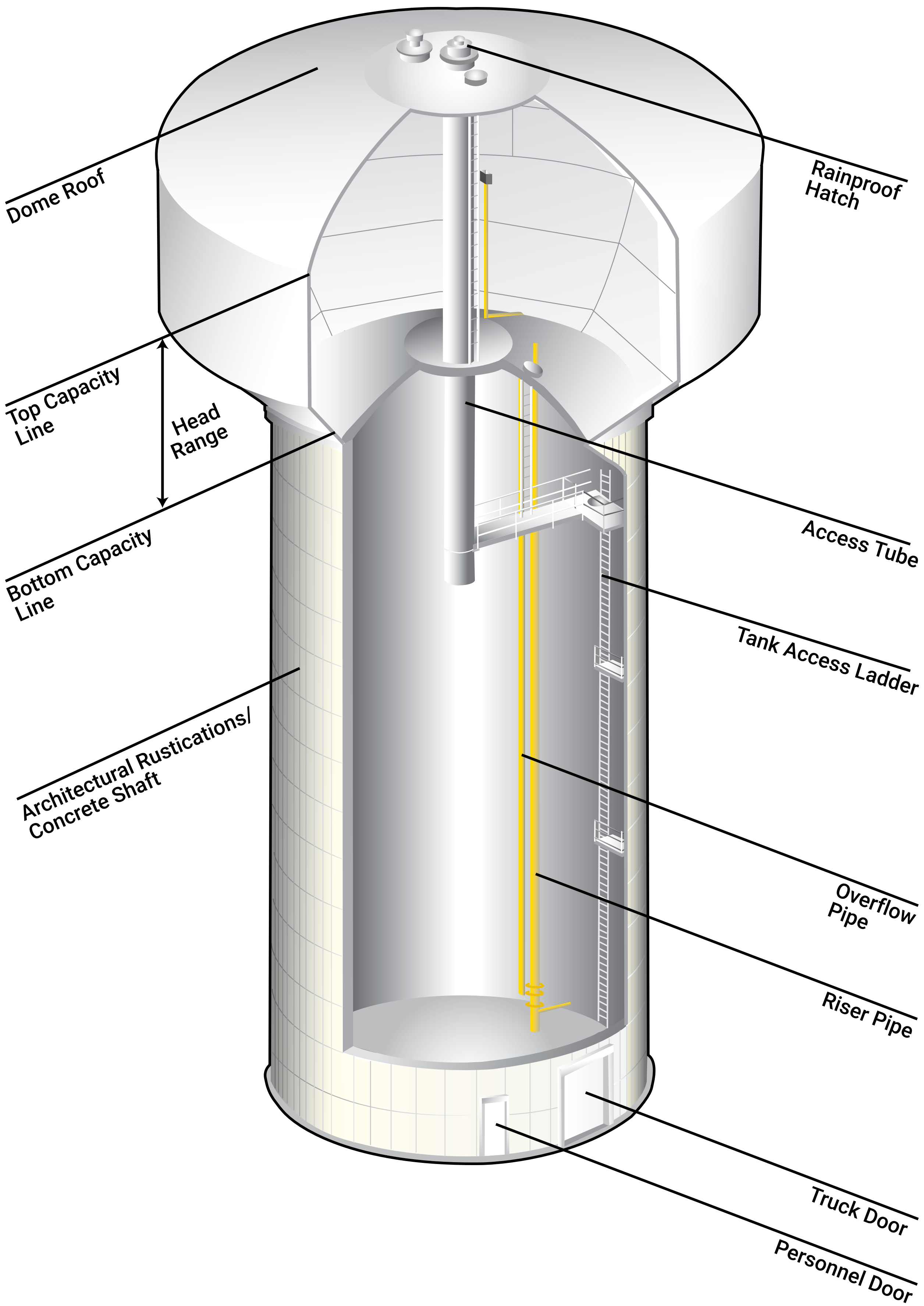
Optimum head range

- Standard design provides efficient head range
  - Minimizes pumping costs
  - Minimizes variation in water pressure
- Optional head ranges available

Dome roofs

- Improves appearance
- No ponding or bird baths
- Reduces topside corrosion and dirt streaks on tank exterior
- Minimizes snow and ice accumulation

Standard features and options



Standard features

- One 36" wide by 80" high personnel door with threshold
- Concrete floor inside base
- Stainless steel riser pipe with expansion joint
- Steel overflow pipe in tank with weir box
- Stainless steel overflow pipe to grade with splash block
- Galvanized ladders and platforms in support structure
- Safety devices on ladders as required by state and federal regulations
- Galvanized walkway with handrails from top of support structure to access tube hatch
- One 48" diameter access tube
- Painted ladder in access tube
- Painter's rings at top of support structure
- Tank drain
- One 24" wide by 36" high painter's ring hatch with louver
- One 30" tank bottom manway with access ladder to walkway
- Two 30" diameter roof hatches
- One 24" diameter painter's ventilation roof hatch
- Minimum 1/4" thick steel roof plates
- Seal welding underside of roof
- Interior lighting in support structure and access tube
- Lightning protection

Options

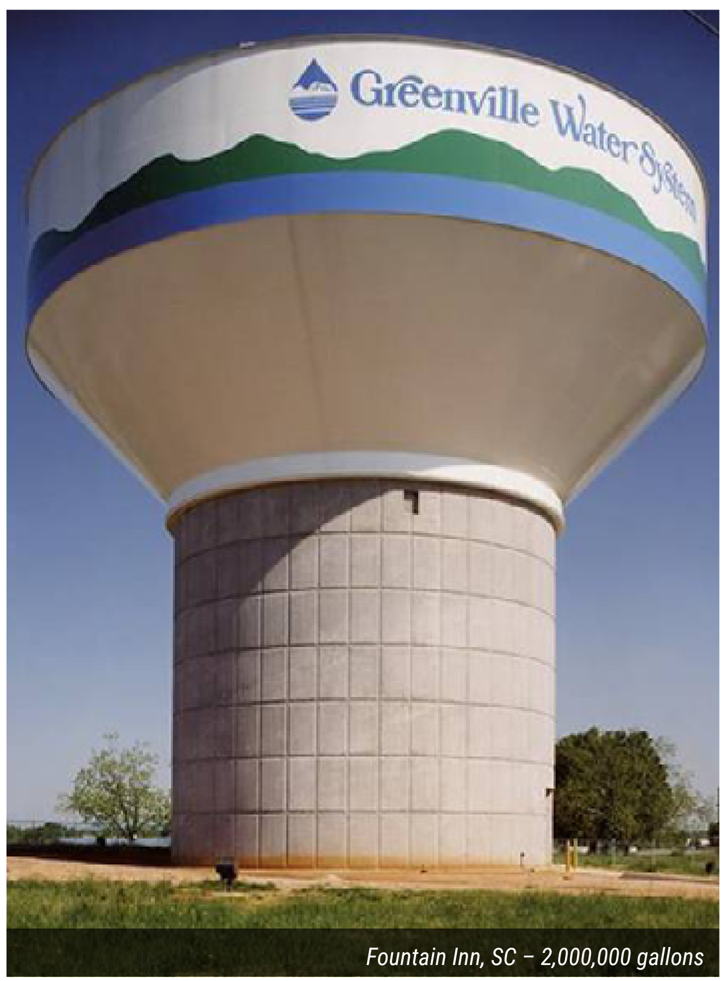
- Lettering, logos and decorative graphics
- Alternate style (as Waterspheroid® tank or Hydropillar)
- Architectural concrete support structure
- FreshMix® circulationsystem
- Structural framing, multiple floors and ceilings inside the support structure
- Additional openings in support structure (e.g., windows)
- Double personnel door
- Overhead doors
- Valve vault inside base
- Control room in support structure
- Dual risers
- Riser insulation and heat tracing
- Alternative ladder arrangements inside support structure
- Exterior access tube ladder
- Upsized 60 in. or 72 in. diameter access tube
- Internal tank ladder on access tube
- Exterior access tube ladder
- Roof handrail
- External security or decorative lighting
- FAA lighting
- Instrumentation
- Telemetry
- Cathodic protection
- Antenna penetrations and supports

Standard capacities and dimensions

Capacity U.S. Gallons	Tank Diameter* ft-in.	Head Range** ft-in.	Support Structure Diameter ft-in.
500,000	50 – 0	37 – 6	28 – 0
600,000	62 – 0	32 – 6	28 – 0
750,000	59 – 0	40 – 0	32 – 0
1,000,000	70 – 0	40 – 0	36 – 0
1,250,000	79 – 0	40 – 0	40 – 0
1,500,000	81 – 0	45 – 0	44 – 0
2,000,000	93 – 0	45 – 0	52 – 0
2,500,000	105 – 0	45 – 0	52 – 0
3,000,000	110 – 0	50 – 0	60 – 0
3,500,000	118 – 0	50 – 0	60 – 0

* Tank diameters based on listed/standard head ranges only.
** CB&I has other head ranges and support structure diameters available for each capacity tank. Please contact us if you need assistance.

Enterprise, AL – 1,500,000 gallons



Fountain Inn, SC – 2,000,000 gallons

League City, TX – 2,000,000 gallons

Charleston, SC – 1,500,000 gallons

Canton, MS – 1,500,000 gallons

Eden Prairie, MN – 2,000,000 gallons

Brownsburg, IN – 1,000,000 gallons

CB&I is the world's leading designer and builder of storage facilities, tanks and terminals. With more than 59,000 structures completed throughout our 130-year history, CB&I has the global expertise and strategically located operations to provide our customers world-class storage solutions for even the most complex energy infrastructure projects.

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Stantec is a global leader in sustainable engineering, architecture, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.

Stantec Consulting Services Inc.
45 Blue Sky Drive, 3rd Floor
Burlington, MA 01803
stantec.com

Water Storage Tank Concept Planning
Truro, MA

Prepared for:
Town of Truro, MA

Prepared by:
Stantec Consulting Services Inc

October 2025

Project/File:
195151014

Stantec Consulting Services Inc.

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1 Executive Summary

This memorandum summarizes the evaluation of siting a new water storage tank in North Truro, Massachusetts which would be connected to the Town of Provincetown's water distribution system. This study includes an evaluation of the physical configuration of the water storage tank including, tank volume and overflow elevation along with the hydraulic implications of this new water storage tank.

The Town of Truro acquired the Walsh property, located in North Truro, in 2019, for municipal purposes such as housing, open space and recreation. A previous study completed by Horsely Whitten Group (HWG) in 2023 evaluated proposed future water demands associated with the Walsh property and other proposed developments. This memorandum recommended a water storage tank volume of 600,000 gallons. Based on the ground elevations in the North Truro area, this water storage tank would be an elevated style water tank. This would create a new high service area in the water distribution system to supply water to the areas of higher elevations in North Truro.

Three potential water storage tank sites are evaluated as part of this study. These sites are:

- Town of Truro Public Safety Building, Route 6
- North Union Wellfield, Town of Provincetown's water supply well site in North Truro
- Quail Ridge Road, adjacent to Walsh Property.

The evaluation of the three water storage tank sites indicates that all sites are feasible to construct a new water storage tank. This study recommends that further evaluation, including evaluating the visual impact of the water storage tank, be completed in order to select a preferred water storage tank site.

In order to fill the proposed water storage tank, a new booster pump station should be constructed in tandem with the water storage tank. The existing South Hollow booster pump station is not adequately sized to fill the proposed water storage tank, nor does it have available space for expansion. In addition to the water storage tank and pump station, a pressure reducing valve vault would also be constructed to allow water from the newly created high service area to be reduced down to the main service area of Provincetown's water system. The booster pump station and pressure reducing valve vault concept design are outside of the scope of this study and therefore are captured from an overall recommendation standpoint. Future investigations and evaluations should be completed to advance the design concepts of these elements.

The proposed 600,000 gallon elevated tank is larger than the current day water demand of North Truro. Only with increases in water demand, either through new development or new connections to the water system, will the tank fluctuate regularly to maintain water quality. If timing of the water storage tank construction is prior to the completion of future development in North Truro, design elements of the water storage tank, booster pump station and pressure reducing valve vault should include provisions to force the turnover of the North Truro water storage tank to fill and drain on a frequent cycle.

Engineer's Opinion of Probable Construction Cost (EOPCC) has been developed as part of this project. The basis of the costs are RS Means, recent bids, published material prices, current labor costs and past projects. This EOPCC is based on using state wage rates for public construction, not utilizing Drinking Water State Revolving Loan Funds, and does not include costs for American Iron and Steel requirements. We caution that the accuracy of the EOPCC may vary greatly due to the current construction / infrastructure market conditions. The current market is very volatile, especially for materials due to delivery delays, tariff uncertainty, scarcity of raw materials and limited production at manufacturing plants. At the present time this EOPCC should not be considered the actual construction cost, but as a relative cost for budgeting. The actual cost could be 15% less to 35% more than the EOPCC.

The table below shows the major items of work and expected costs for each potential tank site. A 30% contingency has been added due to the design phase (conceptual). The construction of the water storage tank will vary based on the final selected water storage tank site. The construction cost for the most expensive site has been presented for budgeting purposes.

Water Storge Tank Opinion of Probable Construction Cost

Item		Site Costs		
		Public Safety Building Complex	North Union Wellfield	Quail Ridge
1	600,00 Gal Pedestal Spheroid Tank	$3,800,000	$3,650,000	$3,650,000
2	In-Tank Mixing System	$75,000	$75,000	$75,000
3	Piping and Valves	$50,000	$400,000	$205,000
4	Site Improvements	$300,000	$300,000	$280,000
5	Site Clearing	$80,000	$80,000	$95,000
6	Access Road	$45,000	$325,000	$325,000
7	Electrical / Instrumentation Work	$125,000	$240,000	$240,000
ESTIMATED CONSTRUCTION COST		**$4,475,000.00**	**$5,070,000.00**	**$4,870,000.00**
5% Mobilization / Demobilization.		**$223,750.00**	**$253,500.00**	**$243,500.00**
2.5% Bonds & Insurance		**$111,875.00**	**$126,750.00**	**$121,750.00**
30% CONTINGENCY		**$1,342,500.00**	**$1,521,000.00**	**$1,461,000.00**
ESTIMATED TOTAL COST		**$6,153,125.00**	**$6,971,250.00**	**$6,696,250.00**

Notes:

1. Piping and valves only includes the work within the fenceline of the water storage tank and does not include any longer connecting mains beyond the site out to the distribution system.
2. Access Road only includes the work within the approach to the site.
3. Does not include any land acquisition or easements.

Booster Pump Station and Pressure Reducing Valve Opinion of Probable Construction Cost

No.	Unit	Description	Estimated Quantity	Unit Price	Estimated Total Cost
1	LS	Booster Pump Station 800 sq. ft. precast building, two (2) 50 HP split case pumps, associated piping and valves, electrical work, and site work	1	$1,500,000	**$1,500,000**
2	LS	Pressure Reducing Valve Vault Below grade vault including two pressure reducing valves along with power for monitoring and controlling valve operation	1	$200,000	**$200,000**
3	LS	Water Storage Tank Connecting Pipe 5,500 feet of new 16", 550 LF of new 12" and appurtenances to connect proposed water storge tank site to existing water distribution system. This item may vary based on final selected water storage tank site.	1	$1,788,000	**$1,788,000**
4	LS	Water Distribution System Improvements Cost assumes the new booster pump station is sited near the existing South Hollow pump station, which as requires an additional 6,500 lf of 12-inch to bring the Cloverleaf and Pond Street Areas to the high service area.	1	$1,950,000	**$1,950,000**
				ESTIMATED CONSTRUCTION COST	**$5,438,000**
				3.5% Mob, Demob, Bonds, Ins, etc.	**$190,330**
				40% CONTINGENCY	**$2,175,200**
				Subtotal Construction Cost	**$7,803,530**
				20% Design and Engineering Services During Construction	**$1,560,706**
				ESTIMATED TOTAL COST	**$9,364,236**

Notes:

1. Does not include any land acquisition or easements
2. Additional conceptual design for the booster pump station and pressure reducing valve vault is recommended prior to initiating design phase.
3. A higher contingency has been carried for these recommendations since the concepts are not as advanced as that of the water storage tank.
4. Item 4 is not required if Cloverleaf and Pond Street areas will remain in the low pressure service area.

2 Water Storage Tank Concept Design

Stantec has been retained to provide a conceptual level memorandum for the North Truro water storage tank including an evaluation and confirmation of the hydraulic operating parameters.

The basis of design for the storage tank includes:

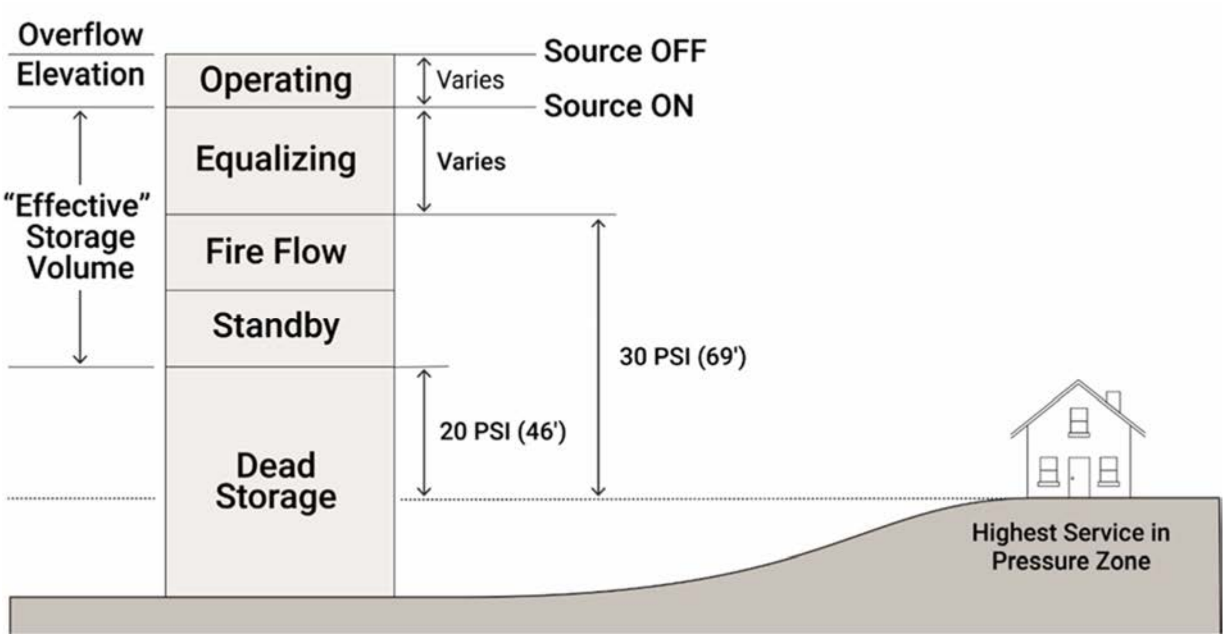
- Review of the Horsley Witten Group (HWG) April 2023 memorandum, noting any changes to the recommendations of the storage tank sizing.
- Tank Siting Plan, evaluating three (3) Town-owned properties to determine the feasibility of constructing a new water storage tank
- Water storage tank design elements including:
  - Inclusion of an active tank mixer.
  - Instrumentation to provide temperature and level to SCADA systems.
  - Review of FAA regulations to determine whether FAA lighting / marking is required and to what level.
  - Accessories – door and security light into the base of the pedestal. Other accessories include an overflow drainage basin (or rip rap basin), finial vent, roof handrails, interior ladders (including safety climb system) or stairs, platforms, access hatches, and manways.
  - Foundation shall have a 10-foot-wide diameter ring of crushed stone with filter fabric around the base of the tank to maintain foundation integrity.
  - Coatings shall meet NSF requirements on interior and exterior of tank, including mildew resistant coating on underside of tank bowl if a pedestal spheroid is selected.

2.1 Water Storage Tank Sizing Considerations

The Town of Truro's (Town) existing water supply is provided by the Town of Provincetown (Provincetown). The Town has recently acquired the Walsh Property, which is anticipated to provide for the development of up to 260 homes. This proposed development for the Town, along with other potential developments, would increase water demand, including the development at higher elevations, necessitating the need for additional water storage capacity. Provincetown currently has two water storage tanks, which service what will become the main or low-pressure system, and total 6.5 million gallons (MG) of storage. The proposed North Truro water storage tank would be in the high-pressure system. Based on the Horsely Whitten Group (HWG) report, the high-pressure system would have a Hydraulic Grade Line (HGL) of EL 220-feet.

Storage volume can be broken down into the following components: operating storage, equalization storage fire flow, standby storage, and dead (unusable) storage, as shown in Figure 2-1 below. Effective volume is equal to the total volume less any dead storage. Operational storage is the volume devoted to supplying the water system under normal operating conditions and while the sources of supply are in the "off" status. Equalization storage is the tank volume which stores water during periods of low demand and releases the water under periods of high demands. This equalizing storage helps to prevent the need for filling the tanks during peak demand hours.

Figure 2-1: Usable Storage



2.1.1 Current North Truro Demands

Stantec reviewed the calculations that were performed by HWG regarding the volume of the proposed tank. Those calculations are based on a single year of data (2022), the max day demand peaking factor, and future development needs based on a residential gallons per capita per day (RGCPD) of 65 gallons per day per person, which is the maximum allowed by MassDEP. Table 2-1 presents the historical data presented in the HWG report.

Table 2-1: Historical North Truro Water Demand Data – From HWG Report

Year	Yearly Consumption (MG)	Max Day Demand (MG)	20% Of Max Day Demand (MG)	Average Day Demand (MG)
2022	32.85*	0.229	0.046	0.090

Ratio of ADD to MDD (peaking factor) is 2.54.
* HWG Memo presents the Yearly consumption as 21 MG. This value does not correspond to the presented Average Day Demand. This yearly consumption has been corrected/recalculated to be 32.85 MG

Stantec assumed that the basic fire flow is 2,000 gpm, for a three-hour duration, or a total of 360,000 gallons. This is based on the HWG report as the nature of the commercial building usage and fire requirements are unknown at this time. Equalization is typically accounted for as 20% of the MDD, or 46,000 gallons.

The total water storage requirement for the water system is the sum of the equalization storage and the fire flow requirement. To meet the more conservative US EPA vulnerability requirements[1], the water storage requirement is the sum of the ADD plus fire flow. Refer to Table 2-2,and Table 2-3 below.

Table 2-2: Quantity of Storage by Type – North Truro Current Requirements

Type of Storage Needs	Quantity
Fire Flow Needs	360,000 gallons
Equalization	46,000 gallons
Average Day Demand	90,000 gallons
Maximum Day Demand	229,000 gallons

Table 2-3: Quantity of Current Water Storage Requirements – High-Pressure System

Type of Storage Needs	Quantity
Fire Flow + Equalization	406,000 gallons
Average Day Demand	90,000 gallons
Fire Flow + Average Day	450,000 gallons

Note: This table includes the total storage required for the high-pressure system, but does not include future / potential development.

To address system vulnerability concerns, the minimum storage amount should be the Fire Flow plus Average Day (0.450 MG). In the event that the water distribution system is unavailable, this affords the North Truro area approximately 5 days' worth of ADD storage, and time to find another temporary source of water while the system is brought back online, by obtaining water from interconnections or other emergency supply pumping. As storage tanks come in standard capacities, the 0.450 MG figure should be rounded up to 0.5 MG. The following section evaluates water storage requirements of future demand (near term) and long term.

[1] The EPA Vulnerability assessment recommends at least 24 hours of storage (ADD) be on site, preferably more than one day should be available.

2.1.2 Future Demand Planning

A review of future anticipated projects was completed to ensure that future water storage capacity would be adequate to meet anticipated residential and commercial development in North Truro. The future demands come from four (4) separate projects as delineated in the HWG report in addition to the existing North Truro water demands presented previously in Tables 2-2 and 2-3;

- the Walsh Property projected to include to 260 homes,
- the Cloverleaf Development (Anticipated water use - 6,305 gallons per day)
- the Pond Road Extension (Anticipated water use - 10,238 gallons per day)
- An additional 250 homes as requested by the Town of Truro.

Stantec analyzed the two years of Provincetown Annual Statistical Reports (2022, and 2023), which indicate that the RGPCD was 58 in 2022, and only 49 in 2023. These are considered to be low RGPCD, so the conservative RGPCD of 65 has been used in Stantec's calculations. Additionally, the HWG report had utilized the available 2022 data for average number of people per home, which was 1.87. Stantec reviewed publicly available data for the current (2025) average number of people per house in Truro. The current estimate is 2.18 people per home. For a more conservative approach, Stantec has used the 2025 data in our calculations. Based on those assumptions, the usage of the future demands as indicated in Table 2-4. The formula used to calculate the demand of the Walsh Property and Additional Homes is:

$$Calculated\ Usage\ (gpd) = (\#\ of\ homes)\ x\ (65\ RGPCD)\ x\ (2.18\ residents\ /\ home)$$

Table 2-4: Estimated Demands for 2030

Development	From HWG Report (gpd)	Calculated (gpd)	MG/Year
Cloverleaf Development	6,305	--	**2.30**
Pond Road Extension	10,238	--	**3.74**
Walsh Property (260 homes)	--	36,842	**13.45**
Additional Homes requested (250 homes)	--	35,425	**12.93**
		Total Future Estimated Demands in MGY	**32.42**

MG/Year was calculated based on the gpd x 365 days.

This revises previously presented data in Table 1 as seen below in Table 2-5.

Table 2-5: Future and Historical North Truro Water Demand

Year	Yearly Consumption (MG)	Max Day Demand (MG)	20% of Max Day Demand (MG)	Average Day Demand (MG)
Future Developments	32.42	0.225	0.045	0.089
2022 (Existing Demand)	32.85	0.229	0.046	0.090
Total Future Demand	65.3	0.454	0.091	0.179

Ratio of ADD to MDD (peaking factor) is 2.54.

The fire flow needs do not change from prior calculations. With the revised data from Table 2-5 above, Tables 2-2 and 3 change as indicated below in Table 2-6 and 7.

Table 2-6: Quantity of Storage by Type – North Truro Future Requirements

Type of Storage Needs	Quantity w/out Future Buildout	Quantity with Future Buildout
Fire Flow Needs	360,000 gallons	360,000 gallons
Equalization	46,000 gallons	91,000 gallons
Average Day Demand	90,000 gallons	179,000 gallons
Maximum Day Demand	229,000 gallons	225,000 gallons

Table 2-7: Quantity of Future Water Storage Requirements – High-Pressure System

Type of Storage Needs	Quantity w/out Future Buildout	Quantity with Future Buildout
Fire Flow + Equalization	406,000 gallons	451,000 gallons
Average Day Demand	90,000 gallons	179,000 gallons
Fire Flow + Average Day	450,000 gallons	539,000 gallons

Based on standard tank capacities, while addressing vulnerability and redundancy, as well as potential for commercial and residential build-out, and water quality concerns, 0.5 MG, 0.6 MG or 0.75 MG could be used for the proposed storage volume. These options all exceed one day of average day water usage in current day demands and exceed one day of water use in future day demands. Even though the projected average day demand is slightly above 0.5 MG, storage requirements should be based on a range of data, not a single year. The HWG report concluded the total volume required was 680,000 gallons, which translated to a 750,000 gallon tank (rounding up for standard tank capacity). Based on available data, Stantec's knowledge of tank pricing related to standard sizing, it is recommended that Truro proceed with a 0.6 MG tank. This tank size is readily available in the pedestal spheroid or the composite style tanks. Of the two tank styles, the Pedestal Spheroid has a head[2] height of 40-feet, and the Composite Tank has a head height of 32.5-feet. For the purposes of this report, the 40-feet head height has been used as it is the most conservative scenario.

2.1.3 Detailed Tank Sizing

This report focuses on the high-pressure system in terms of the sizing of the new tank. The required elevation to maintain a system pressure of 20 psi is at elevation 164.2 feet, based on the highest house's threshold which has an elevation of 118 feet (currently). The highest potential new homes (future buildout) are located at EL 140 (located within the Walsh property). Stantec has analyzed the new tank using multiple variables – the first of which is the highest threshold elevation for servicing homes/businesses, utilizing both the existing EL 118 and the proposed EL 140. Stantec also analyzed the new tank hydraulics based on the minimum usable storage elevation – the MassDEP and EPA require 20 psi as a service pressure at the threshold elevation, as indicated in Figure 2-1 above. However, Provincetown requires 40 psi as a threshold service elevation. The HWG report indicates that Provincetown may not require 40 psi for this high-pressure zone. As such, Stantec analyzed the tank at 20 psi, 30 psi, 35 psi and 40 psi at the threshold. This provides the amount of dead storage that could be in the tank. Our initial calculations were based on the HWG's report setting the overflow (hydraulic grade line) at EL 220. Dead storage should be minimized to 10% or less of the tank's total volume. The calculations are summarized in Table 2-8 below.

Table 2-8: Dead (Inactive) Storage Amounts – Overflow at EL 220

	Dead (Inactive) Storage Amount			
	Highest Threshold EL 118		Highest Threshold EL 140	
Minimum Threshold Pressure	Gallons	% of Tank	Gallons	% of Tank
20 psi	0	0.0	93,000	15.5
30 psi	109,500	18.3	439,500	73.3
35 psi	282,750	47.1	600,000	100
40 psi	456,000	76.0	600,000	100

Regardless of which highest threshold elevation (highest serviceable elevation) is desired to be used, to provide pressure for fire flow and maintain the lowest amount of dead water, the Provincetown minimum pressure at the threshold of 40 psi cannot be met if the overflow is set at EL 220. The potentially lower 35 psi pressure at the threshold cannot be met if the highest serviceable elevation is EL 140, and due to the high dead water amount at the current serviceable elevation of 118, it is not recommended to use that

[2] Head: The vertical distance between the bottom of the bowl and the overflow in elevated tanks.

overflow elevation. Provided that the tank only needs to meet the EPA / MassDEP minimum threshold elevation of 20 psi and fire flow, and the service elevation remains at EL 118 (reducing the location of the potential homes on the Walsh property), the new tank will work with an overflow set at EL 220. The new tank will work with an overflow of EL 220 for the highest serviceable elevation of 140, with the realization that there is 93,000 gallons of dead storage which is slightly more than is considered acceptable within the tank industry.

If the desire to service the new high-pressure zone is to follow Provincetown's minimum service pressure of 40 psi, the overflow elevation would need to increase to EL 250 if the service elevation remains EL 118, and to EL 272 if the service elevation is 140. Based on discussions with Provincetown it was agreed that the highest home service elevation should be set to 140. As such, visual representations of the overflow elevations to service 20 psi, 30 psi and 40 psi with the service elevation set to 140 is shown in Figures 2-2, 2-3, and 2-4 below. Table 2-9 presents a summary of the required overflow elevations based on highest service threshold elevation.

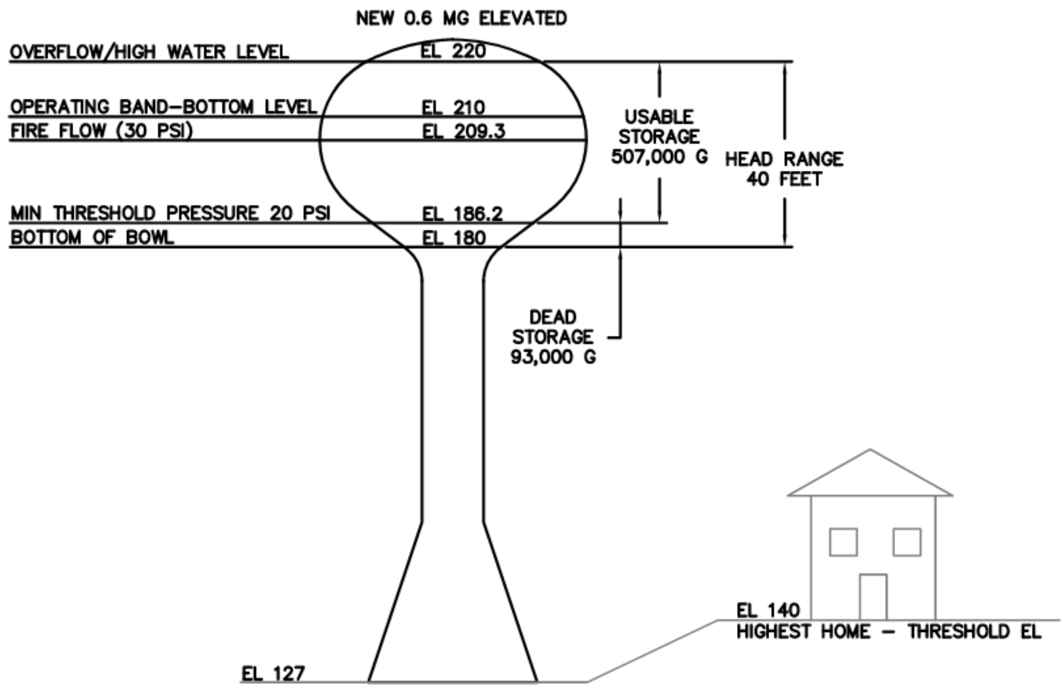
Table 2-9: Minimum Overflow Elevation needed to Obtain Minimum Threshold Pressure at Highest Service Threshold Elevation

	Minimum Overflow Elevation Required	
Minimum Threshold Pressure	**Highest Threshold EL 118**	**Highest Threshold EL 140**
20 psi (DEP Requirement)	EL 205	EL 226
30 psi	EL 228	EL 250
40 psi (Provincetown Minimum)	EL 250	EL 272

Adjusting the overflow elevation higher will have impacts on the lowest served elevation within the distribution system. Using an overflow of EL 272, and a lowest threshold elevation within the new pressure zone of 59, 68, or 78 (depending on where the limits of the new zone are), the service pressures at the lowest threshold elevation of EL 59 (worst case) become 92 psi, at EL 68 become 88 psi, and at EL 78 provides a service elevation of 84 psi. All of these are acceptable, and the lowest threshold elevation of 59 should be the lowest served.

Based on the minimum service pressure at the threshold elevation of 30 psi, dead water, and servicing all homes between EL 59 and EL 140, Stantec recommends the new tank be a 0.6 MG tank, with an overflow elevation set at EL 250. This is the scenario shown in Figure 2-3.

Figure 2-2: Dead Storage with Highest User at EL 140, Overflow EL 220, 20 psi Min. Service Pressure



Note: Ground elevation is shown here as the ground at the North Union Well Field site. All pressures relate to the threshold elevation of the highest home.

Figure 2-3: Dead Storage with Highest User at EL 140, Overflow EL 250, 30 psi Min. Service Pressure

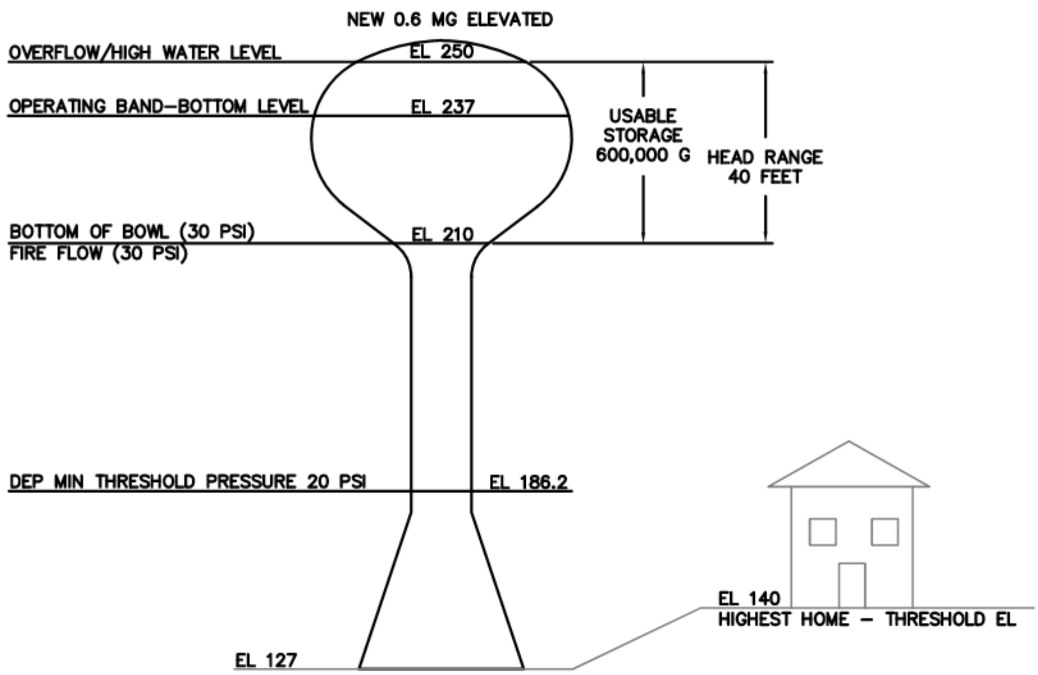
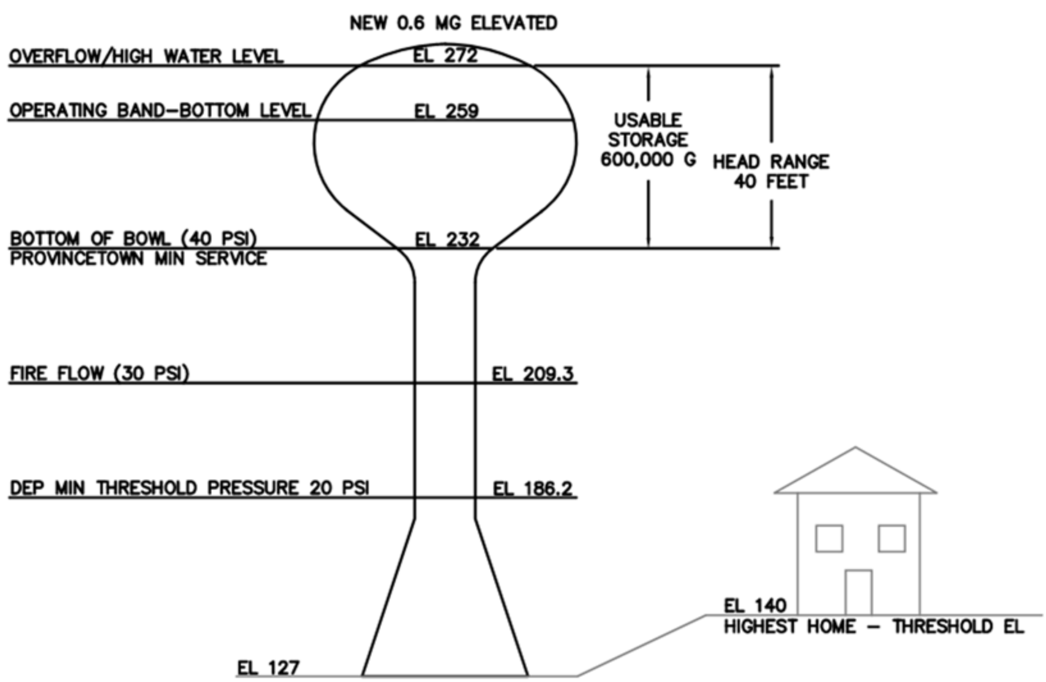


Figure 2-4: Dead Storage with Highest User at EL 140 Overflow EL 272, 40 psi Min. Service Pressure



Note: Ground elevation in Figures on this page are shown here as the ground at the North Union Well Field site. All pressures relate to the threshold elevation of the highest home.

Based on discussions with the Town of Provincetown, it was agreed that maintaining a minimum pressure of 30 psi at the highest anticipated home (elevation 140) would be appropriate for tank sizing. Therefore an overflow elevation of elevation 250 feet is recommended.

2.2 Water Storage Tank Siting Analysis

The Town has provided three (3) potential tank site locations for evaluation. These sites are:

- Public Safety Building Complex, Parcel ID 039-323-000, nearest address is 340 Route 6(2.69 acres)
- Quail Ridge, Parcel ID 043-003-000, located on Quail Ridge Road (9.40 acres)
- North Union Well Field, Parcel ID 040-077-000, address is 245 Old Kings Highway (4.19 acres).

Stantec has reviewed the MassGIS MassMapper, MapsOnline, National Resource Conservation Service, and Town of Truro Assessor's database for information on topography, environmental concerns (e.g. - wetlands, priority habitats), soils, parcel / lot size, access, and proximity to water system. Each of these parameters, along with foundation type and tree removal quantity, went into a scoring system to determine which parcel is feasible and/or most desirable for the tank location. Figure 2-5 shows the three parcels that were evaluated in relationship to each other. The scoring system and parameters evaluated are defined below.

Figure 2-5: Tank Siting Parcel Location Map

2.2.1 Scoring System

The scoring system is further described below and presented in the order of most important criterion to least important criterion. The maximum number of points for any category is 5 points (i.e. best/most desirable option), and the least favorable option is 0 points. The future buildout category is the only category that awards either 1 or 0 points and is further discussed below. The maximum total number of points for any parcel is 41, and the minimum number of points is 0 points. As each parameter is reviewed, the three parcels for evaluation are scored. A comprehensive score table is at the end of the section showing all of the parameters and total scores for each parcel.

2.2.1.1 Parcel / Lot Size

Each parcel was initially evaluated based on lot size. The minimum size lot needed for construction is 150-foot by 150-foot square (approximately 0.5 acres), which would allow for the construction and future maintenance of a single tank. Parcels that are greater than 0.5 acres are most desirable. A parcel equal to or larger than 0.5 acre but with individual dimensions less than 150-feet on any side may work and was hence considered the next best choice. A parcel smaller than 0.5 acres is not feasible for tank construction. See Table 2-10 for Evaluation Criteria and Table 2-11 below for scoring. See Figure 2-6, 2-7, and 2-8 below for each parcel's dimensions.

Table 2-10: Parcel / Lot Size Evaluation Criteria

Criteria	Points
Greater than or equal to 0.5 acre (minimum size 150'×150')	5
Greater than or equal to 0.5 acre (less than 150' on any side)	2
Less than 0.5 acre	0

Table 2-11: Parcel / Lot Size Scoring

Criteria	Points
Public Safety Building Complex, Parcel ID 039-323-000 Parcel Size: 2.69 acres, Tank Lot Size: 0.63 acres	5
Quail Ridge, Parcel ID 043-003-000 Parcel Size: 9.4 acres, Tank Lot Size: 0.74 acres	5
North Union Well Field, Parcel ID 040-077-000 Parcel Size: 4.19 acres, Tank Lot Size: 0.63 acres	5

Figure 2-6: Public Safety Building Complex, Parcel ID 039-323-000

Figure 2-7: Quail Ridge, Parcel ID 043-003-000

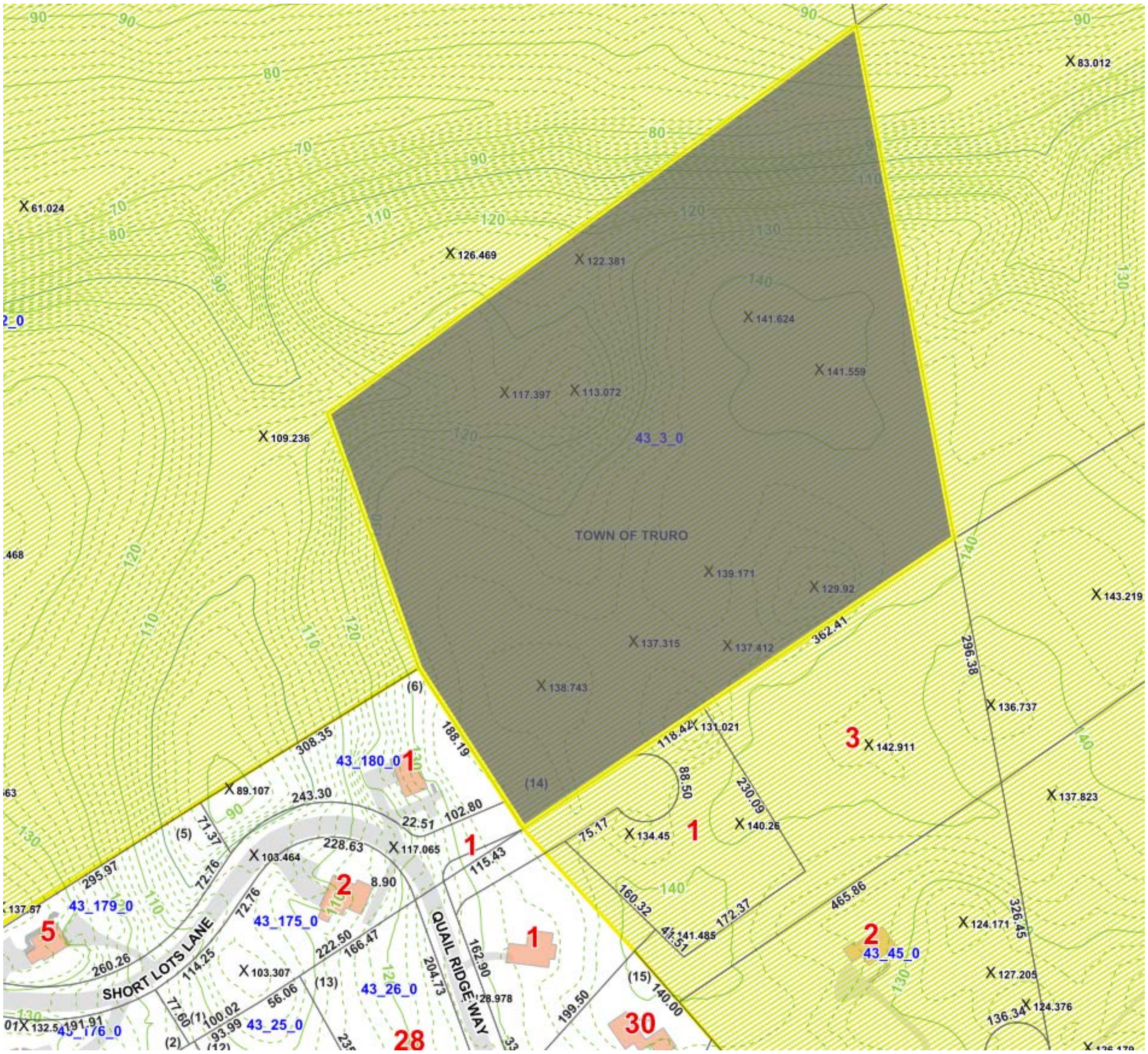
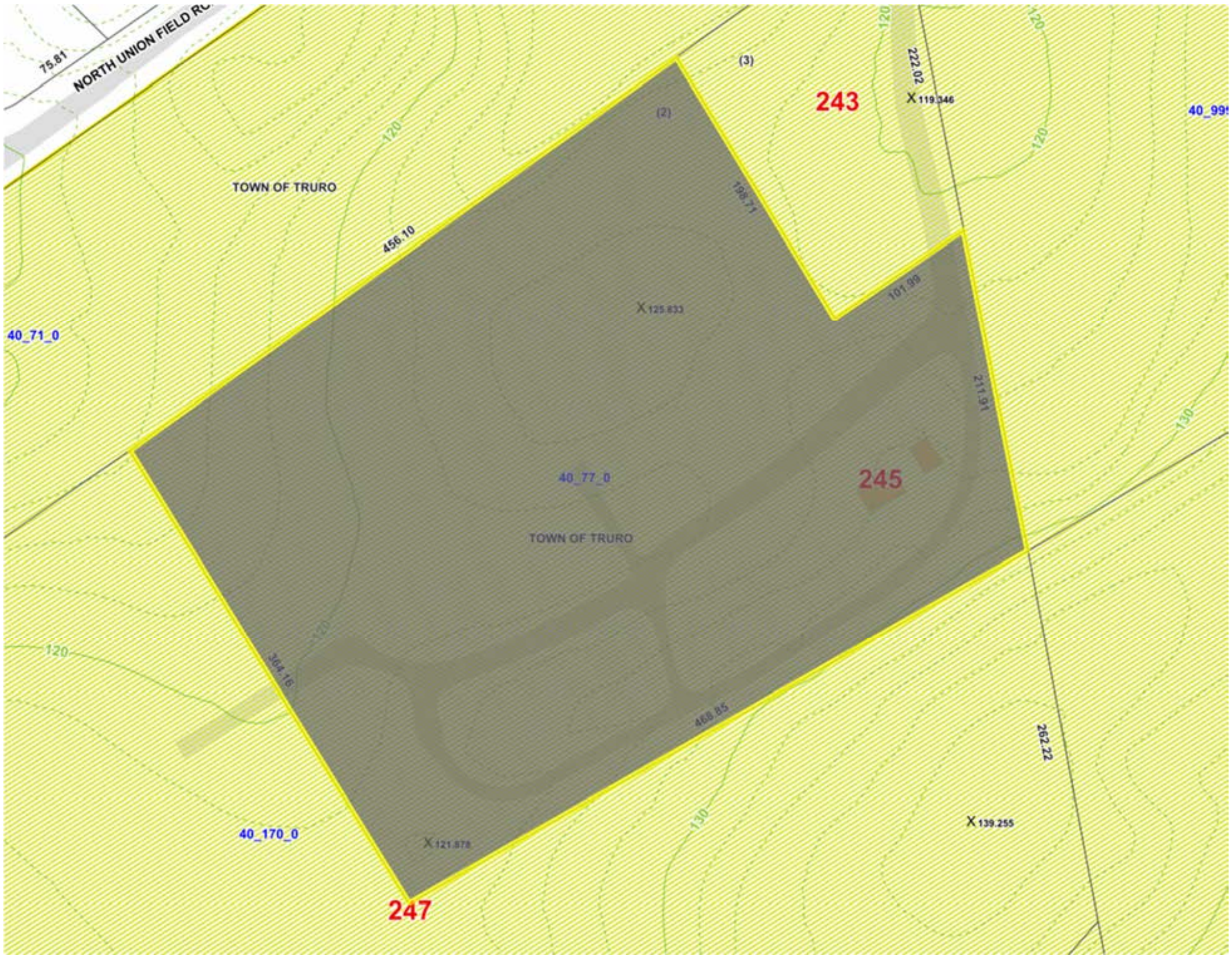


Figure 2-8: North Union Well Field, Parcel ID 040-077-000



2.2.1.2 Future Buildout

The future buildout criterion investigated whether it was possible to subdivide a larger parcel such that a second tank could be constructed on the same parcel in the future, either through replacement of an existing tank, or expansion of the elevated storage capacity on the site for redundancy. If it was determined that there was enough land for more than one tank, the parcel scored an additional point. If there was room for a single tank only, the parcel did not receive any additional points. This is the only criterion that did not follow the five-point scoring system, as it was not considered critical for locating a tank site and was instead regarded as providing a slight scoring edge to those parcels capable of accommodating water storage redundancy. The scoring for future buildout is summarized in Table 2-12 for Evaluation Criteria and Table 2-13 below for scoring

Table 2-12: Future Buildout Evaluation Criteria

Criteria	Points
Yes, the parcel can hold more than one tank / offers redundancy	1
No, the parcel only has room for one tank	0

Table 2-13: Future Buildout Scoring

Criteria	Points
Public Safety Building Complex, Parcel ID 039-323-000	1
Quail Ridge, Parcel ID 043-003-000	1
North Union Well Field, Parcel ID 040-077-000	1

2.2.1.3 Proximity to Water System

The proximity to water system criterion investigated whether a 10-inch or larger water distribution or transmission main was within a reasonable distance to the proposed tank site. This is primarily considered the distance from along roads. While a new water main could be laid to connect to the proposed tank parcel, the longer the distance that the transmission main needs to be extended, the more expensive the tank project will be. A transmission main within 499-feet of the parcel was considered the most favorable option and was attributed 5 points. A transmission main greater than or equal to 500-feet but less than 1000-feet was regarded as the next best option and was allotted 3 points. A transmission main greater than or equal to 1000-feet was the least desirable option and was worth 0 points. The scoring for proximity to water system is summarized in Table 2-14 for Evaluation Criteria and Table 2-15 below for scoring

Table 2-14: Proximity to Water System Evaluation Criteria

Criteria	Points
Less than 500 feet to 10" main or larger	5
Less than 1000 feet to 10" main or larger	3
Greater than 1000 feet to 10" main or larger	0

Table 2-15: Proximity to Water System Scoring

Criteria	Points
Public Safety Building Complex, Parcel ID 039-323-000	5
Quail Ridge, Parcel ID 043-003-000	3
North Union Well Field, Parcel ID 040-077-000	3

2.2.1.4 Elevation

The elevation criterion measures the general ground elevation of the parcel versus the system's hydraulic grade line elevation (i.e. the overflow elevation of the tanks within the same pressure zone). The head space (or distance between the overflow and the bottom of the bowl where water is stored) varies depending on the volume of water inside the tank. For the 0.6 MG pedestal spheroid tank, the headspace is 40-feet. A minimum of 80-feet from the ground to the tank overflow is required to construct a tank, and hence, below 79-feet was deemed non-buildable, and received 0 points. Between 80 and 100-feet from the ground to overflow, would mean a "short" elevated tank, which is slightly more costly to build due to added structural requirements in the tank's column. While short tanks are buildable, they were regarded as slightly less favorable due to cost and received 3 points. Tanks at 101-feet to 125 feet are the most desirable and were attributed 5-points. Tanks over 125-feet to overflow are more costly due to added structural requirements in the tank's column, and received 3-points. The scoring for elevation is summarized in Table 2-16 for Evaluation Criteria and Table 2-17 below for scoring.

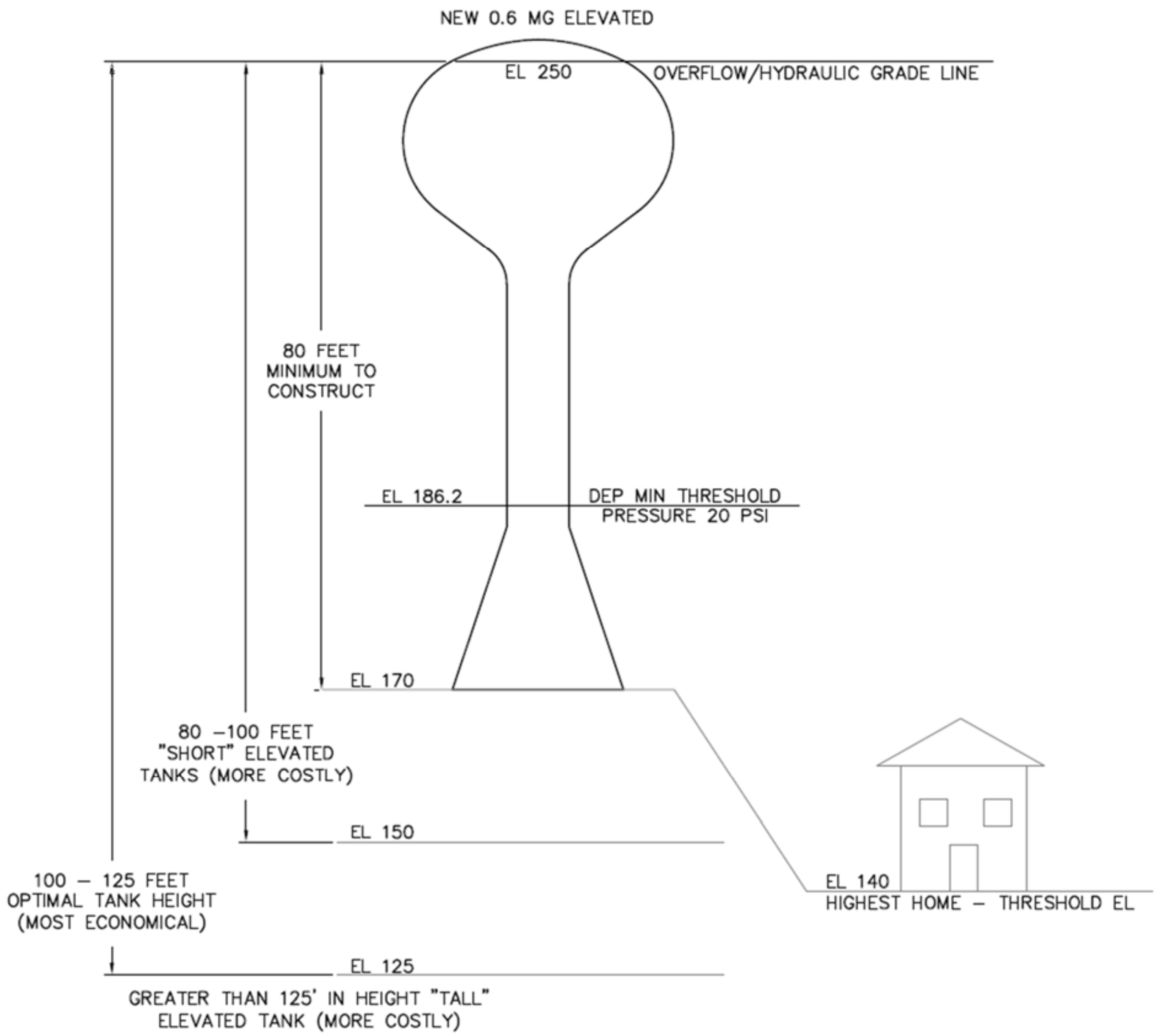
Table 2-16: Elevation Evaluation Criteria

Criteria	Points
Less than or equal to EL 125 feet (tall tanks, more expensive)	3
Between EL 125 **feet and EL** 150 **feet** (best cost)	5
Between **EL** 150 feet and **EL** 170 feet (short elevated tanks)	3
Greater than or equal to **EL** 170 feet (not buildable)	0

Table 2-17: Elevation Scoring

Criteria	Points
Public Safety Building Complex, Parcel ID 039-323-000	3
Quail Ridge, Parcel ID 043-003-000	5
North Union Well Field, Parcel ID 040-077-000	5

Figure 2-9: Hydraulic Gradeline vs. Elevation for Constructability



2.2.1.5 Environmental Evaluation Criteria

The environmental criterion examined GIS layers to determine what environmental issues (if any) were present on the parcels. The most favorable ones were those with no environmental concerns (wetlands, conservation land, endangered species, or a combination thereof), and scored 5 points. Although not as favorable an option, a tank can be constructed on a parcel within an endangered species habitat if special construction conditions are put in place to mitigate impacts. This scenario was allotted 3 points. Parcels containing conservation land, wetlands, or a combination of wetlands and endangered species were considered non-buildable and were given 0 points. The scoring for environmental evaluation criteria is summarized in Table 2-18 for Evaluation Criteria and Table 2-19 below for scoring

Table 2-18: Environmental Evaluation Criteria

Criteria	Points
No Environmental Concerns	5
Endangered Species	3
Conservation Land	0
Wetlands	0
Wetlands + Endangered Species	0

Table 2-19: Environmental Scoring

Criteria	Points
Public Safety Building Complex, Parcel ID 039-323-000	5
Quail Ridge, Parcel ID 043-003-000	3
North Union Well Field, Parcel ID 040-077-000	3

Note: Figures 2-6, 2-7 and 2-8 show priority habitats as yellow and white or yellow, green and white stripes across the properties. Both Quail Ridge and the North Union Well Field have priority habitats on them. There are no indications of vernal pools or designated wetlands on any of the properties. An NHESP filing will need to be completed during design for the Quail Ridge and North Union Well Field properties to determine what species may be present, and what precautions need to be observed during construction for those species.

2.2.1.6 Soils Evaluation Criteria

The soils criterion reviewed soils maps published by the National Resource Conservation Service (NRCS) to determine the dominant soil series for each parcel. Information regarding soil/geological associations, depth to rock and estimated competency of rock were evaluated. The sites where mapping indicates the presence of competent rock for tank foundations, were scored 5 points. Sites where mapping indicate that gravel is predominant were considered the next best option and were given 4 points. Sand is less desirable than gravel, but is still workable, and thus parcels where mapping indicates sand prevails were allotted 3 points. While a tank could be constructed on land where workable clay is prevalent, the scenario is not very desirable and was attributed 2 points. Parcels where mapping indicates non-desirable silt/clay/peat is dominant, were considered non-buildable and scored 0 points. The scoring for proximity to water system is summarized in Table 2-20 for Evaluation Criteria and Table 2-21 below for scoring

No formal on-site geotechnical investigations have been conducted at this time, but are recommended prior to any design work taking place.

Table 2-20: Soils Evaluation Criteria

Criteria	Points
Rock - Competent	5
Gravel	4
Sand	3
Clay - Workable	2
Non-Desirable Silt/Clay/Peat	0

Table 2-21: Soils Scoring

Criteria	Points
Public Safety Building Complex, Parcel ID 039-323-000	3
Quail Ridge, Parcel ID 043-003-000	3
North Union Well Field, Parcel ID 040-077-000	3

The soils designation at both the North Union Wellfield and Quail Ridge properties is annotated as "Carver 252C". At the Public Safety Building property, the northeastern corner of the property (highest elevation, and most likely tank location) contains soils annotates as "Carver 252A", whereas the remainder of the property is annotated as "Carver 252B".

2.2.1.7 Foundation Type

Tanks have two possible foundation types, which are dependent on geology. Tanks that can sit on bedrock, gravels, and high pound per square foot (psf) soil bearing pressures are a ringwall style foundation. These tend to cost less, and are easier to design and construct. High soil bearing pressures are those above 3000 psf. Tanks that sit on sands, workable clays, and soils that have low soil bearing pressures (less than 3000 psf) require pile foundations. These take longer for design and construction and tend to be more expensive. Lastly, non-desirable soils (silts, some clays, and peat) are considered non-buildable. Ringwall foundations were scored with 5 points, piles are scored with 3 points, and unbuildable based on the soils scoring above are awarded 0 points. The scoring for the foundation type is summarized in Table 2-22 for Evaluation Criteria and Table 2-23 below for scoring

No formal on-site geotechnical investigations have been conducted at this time, but are recommended prior to any design work taking place. As part of those geotechnical considerations, soil samples will be sent to labs for testing to determine soil bearing pressures.

Table 2-22: Foundation Type Criteria

Criteria	Points
Ringwall (used in high psf soils)	5
Piles (used in low psf soils)	3
Unbuildable based on Soil Score of 0	0

Table 2-23: Foundation Type Scoring

Criteria	Points
Public Safety Building Complex, Parcel ID 039-323-000	3
Quail Ridge, Parcel ID 043-003-000	3
North Union Well Field, Parcel ID 040-077-000	3

2.2.1.8 FAA Evaluation

New tanks are evaluated for structure height in relationship to airports and obstruction lighting and markings. FAA Section 77.9, of Form 7460 requires that the FAA be notified if a new structure is 200 feet in height from ground level, or if that structure does not meet the slope to the nearest airport, provided the airport's nearest point is within 20,000 feet. FAA Advisory Circular AC 70/7460-1M requires that any structure that is 150 feet above ground shall be lighted. Any structure that is 200 feet or more in height shall be marked (checkerboard paint) and lighted. FAA lighting will be required if the structure is above 150 feet, but less than 350 feet. If a tank triggers either of these requirements, FAA notifications and approvals are required. To comply with FAA Section 77.9, a review of the Cape Cod airports (Provincetown Municipal, Nantucket Memorial, Martha's Vineyard, and Barnstable Airport) have indicated that none are within 20,000 feet (approximately 3.8 miles). As such, the scoring for this category will be based on tank height. To determine the tank height, the top of the structure (including all appurtenances) will be the height between ground and overflow, plus 15 feet.

Tank heights at 150 feet or less scored 5 points, heights between 151 feet and 199 feet scored with 3 points, and tanks greater than 200 feet scored 0 points. The scoring for FAA evaluation is summarized in Table 2-24 for Evaluation Criteria and Table 2-25 below for scoring

Table 2-24: FAA Evaluation Criteria

Criteria	Points
Tank height equal to or less than 150 feet	5
Tank height between 151 feet and 199 feet	3
Tank height 200 feet or greater	0

Table 2-25: FAA Evaluation Scoring

Criteria	Points
Public Safety Building Complex, Parcel ID 039-323-000	3
Quail Ridge, Parcel ID 043-003-000	5
North Union Well Field, Parcel ID 040-077-000	5

2.2.1.9 Land Clearing Criteria

The land clearing criterion examined satellite images, and the Truro's assessor's database of each site. A layout of the 0.6 mg tank showing the pedestal footprint and the bowl diameter, along with a future tank to show potential location is shown in Figures 2-10, 2-11, 2-12 below. In order to determine the land clearing quantity, the minimum land clearing about (150' x 150'), along with an access road has been sketched in for each parcel. Land clearing, especially in areas that are priority habitats, can be difficult between permitting and timing, and can be costly. The entire 150' x 150' area and area designated as access are to be cleared, unless the area was already clear of all trees. Parcel with less than 0.2 acres of total clearing scored 5 points. Parcels between 0.2 acres and 0.7 acres scored 3 points. Parcels greater than 0.7 acres received 0 points. The scoring for land clearing is summarized in Table 2-26 for Evaluation Criteria and Table 2-27 below for scoring

Table 2-26: Land Clearing Criteria

Criteria	Points
Less than 0.2 acres of clearing	5
Between 0.2 acres and 0.7 acres	3
Greater than 0.7 acres	0

Table 2-27: Land Clearing Scoring

Criteria	Points
Public Safety Building Complex, Parcel ID 039-323-000	3
Quail Ridge, Parcel ID 043-003-000	0
North Union Well Field, Parcel ID 040-077-000	3

Figure 2-10: Approximate Layout – Public Safety Building Complex, Parcel ID 039-323-000

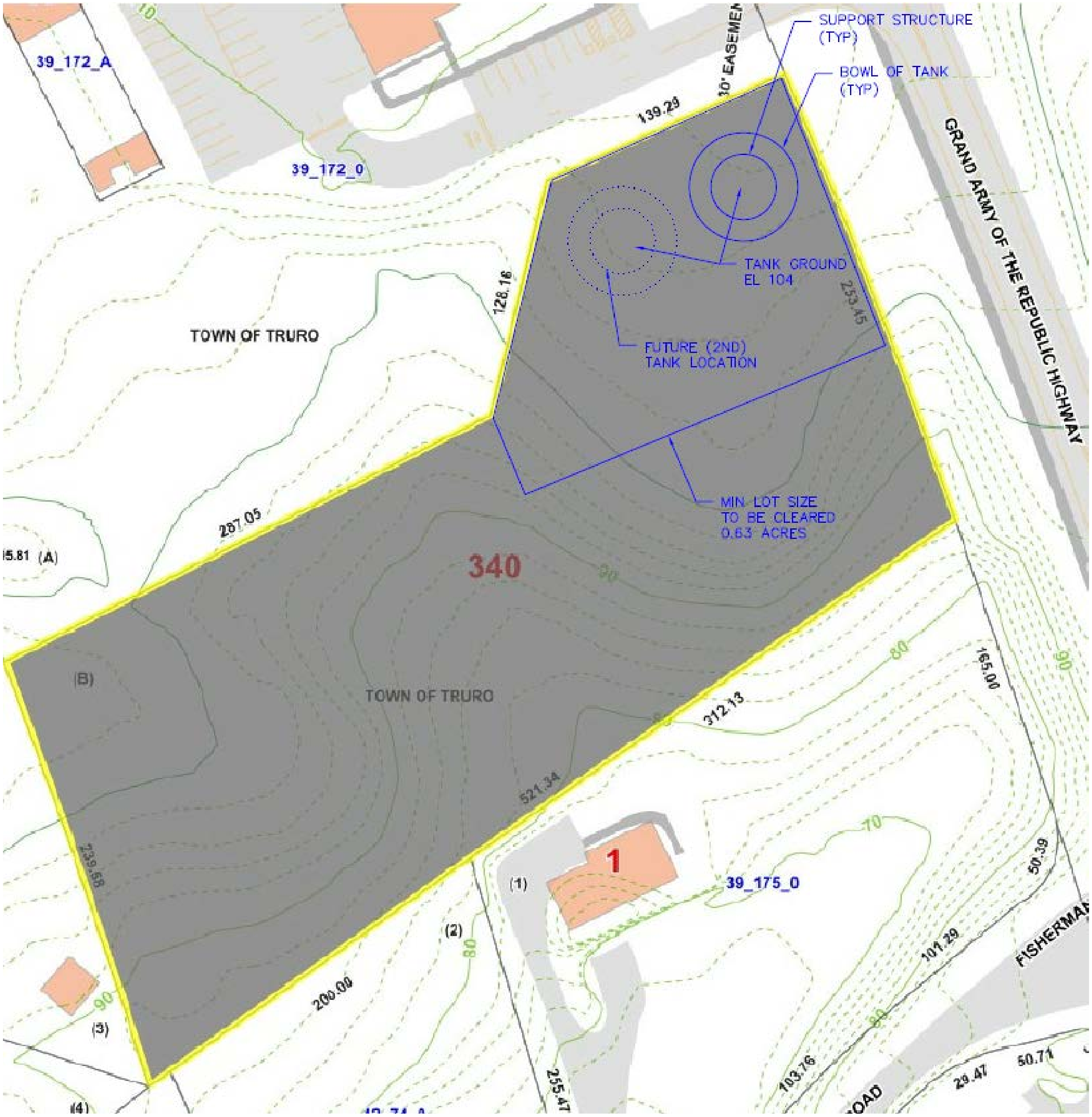


Figure 2-11: Approximate Layout - Quail Ridge, Parcel ID 043-003-000

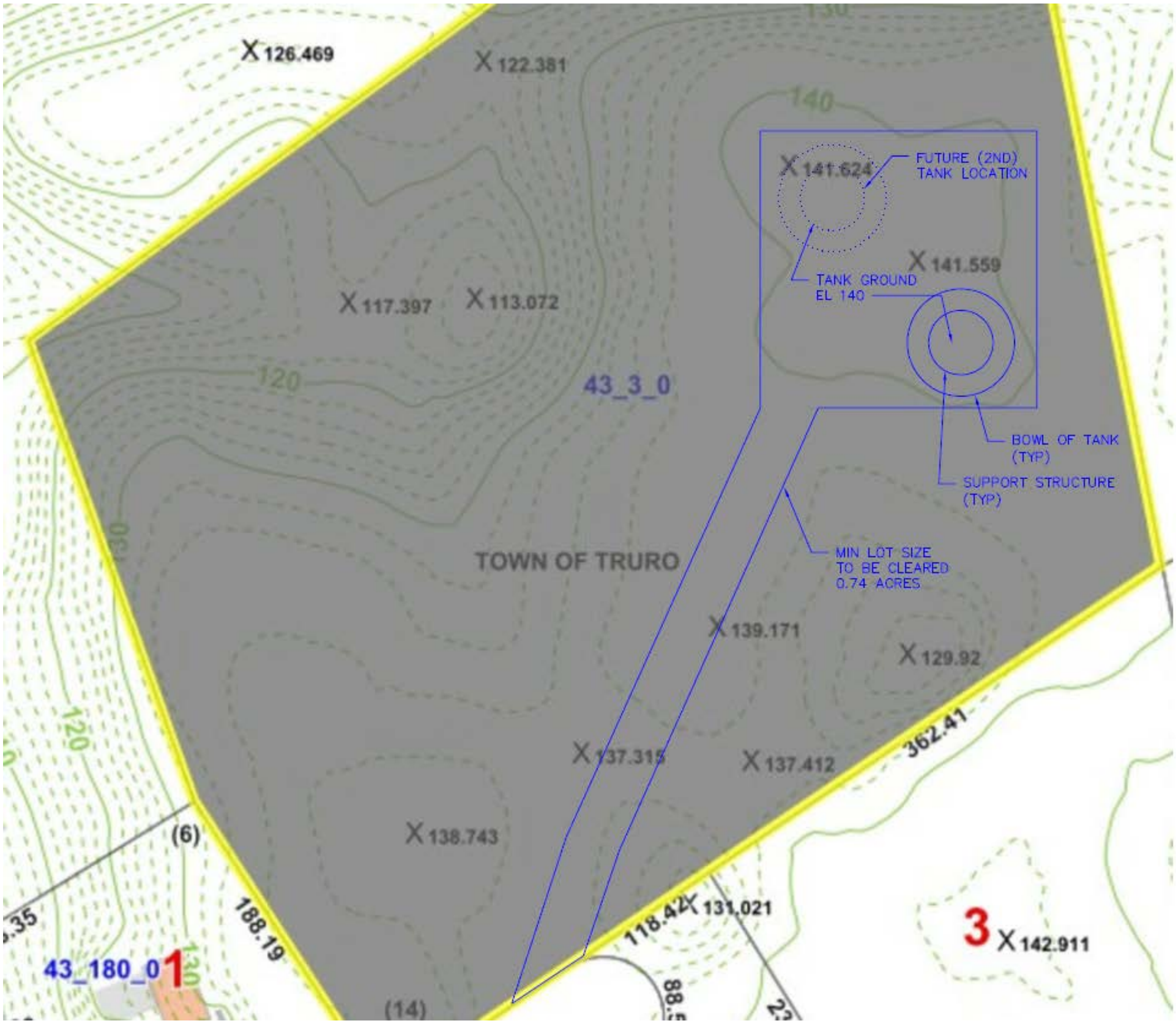
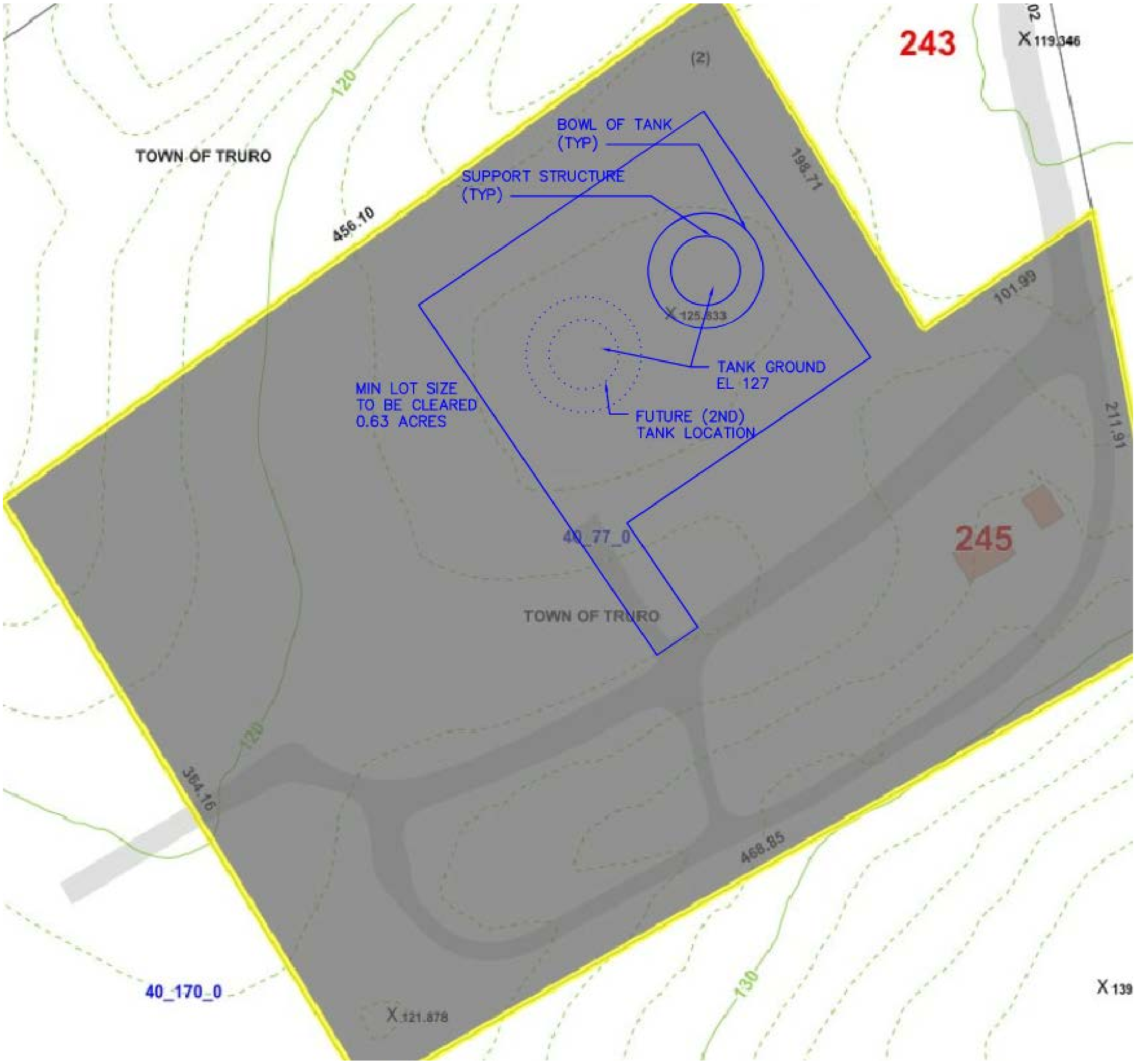


Figure 2-12: Approximate Layout – North Union Well Field, Parcel ID 040-077-000



2.2.1.11 Access Road

The access road criterion examined satellite images, and the approximate layouts in Figures 2-10, 2-11, and 2-12 above. An access road or driveway is required for every site. There is a significant cost with a longer access road versus a shorter access road in terms of paving, grading, and road construction, both as a temporary road and a permanent road. As the cost is the same per linear foot of length (the widths and pavement / base layer depths would be the same), this criteria looks at the overall length of the road as taken at the center line, from the nearest right of way to the edge of the tank clearing (the 150' x 150' site). If the tank is located on the edge of the property abutting right of way, a length of 0 feet is used and scores 5 points. An access road of 100-feet or less in length scored 3 points. Access roads over 100 feet scored 0 points. The scoring for access roads is summarized in Table 2-28 for Evaluation Criteria and Table 2-29 below for scoring.

Table 2-28: Land Clearing Criteria

Criteria	Points
No access road, parcel is against the right of way (curb cut)	5
Access road length is 100 feet long or shorter	3
Access road length is greater than 100 feet.	0

Table 2-29: Land Clearing Scoring

Criteria	Points
Public Safety Building Complex, Parcel ID 039-323-000	5
Quail Ridge, Parcel ID 043-003-000	0
North Union Well Field, Parcel ID 040-077-000	3

2.2.1.12 Compiled Parcel Criteria

The summary of the scoring criteria for each tank is indicated in Table 2-30 below. Based on the scores, all three sites are feasible for a tank, however, the Public Safety complex ranked highest with a score of 36, closely behind is the North Union Well Field with a score of 34, and lastly, with a score of 25 is the Quail Ridge property. Based on the scoring, Stantec recommends continuing to evaluate all three water storage tank sites. The preferred site will depend on several additional factors, including but not limited to the results of the balloon study, costs, environmental studies, geological data, other anticipated use for the site, and potential for abutter feedback / visual impacts.

Table 2-30: Compiled Scoring of All Parcels

Criteria	**Public Safety Building Complex**	**Quail Ridge**	North Union Well Field
Parcel ID Number	039-323-000	043-003-000	040-077-000
Parcel / Lot Size	5	5	5
Future Buildout	1	1	1
Proximity to Water System	5	3	3
Elevation	3	5	5
Environmental	5	3	3
Soils	3	3	3
Foundation Type	3	3	3
FAA Evaluation	3	5	5
Tree Removal Quantity (Lot Clearing)	3	0	3
Access Road	5	0	3
Total Score	**36**	**28**	**34**

The subsequent paragraphs discuss options that are common to either site, including issues such as tree removal, fencing, lighting, and environmental concerns.

2.3 Water Storage Tank Site Design Elements

The subsequent paragraphs discuss options that are common to any site, including issues such as tree removal, fencing, lighting, and environmental concerns.

2.3.1 Security

2.3.1.1 Lighting

Lighting on the access road/driveway should be provided for security, safety, and utility. Lighting in this area would be a deterrent to anyone attempting to access the site and provide ambient light during the darker hours of the day. The site lighting would also provide the operators needing access at night increased site visibility.

Several options for access road lighting are available to choose from. Traditional lighting choices include pole mounted lights (similar to those in parking lots) and streetlights (mounted on telephone poles). Commercial bollards[3] with LED lights can be seen in the image on the right. Bollards up the access road are the less traditional but recommended option in residential areas, or areas where a reduction in light pollution is required.

Whether bollards or traditional lighting is selected for the site, photocell controls are recommended over timer controls. Photocell controls would decrease the energy consumption of the lights without reducing the utility of the lights or raising the system maintenance needs, as photocells do not require resetting throughout the year.

A pole-mounted light by the access gate is also recommended, regardless of the other choices made. Access into the main portion of the site typically requires unlocking a gate, and “task lighting” is better provided by a pole mounted light than by bollards.

2.3.1.2 Fencing

Site security at the Truro tank site can be accomplished with an 8-foot-high chain link fence topped with optional barbed wire around the perimeter of the tank site. A double leaf vehicle gate will be included in the fence to allow maintenance access to the tank. A triangle gate will be located approximately 15-feet from the existing roadway / driveway to prevent unauthorized vehicles from traveling down the new

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[3] Image from https://www.eledlights.com/products/18w-color-adjustable-bollard-led-retrofit

access road (this would not be necessary at the Public Safety Building Complex site, as the site abuts the road). See image below for a triangle gate. If the existing site at 245 Old Kings Highway already has fencing and gates preventing unauthorized people from entering, the additional triangle gate would not be required.

Figure 2-13: Triangle Gate

2.3.2 Piping

The tank pipeline size shall be determined during more detailed design. A single inlet / outlet pipe will penetrate the tank foundation then head into the bowl. The tank pipeline will not reduce in size. The piping can be ductile iron pipe or steel pipe; however, it is recommended to use ductile iron up to the tank and then steel piping through the foundation until termination at the bowl – this makes coating and future maintenance easier within the tank structure.

Additional piping requirements include piping from the tank overflow basin to a detention basin, piping for a hydrant to drain the tank, and additional control valve piping near the tank. The hydrant will discharge into the overflow basin, travel through the overflow basin and out to the detention basin. The detention basin is riprap lined, which dechlorinates water as it flows over the rocks, and allows for the water to slowly drain from the detention basin into the ground. It also dissipates the energy of the water and overflows the basin to reduce erosion. A typical overflow basin and detention basin detail are shown below. This basin will be customized based on tank inlet, outlet, and overflow piping size.

Figure 2-14: Detention Basin Elevation

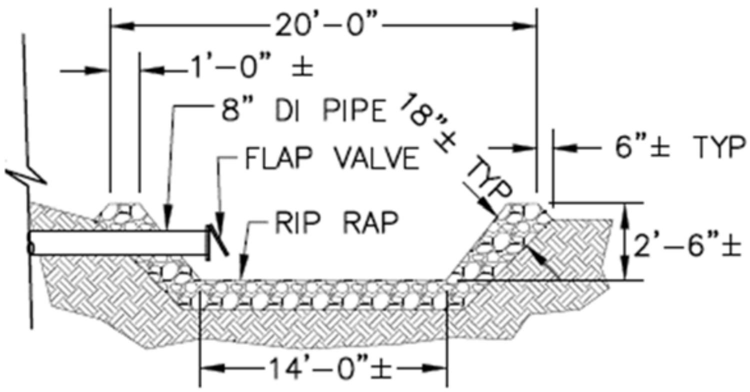
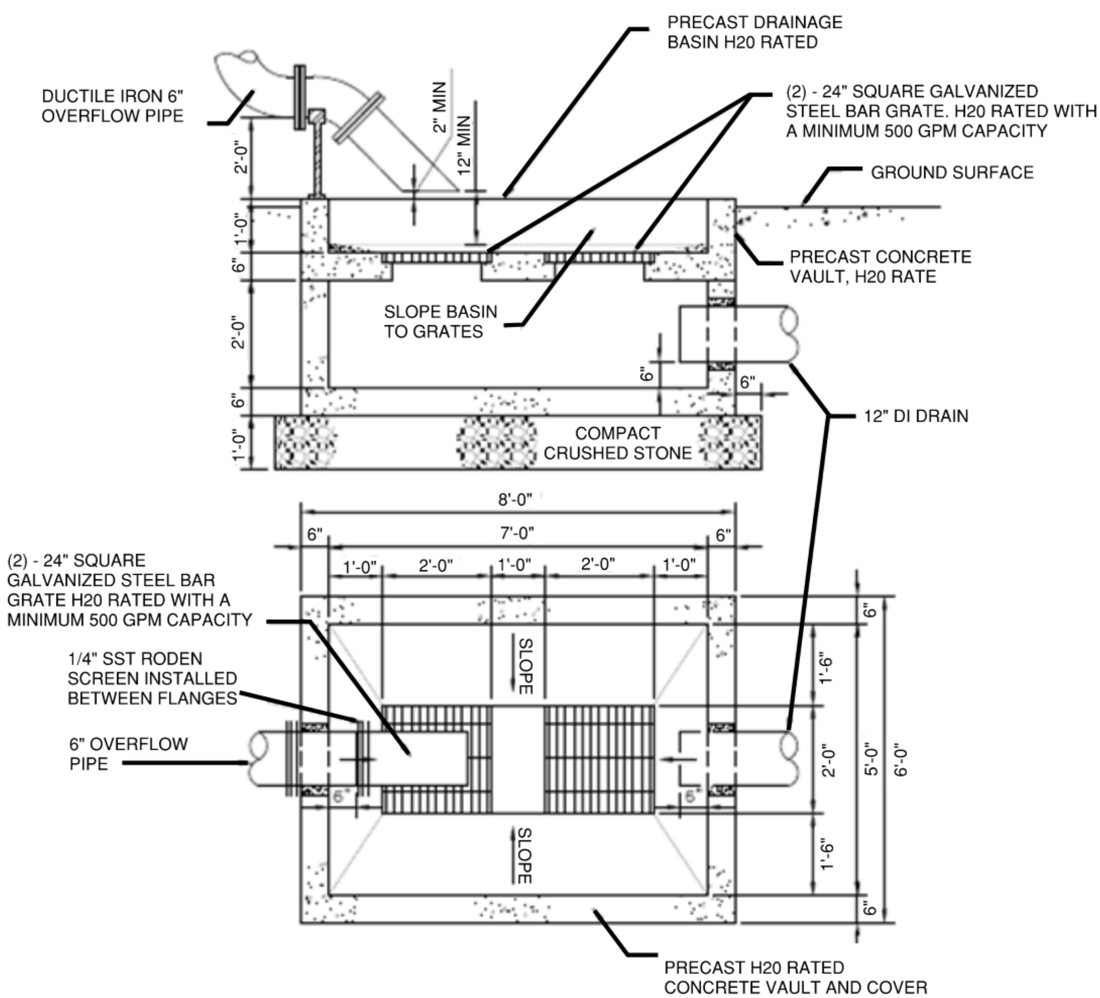


Figure 2-15: Overflow Basin



2.3.3 Access Road / Driveway

The tank site and access road / driveway shall be designed to allow construction vehicles and crane access to the site for construction of the new water tank. The access roadway will be at least 15-feet wide, with sufficient corner radius as needed and have a maximum grade of 6%. Site drainage needs are specific to each site and will be evaluated during detailed design.

Roadbed materials for construction of the access road will comprise of 8-inch gravel borrow, 6-inch dense graded stone, and a 3-inch temporary paved driveway apron entrance/tracking pad, at a minimum 50-foot long. Upon completion of the new water tank, the temporary driveway will be removed and a 15-foot wide paved access road consisting of new 2.5-inch intermediate and 1.5-inch surface courses will be installed. A parking/turnaround area will be provided around / in front of the tank.

2.3.4 Tank Styles

2.3.4.1 Pedestal Spheroid

See brochure in Appendix A for more details)

Pedestal Spheroid tanks are constructed of welded steel with a flared base at the bottom with a straight column, and a rounded spheroid (ball) on top. All access to the top of the tank is through the (dry) interior of the tank. The flared base (pedestal) has a personnel-door and larger tanks can be equipped with a roll up door as well. A pedestal spheroid tank comes in capacities ranging from 50,000 gallons to 1.5 million gallons of storage. As with any new storage tank, using manufacturer's standard head ranges (the distance from the bottom of the bowl to the overflow/high water line) reduces costs. This style of tank has limited space for running cables from the bottom of the tank to the top of the tank for things like cellular antennas. For a 600,000-gallon tank in this style, the diameter would be 58.167-feet and have an 8-foot diameter stem. The image on the right is a typical pedesphere elevated storage tank. The new elevated tank would have an overall tank height of approximately 161-feet at the Public Safety Building Complex Site, 138-feet at the North Union Well Field Site, and 125-feet at the Quail Ridge Site, based on an overflow at EL 250.

2.3.4.2 Composite Tanks

(See brochure in Appendix B for more details)

Composite tanks consist of a steel bowl on top of a concrete pedestal. Composite tanks (photo to the right) come in capacities ranging from 500,000 gallons to 3.50 million gallons of storage. For a 600,000-gallon tank, the pedestal (the bottom portion of the tank, frequently called the column) diameter is 28-feet dependent on soil conditions, and the tank bowl diameter would be 62-feet. Pedestal diameters are determined by soil bearing capacities, total tank height, and tank size. All the tank dimensions will be determined by the manufacturer during design and construction. Regardless of the pedestal diameter, the sites have adequate space to construct this style of tank. Maintenance (cleaning and painting) of this style of tank does require a complete coating, from the top of the tank to the foundation on the pedestal. Like pedestal spheroid tanks, these tanks are equipped with a personnel-door at the base, and depending on the column diameter, it is often possible to add a roll-up door to the base, allowing for vehicle storage or to bring large items into the tank.

The benefits to a composite tank over an all-steel tank is the insulative properties of the concrete, which assist with keeping the interior of the pedestal cooler in the summer and warmer in the winter, simply because the concrete is thicker walled.

2.3.4.3 Recommended Style of Tank

Cost is a factor. Traditionally, the pedestal spheroid tank is less expensive from a capital cost but may be more expensive for future painting maintenance. Composite style tanks can accommodate office space in the base of the tanks, or provide storage of equipment or materials. If there is a possibility of anyone using the base of the tank as an office space, or reporting there daily for work as their workspace, support of life systems must be added into the tank during design.

For an even comparison of the cost of the two styles of tank, it is assumed that neither tank will have a office space inside, logos, mixers, instruments, electrical, heating, etc. A comparison of the structure capital costs with a pile foundation and basic coating (obtained in March 2025) indicated the Pedestal Spheroid structure would cost $3.8 million and the Composite Tank would cost $4.4 million.

It is recommended that consideration of the style of water storage tank be considered as part of the visual impacts of siting the water storage tank at the three feasible water storage tank sites. A more detailed life cycle cost analysis could be completed for each tank site based to be considered as part of the final selection of water storage tank site.

2.3.5 Tank Appurtenances

2.3.5.1 Coatings

Coatings on the tank interior surfaces must comply with NSF/ANSI 61 requirements, for Drinking Water System Components. The exterior coatings are not required to comply with NSF/ANSI 61, but for a pedestal spheroid style tank, the underside of the bowl, and the pedestal column and bell should receive a mildew resistant coating. Both sites are within 10 miles (straight line) from the Atlantic Ocean. Marine coatings (those designed for saltwater environments) are recommended for the exterior of the tank. Coatings are typically chosen from the manufacturer's standard color palette, and most municipalities choose a single color. However, Sherwin Williams now has a "Water Tank Color Designer[4]" (design tool) that allow engineers and owners to produce simple renderings of potential tanks in a variety of colors, patterns and logos. Additionally, Tnemec also has a "Tank 3D" tool that is similar to allow engineers and owners to produce simple renderings of tanks in a variety of colors, patterns, and logos. Neither design tool allows for exact configurations (size / height) to be coated but does provide for a number of tank styles in limited capacities. These tools are available to anyone and will be used during the next phase of design to provide some general visuals of the tank.

2.3.5.2 Piping / At and Below Grade Considerations

Piping for the tank shall consist of a single inlet/outlet pipe through the foundation. On the exterior of the tank, the overflow will drain to an overflow basin, which will then either daylight the flow or the flow can be piped to a sewer or storm drain system. The overflow basin provides the MassDEP-required air gap separation and prevents erosion near the tank. Other exterior piping features will include valving outside the tank foundation for taking the tank out of service, and a hydrant for draining the tank for maintenance. Refer to Paragraph 2.3.2 for more information on the piping.

2.3.5.3 Equipment

Tanks are sized such that they frequently hold more water than is used in any given 24-hour period. To provide the best water quality, the AWWA recommends that all potable water storage tanks turnover (completely empty and refill) at least once every three days. Mixers are recommended in every tank as they help with water quality by keeping the water homogenous. There are two categories of mixers, passive and active, as shown in Figures 2-16 and 2-17. Passive mixers only work during a fill cycle. For the most part, passive mixers do best in clearwell tanks, or tanks that turnover multiple times per day. The MassDEP requires that all tanks are "homogenous", meaning a mixer is required. As such, it is recommended that an active mixer be installed in the tank. An active mixer is powered and runs 24 / 7, 365 days a year. The mixer prevents stratification resulting in better water quality and less ice build-up in

[4] https://swcoloryourtank.com/

the winter months. The mixing of the tank water makes it homogenous, providing a consistent water age and quality throughout the tank. The recommended submersible mixer for the North Truro water storage tank is a Gridbee® GS-12 Mixer as manufactured by Ixom Watercare[5] or a Pax PWM-400 impeller style submersible mixer by PAX Water Technologies.[6] It should be noted that these are the only two companies that produce water lubricated, no-maintenance mixers that are NSF 61 certified and for use in potable water storage tanks that meet the application requirements. Therefore, the specification will not list an "or equal" and a proprietary memo may be required. The GS-12 mixer is a sheet flow mixer, meaning it pulls water from the bottom of the tank bowl via the bottom of the mixer, and pushes the water out the top of the mixer in a sheet. The PWM-400 mixer is an impeller style mixer that has a spiral impeller located on a tripod. The impeller spins causing the water to swirl, which induces mixing. This is similar to the way a whirlpool works, but at much slower velocities.

Figure 2-16: Passive Mixer (Tideflex)

Figure 2-17: Active Mixers

[5] https://www.ixomwatercare.com/equipment/gs-series-submersible-mixers
[6] https://www.paxwater.com/impeller-mixers

2.3.5.4 Lighting

The Town can choose from two tank lighting options: traditional lights (such as pole and/or fence lighting) that light the site and entrance into the tank or "uplighting" or "downlighting" – which light the tank. Either option would enhance the tank security.

Uplighting[7] is recommended for multiple reasons. Uplighting highlights the tank, potentially changing the perceived view of "eyesore" or "blight on landscape" to "art" or "signage." Uplighting can be put further up the tank to highlight the bowl (image on right) or be installed at ground level. In addition to improving the aesthetics of the tank, uplighting would reduce the ambient light levels that would reach housing adjacent to the site.

Security lighting above the tank door would come as standard with any tank type selected; however, it should be noted that this only lights a small portion of the base.

Interior tank lighting would be assessed with space usage in mind. Whatever primary end use the Town decides on for the interior of the tank, the light levels within the tank would be proposed to conform to recommended light levels for either the intended end use or typical tank interiors.

Lighting controls for the tank are recommended. The exterior lighting for the tank is recommended to be controlled via photocell to reduce the energy consumption of the lights without compromising the lights' utility. Lighting controls for the tank interior lighting would be assessed when the intended use of the tank interior space is finalized.

2.3.5.5 Instrumentation

The tank will be equipped with instrumentation to monitor level and temperature, of the water. In addition to the instrumentation signals, feedback from a tank mixer and security signals shall be integrated into a small local controller. The tank would be connected to Provincetown's existing SCADA system.

2.3.5.6 Electrical

The tank and site will require new electrical service to feed the proposed loads including the site lighting, tank lighting, active mixer, instrumentation for the SCADA system, and any other electrical elements intended for the site.

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[7] https://m.facebook.com/AvonLakeWater/photos/a.374024422630297/3157788717587173/?type=3

The existing electrical site conditions will be assessed for any coordination requirements, including finding an appropriate location for an above ground cabinet with a meter and a small load center to feed the electrical loads intended for the site.

2.4 Cost Comparison

The Engineer's Opinion of Probable Construction Costs (EOPCC) is based on costs from RS Means, recent bids, published material prices, current labor costs and past projects. This EOPCC is based on using state wage rates for public construction, not utilizing Drinking Water State Revolving Loan Funds, and does not include costs for American Iron and Steel requirements. We caution that the accuracy of the EOPCC may vary greatly due to the current construction / infrastructure market conditions. The current market is very volatile, especially for materials due to tariffs, delivery delays, scarcity of raw materials and limited production at manufacturing plants. At the present time this EOPCC should not be considered the actual construction cost, but as a relative cost for budget purposes. The actual cost could be 15% less to 35% more than the EOPCC.

As any of the Sites would be suitable for construction of the tank, the engineer's opinion of probable construction cost for all three sites is shown below. These costs look at approximate costs based on tank height, fencing, paving, etc. and added 30% contingency. Costs include basic items (pole lighting not bollard or up/down lighting on the tank, no logos, no special foundations, etc.). Costs will be better defined during design. Costs do not take into effect inflation, they are in current dollars. Costs can be seen in Tables 2-31, 2-32 and 2-33 below.

Notes on Tables 2-31, 2-32 and 2-33:

1. Piping and valves only includes the work within the fenceline/access road of the water storage tank and does not include any longer connecting mains beyond the site.
2. Access Road only includes the work within the approach to the site (within the parcel boundaries).
3. Does not include any land acquisition or easements.
4. Engineering Design costs are not included. The costs will vary by site based on permitting requirements, and off site piping.

Table 2-31: Public Safety Building Complex Site - EOPCC

No.	Unit	Description	Estimated Quantity	Unit Price	Estimated Total Cost
1	LS	600,000 Gal pedestal spheroid tank, 145' height	1	$3,800,000.00	**$3,800,000.00**
2	LS	In-Tank Mixing System (1 tank)	1	$75,000.00	**$75,000.00**
3	LS	Piping and Valves	1	$50,000.00	**$50,000.00**
4	LS	Site Improvements (overflow basin, fencing, etc.)	1	$300,000.00	**$300,000.00**
5	LS	Site Clearing	1	$80,000.00	**$80,000.00**
6	LS	Access Road	1	$45,000.00	**$45,000.00**
7	LS	Electrical Work/ Instrumentation Work	1	$125,000.00	**$125,000.00**
			ESTIMATED CONSTRUCTION COST		**$4,475,000.00**
			5% Mobilization / Demobilization.		**$223,750.00**
			2.5% Bonds & Insurance		**$111,875.00**
			30% CONTINGENCY		**$1,342,500.00**
			ESTIMATED TOTAL COST		**$6,153,125.00**

Table 2-32: North Union Wellfield Site - EOPCC

No.	Unit	Description	Estimated Quantity	Unit Price	Estimated Total Cost
1	LS	600,000 Gal pedestal spheroid tank, 125' height	1	$3,650,000.00	**$3,650,000.00**
2	LS	In-Tank Mixing System (1 tank)	1	$75,000.00	**$75,000.00**
3	LS	Piping and Valves	1	$400,000.00	**$400,000.00**
4	LS	Site Improvements (overflow basin, fencing, etc.)	1	$300,000.00	**$300,000.00**
5	LS	Site Clearing	1	$80,000.00	**$80,000.00**
6	LS	Access Road	1	$325,000.00	**$325,000.00**
7	LS	Electrical Work/ Instrumentation Work	1	$240,000.00	**$240,000.00**
			ESTIMATED CONSTRUCTION COST		**$5,070,000.00**
			5% Mobilization / Demobilization.		**$253,500.00**
			2.5% Bonds & Insurance		**$126,750.00**
			30% CONTINGENCY		**$1,521,000.00**
			ESTIMATED TOTAL COST		**$6,971,250.00**

Table 2-33: Quail Ridge Site - EOPCC

No.	Unit	Description	Estimated Quantity	Unit Price	Estimated Total Cost
1	LS	600,000 Gal pedestal spheroid tank, 125' height	1	$3,650,000.00	**$3,650,000.00**
2	LS	In-Tank Mixing System (1 tank)	1	$75,000.00	**$75,000.00**
3	LS	Piping and Valves	1	$205,000.00	**$205,000.00**
4	LS	Site Improvements (overflow basin, fencing, etc.)	1	$280,000.00	**$280,000.00**
5	LS	Site Clearing	1	$95,000.00	**$95,000.00**
6	LS	Access Road	1	$325,000.00	**$325,000.00**
7	LS	Electrical Work/ Instrumentation Work	1	$240,000.00	**$240,000.00**
			ESTIMATED CONSTRUCTION COST		**$4,870,000.00**
			5% Mobilization / Demobilization.		**$243,500.00**
			2.5% Bonds & Insurance		**$121,750.00**
			30% CONTINGENCY		**$1,461,000.00**
			ESTIMATED TOTAL COST		**$6,696,250.00**

2.5 Storage Tank Design Summary

Table 2-30 demonstrates that the most desirable parcel for the new tank is the Public Safety Building Complex, followed closely by the North Union Well Field, as these two parcels had the highest scores. The Quail Ridge parcel also remains feasible as a water storage tank site. The recommended style of tank is the 600,000 gallon elevated tank (final tank type to be determined as part of final selection of tank site) with an overflow set at EL 250 (hydraulic gradeline of the new service area), and the ability to service all homes at EL 140 or less.

Table 2-30*: Compiled Scoring of All Parcels*

Criteria	**Public Safety Building Complex**	**Quail Ridge**	North Union Well Field
Parcel ID Number	039-323-000	043-003-000	040-077-000
Parcel / Lot Size	5	5	5
Future Buildout	1	1	1
Proximity to Water System	5	3	3
Elevation	3	5	5
Environmental	5	3	3
Soils	3	3	3
Foundation Type	3	3	3
FAA Evaluation	3	5	5
Tree Removal Quantity (Lot Clearing)	3	0	3
Access Road	5	0	3
Total Score	**36**	**28**	**34**
Estimated Project Cost (Tank Only)	**$6.153M**	**$6.971M**	**$6.696M**

The design criteria that were evaluated throughout the various sections of the report are summarized below. These recommendations will be used as the basis of the Tank Design.

- Any of the three sites are viable and feasible for placing a tank. The least costly and highest scoring parcel is for the Public Safety Building Complex. The North Union Well Field site is the most costly but second-best scoring parcel for the tank. The Quail Ridge Site is the second-best cost, but is the lowest scoring parcel. Further investigations (geotechnical, environmental, visualization, etc.) are required. These investigations and / or public opinion may determine which site should be used for the tank.

- The selected site requires tree removal, security, lighting, fencing and piping. The selected site needs to be cleared of trees within the 150-foot square parcel. The site clearing is necessary for construction. To facilitate borings for the design of the desired tank and to obtain more geotechnical information on each site, tree clearing of an access path and tree clearing the diameter of the tank base will be required for each site. Security lighting and fencing are recommended, with the majority of site lighting being low level to reduce light pollution. Access roads / driveways should be 15 feet wide.

- The new tank requires 539,000 gallons of storage, which translates to a standard tank capacity of 0.6 MG. This provides for 360,000 gallons of fire flow, plus the average day demand with future buildout of 179,000 gallons. Based on the ground elevation, and estimated highest served area from topographic maps, Stantec recommends the overflow elevation be set at EL 250. This allows for service of all structures with a threshold elevation between EL 59 and EL 140.

- The new tank, if located on the North Union Well Field Site or the Quail Ridge Site would be located within the habitat of a local rare species and that may require special conditions in the tank design package.

- The style of tank will be evaluated as part of the tank siting and visual review of the feasible tank sites.

- The tank is not expected to exceed 150-feet in height and does not require any special FAA lighting or marking considerations if located at the North Union Well Field Site or the Quail Ridge Site. If the tank is located at the Public Safety site, the tank height will exceed 150 feet in height and will require FAA lighting and permits.

- An active mixer will be provided in the new tank.

3 Water Storage Tank Hydraulic Analysis

Stantec performed a hydraulic analysis using and updating the existing Provincetown hydraulic water model that was provided by Apex Co. The analyses performed were under an extended period simulation with a duration of 24-hours, unless otherwise indicated. The model runs assumed the new North Truro Tank is located at the North Union Well Field site as it provides the most conservative model results.

3.1 Demand Scenarios

3.1.1 Average and Maximum Day Demands

The existing average and maximum day demands used for the hydraulic analysis were already inputted into the model from the previous Horsley Witten Group (HWG) memorandum completed in 2023. The following table provides a summary of the demands in the hydraulic model for the entire water distribution system.

Table 3-1. Existing Average and Maximum Day Demands

Description	Demand, gpd (gpm)
Average Day	90,000 gpd (63 gpm)
Maximum Day	228,600 gpd (159 gpm)

3.1.2 Future Average and Maximum Day Demands

The future average and maximum day conditions include the addition of the Clover Leaf Development, the Pond Road Extension, Walsh Property, and future buildout to the above demands. The demands were obtained from the previous Horsley Witten Group (HWG) Memorandum completed in 2023. Table 3-2 below provides a summary of the future additional demands in the hydraulic model.

Table 3-2. Future Additional Average and Maximum Day Demands

Description	Average Day Demand, gpd (gpm)	Maximum Day Demand, gpd (gpm)	Model Location
Clover Leaf Development	6,305 (4)	16,015 (11)	J-963
Pond Road Extension	10,239 (7)	26,005 (18)	J-962
Future Walsh Property	32,500 (23)	82,550 (57)	J-249
Future Buildout[1]	33,800 (23)	85,852 (60)	J-980 & J-982
1 – Assumes the addition of 250 homes			

3.1.3 Connection to Wellfleet

There has been discussion between the Town of Truro and the Town of Wellfleet about a potential interconnection location. The Wellfleet town boundary is approximately 4.5 miles from the end of the existing Truro water distribution system. This long distance may provide hydraulic challenges to sharing water. At this point in time, no further investigation has been conducted.

3.1.4 Future Maximum Day with Fire Flow

A fire flow analysis was conducted to evaluate impacts of fire flows. Three (3) locations were selected and evaluated for the hydraulic model simulations. The locations are shown in the following figure.

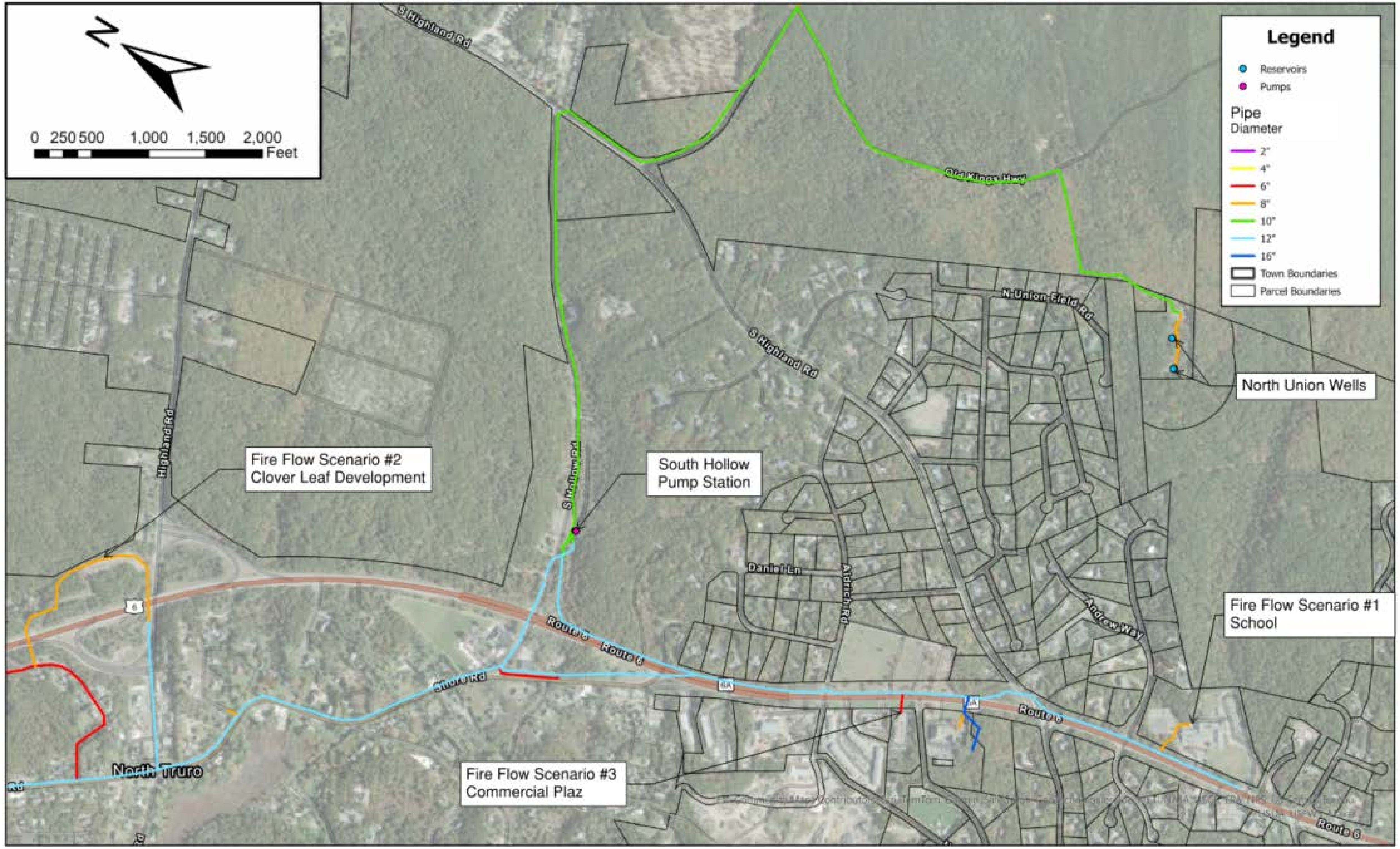


Figure 3-1: Fire Flow Locations

Stantec does not have the building types, square footage, or sprinkler information for the buildings in Truro. Therefore, a conservative fire demand of 2,000 gpm for a duration of 3-hours was used based on the 2024 International Fire Code (IFC). The fire demand occurs when the new Truro tank is full 2 p.m. and 4 p.m.

3.2 Existing Conditions Analysis

The existing hydraulic model consists of the Knowles Crossing Water Treatment Plant (KCWTP), two (2) storage tanks in Provincetown, North Union Field Wells and the existing South Hollow Booster Pump Station in North Truro. Figure 3-2 provides a system map. Table 3-3 through Table 3-7 provide the existing asset information.

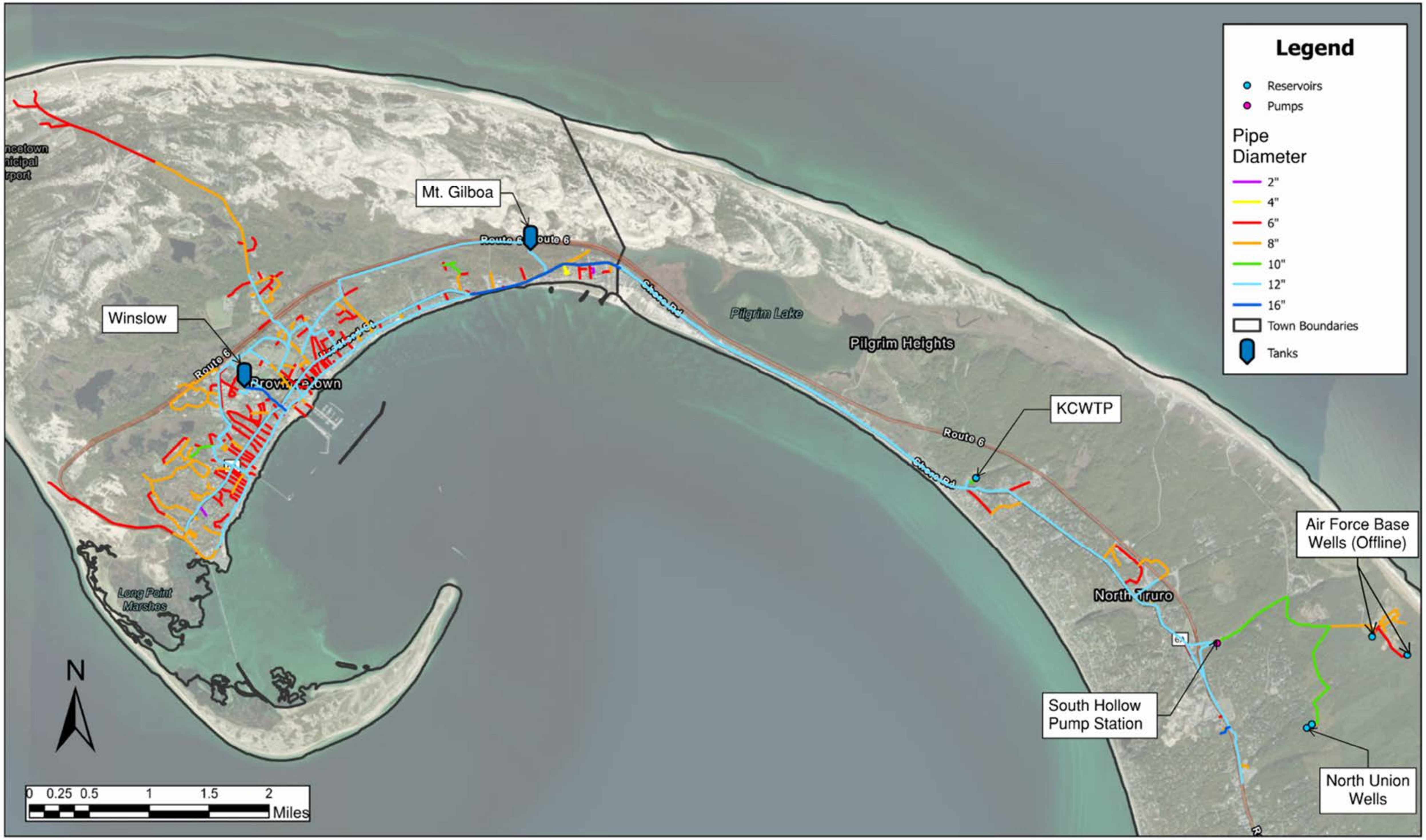


Figure 3-2: Existing Water Distribution System Map

Table 3-3. Knowles Crossing Water Treatment Plant (KCWTP)

Description	Pump #1	Pump #2
Design Flow, gpm	560 gpm	560 gpm
Design Head, ft	273 ft	262 ft
Pump On, ft[1]	159.44 ft	--
Pump Off, ft[1]	169.30 ft	--
1 – Controlled off Winslow Tank Levels		

Table 3-4. Existing Storage Tank Data

Description	Winslow Tank[1]	Mt. Gilboa[2]
Base Elevation, ft	67.80	87.50
Minimum Elevation, ft	67.80	87.50
Maximum Elevation, ft	175.80	167.50
Diameter, ft	78	76
Total Volume, MG	3.8	2.7
Inlet / Outlet Pipe Diameter	16”	12”
1 – Primary tank that is filled by KCWTP and North Union Wells 2 – Operates off an altitude valve		

Table 3-5. North Union Field Wells

Description	North Union #1	North Union #2
Design Flow, gpm	372	375
Design Head, ft	96	91
Pump On, ft[1]	159.44	159.44
Pump Off, ft[1]	169.30	169.30
1 – Controlled off Winslow Tank Levels		

The existing model received from Apex Co. did not include controls for the existing South Hollow pump station. The model was updated based on information provided by the Town of Provincetown which included that the existing station maintains a discharge pressure of 90 psi and typically sees approximately 10 – 20 gpm depending on the demand. Table 3-6 provides the existing station properties.

Table 3-6. Existing South Hollow Pump Station Properties

Description	Lead Pump	Lag Pump	Fire Pump
Design Flow, gpm	30	30	150
Design Head, ft	90	90	1,100
Pump On, psi[1]	80	75	55
Pump Off, psi[1]	90	85	95
1 – Based on discharge pressure directly outside the station			

Since there is always demand in the system, the pump station should always be in operation. Stantec developed model controls for DP-1 so that the discharge pressure just outside the station (J-849) maintains 90 psi by adjusting the speed of the pump to replicate the field conditions. Therefore, the model controls that were implemented are shown in Table 3-7.

Table 3-7. Existing South Hollow Pump Station Controls

Condition	Pump Setting
J-849 <= 80 psi,	0.77
J-849 >= 90 psi,	0.60[1]
1 – Minimum pump speed to prevent motor overheating	

3.2.1 Existing Conditions Model Results

The North Truro area of the water system currently has no water storage tank and is served by the South Hollow Booster Pump Station which includes two domestic pumps and one fire pump. Operating pressures and available fire flows are limited based on the existing operating parameters of the existing pump station. Typically for this type of memorandum, we would compare existing conditions to future conditions. Since the existing conditions include no storage tank, the data is less relevant for comparison to future conditions with a new water storage tank online. Also, without actual SCADA operating data for the existing booster pump station, assumptions in the hydraulic model may not accurately represent existing conditions.

3.3 Future Conditions Analysis

The future conditions analysis includes the addition of the future North Truro 0.6 MG water storage tank. Earlier sections of this report evaluated three potential water storage tanks sites: Public Safety Building, Quail Ridge and the North Union Well Field. This hydraulic model evaluation is based on siting a new water storage tank at the North Union Well Field. This site is in close proximity to the Quail Ridge parcel and both parcels will require a long connecting water main to connect the proposed storage tank to the existing water distribution system. Constructing water storage tanks at the end of long connecting mains can sometimes cause an hydraulic restriction and therefore is a more conservative hydraulic modeling approach. The North Union Well Field is located at 247/245 Old Kings Highway, adjacent to the Walsh property, and shown in Figure 3-3. The parameters are as follows:

Table 3-8. Proposed North Truro Water Storage Tank at North Union Wellfield

Description	
Base Elevation	127 ft
Minimum Elevation (Bottom of Bowl	210 ft
Maximum Elevation (Tank Overflow)	250 ft
Diameter	58 ft
Operating Volume	Approx. 0.2 MG
Total Usable Volume	0.6 MG
Inlet / Outlet Pipe Diameter	16”
Inlet / Outlet Pipe Length	Approx. 5,500-LF

It is recommended to install the new tank inlet/outlet pipe along the proposed road of the Walsh property development. This will allow for easy access and minimize tree clearing.

Provincetown has an existing booster pump station located on South Hollow Rd. For the purpose of this technical memorandum, it is assumed that a new booster pump station will be required to fill the new storage tank. The preliminary pump design and controls are provided in Table 3-9.

Table 3-9. Preliminary Sizing of New North Truro Booster Pump Station

Description	
Design Flow	500 gpm
Design Head	260 ft
Pump On[1]	<= 237 ft
Pump Off[1]	>= 249 ft
1 – Based on the new North Truro Water Storage Tank Levels	

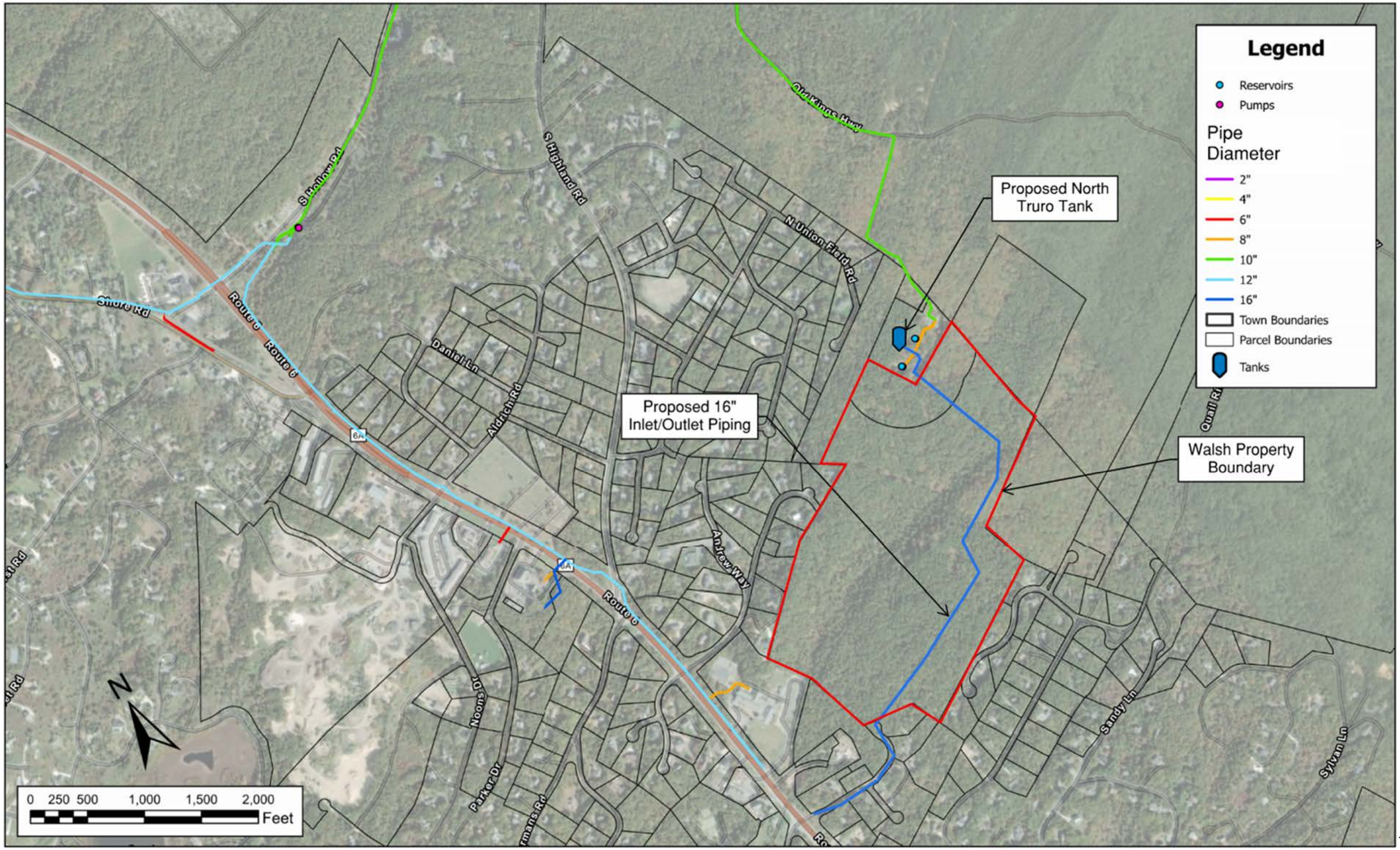


Figure 3-3: Proposed Water Storage Tank Location Map

3.3.1 Future Conditions Pressure Zones

The existing water distribution system currently has one (1) pressure zone. With the addition of the proposed North Truro Tank, two (2) new pressure zones will be created. The new high-pressure zone is the area east of the new South Hollow Pump station and will be served by the new storage tank. The new low-pressure zone is the area west of the South Hollow Pump station, including the Cloverleaf development and the Pond Road Extension, and will be served by the existing Winslow and Mt. Gilboa storage tanks. However, with piping upgrades, the Cloverleaf and Pond Road Extension demands (shown in Table 3-2 and Table 3-10) could be met by the new storage tank in the high service area.

The different pressure zone boundaries described above are shown in Figure 3-4 and Figure 3-5. Figure 3-6 depicts the system improvements needed for Cloverleaf and Pond Road Extension to be in the high-pressure zone.

The demand breakdown for North Truro by pressure zone is shown in Table 3-10:

Table 3-10. North Truro Water Storage Tank Demands

Description	Low Pressure Zone	High Pressure Zone	Total Demand in North Truro
Existing Conditions			
Average Day, gpm	58	5	63
Maximum Day, gpm	146	12	159
Cloverleaf + Pond Road Extension in Low Pressure Zone (Figure 3-4)			
Average Day, gpm	69	51	120
Maximum Day, gpm	176	129	305
Cloverleaf + Pond Road Extension in High Pressure Zone (Figure 3-5)			
Average Day, gpm	58	62	120
Maximum Day, gpm	146	159	305

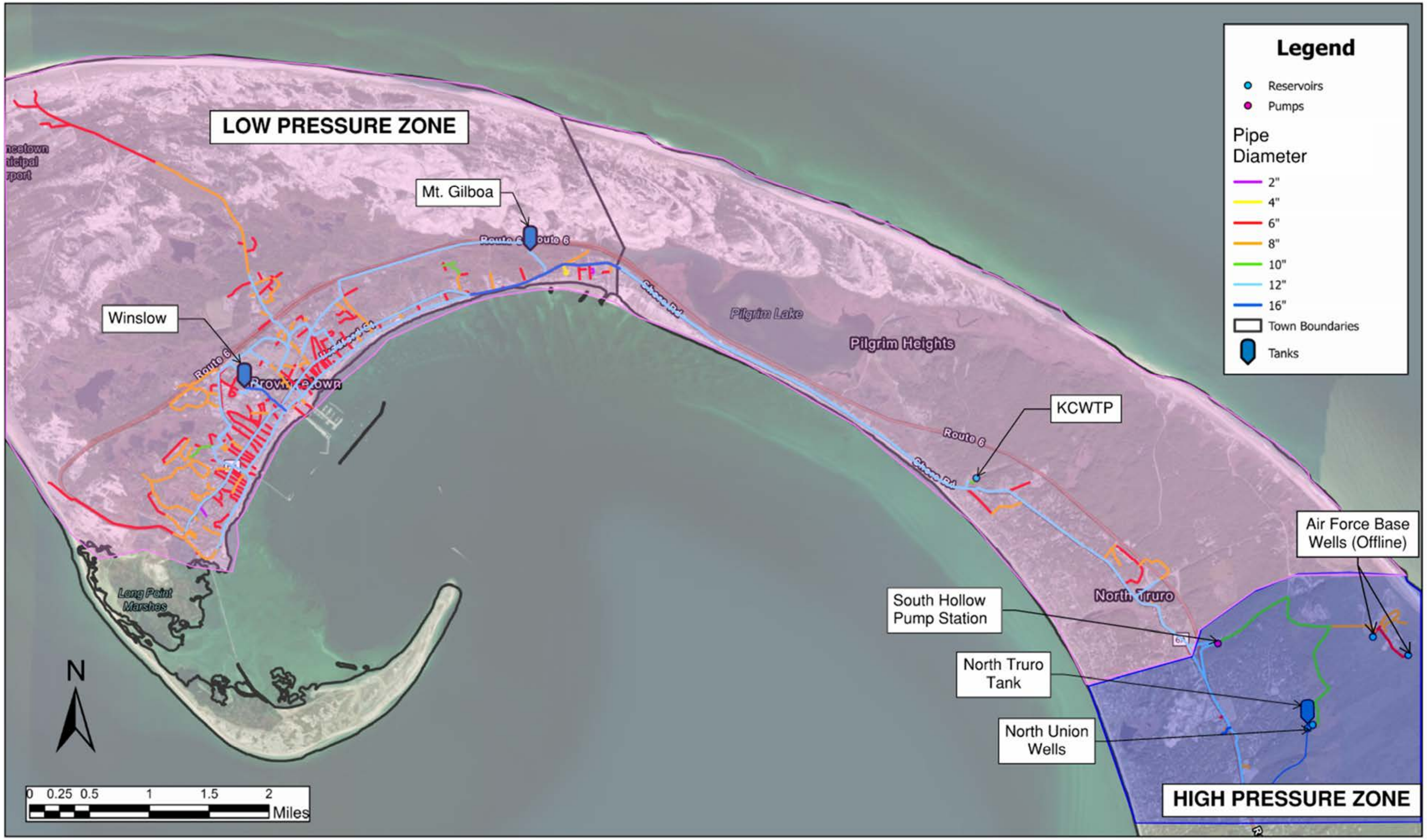


Figure 3-4: Future Conditions – Pressure Zones (Cloverleaf and Pond Rd. in Low Pressure Zone)

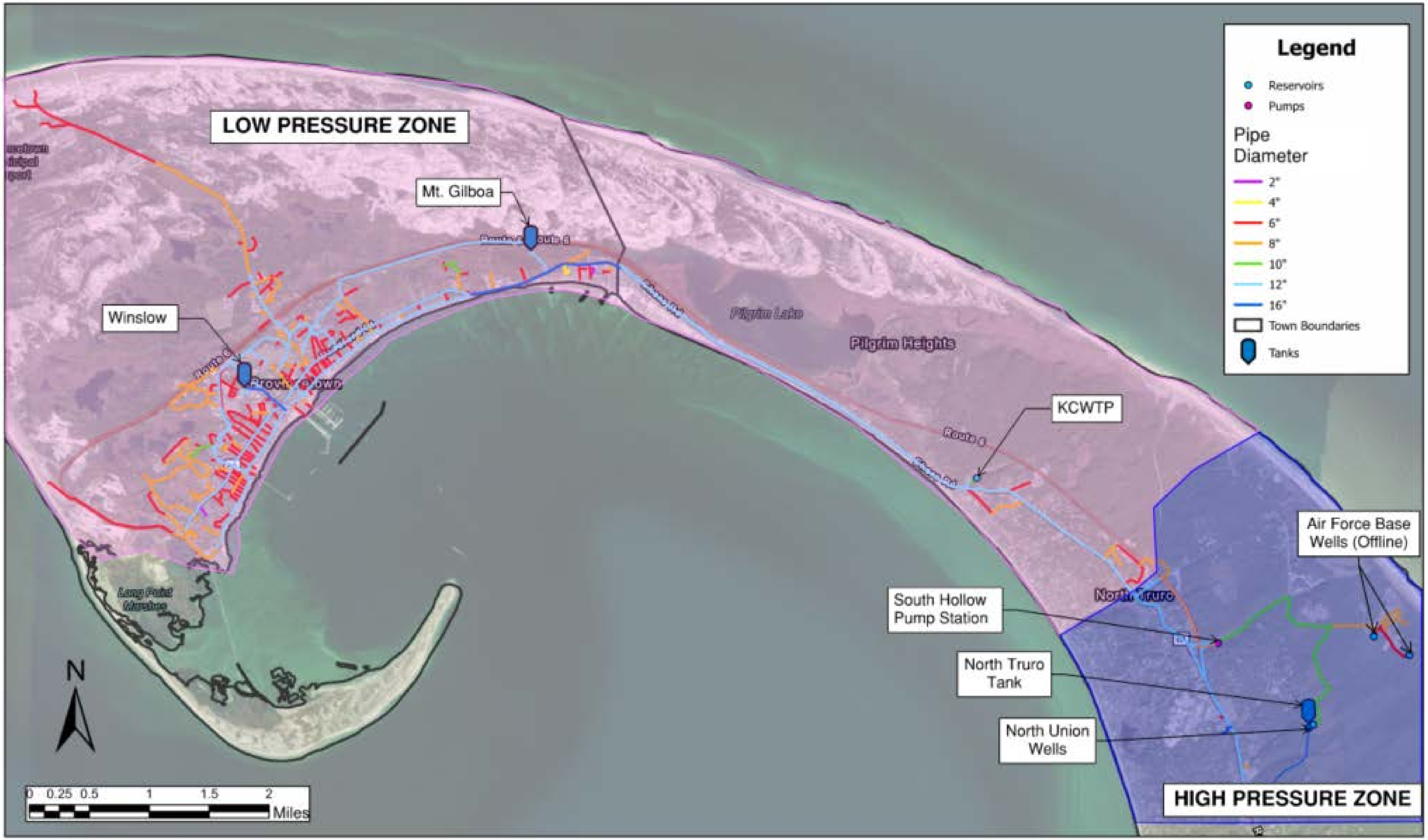


Figure 3-5: Future Conditions – Pressure Zones (Cloverleaf and Pond Rd. in High Pressure Zone)

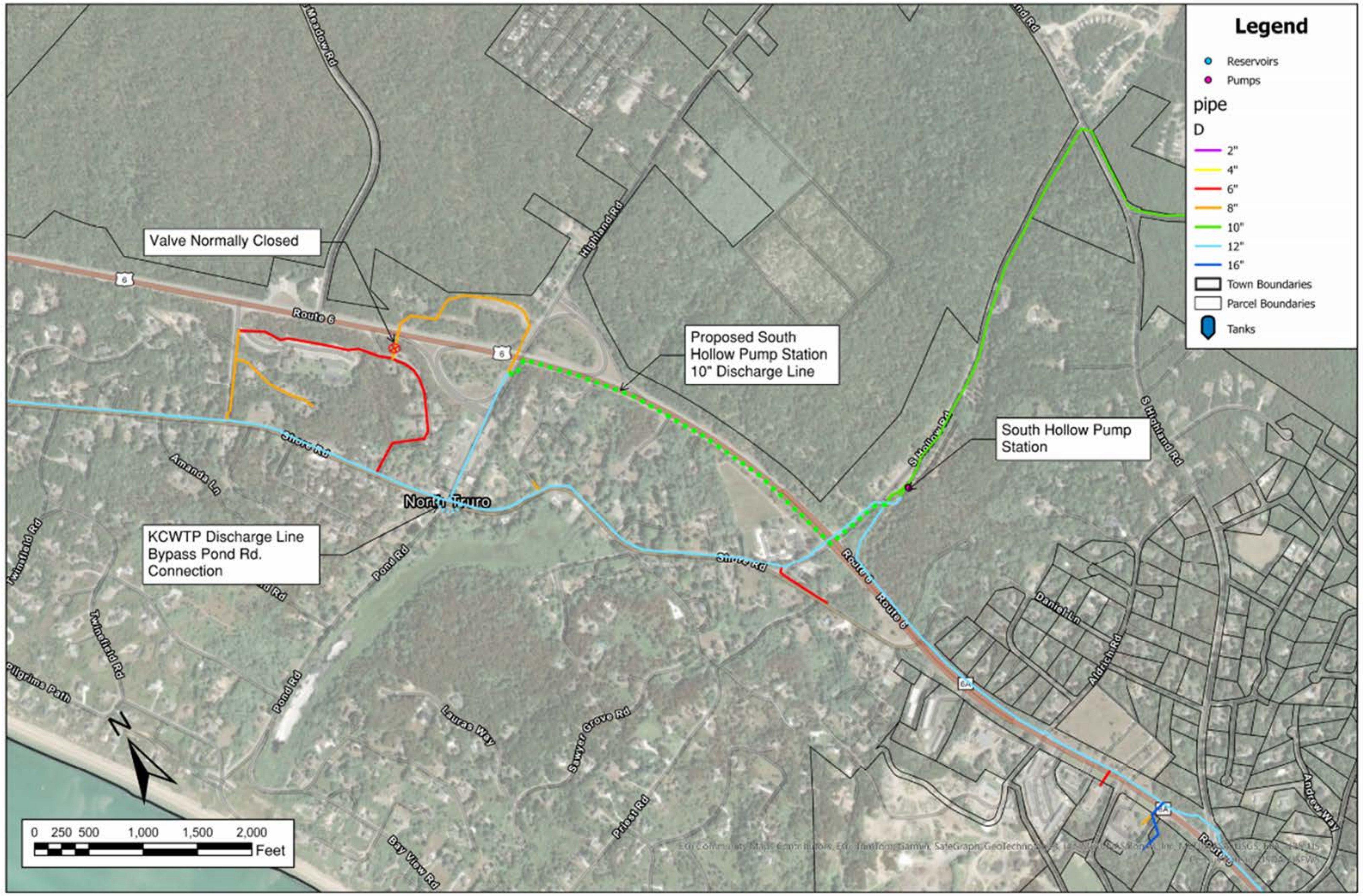


Figure 3-6: Future Conditions – Proposed Improvements (Cloverleaf and Pond Rd. in High Pressure Zone)

3.3.2 Future Conditions Model Results

Current Average Day Demand

Under this scenario, pressures range between 33 and 104 psi throughout the entire distribution system. The proposed high-pressure zone experiences pressures between 41 and 104 and the low-pressure zone experiences pressures between 33 and 91 psi.

Under the existing average day demands and future demand conditions, the North Truro storage tank would slowly drain over the course of approximately 23 days due to the existing, low demands in North Truro. Figure 3-7 provides the hydraulic grade of the tank under this scenario.

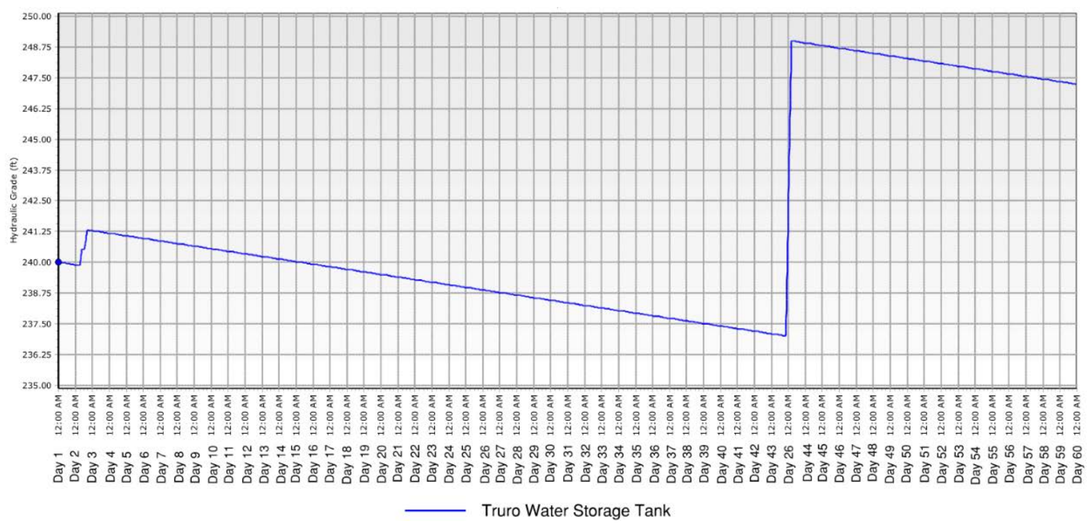


Figure 3-7: Existing ADD with New Tank – North Truro Tank Levels

This is a significantly long draw cycle for a water storage tank. This scenario demonstrates that more development and/or existing water users should be connected to the new high service area in order to support improved water storage tank operation and deliver a higher water quality.

Current Maximum Day Demand

Under this scenario, pressures range between 36 and 104 psi throughout the entire distribution system. The proposed high-pressure zone experiences pressures between 51 and 104 and the low-pressure zone experiences pressures between 36 and 68 psi.

With existing maximum day demands, the North Truro tank quickly fills and slowly drains, over the course of approximately 15.5 days, as shown in Figure 3-8.

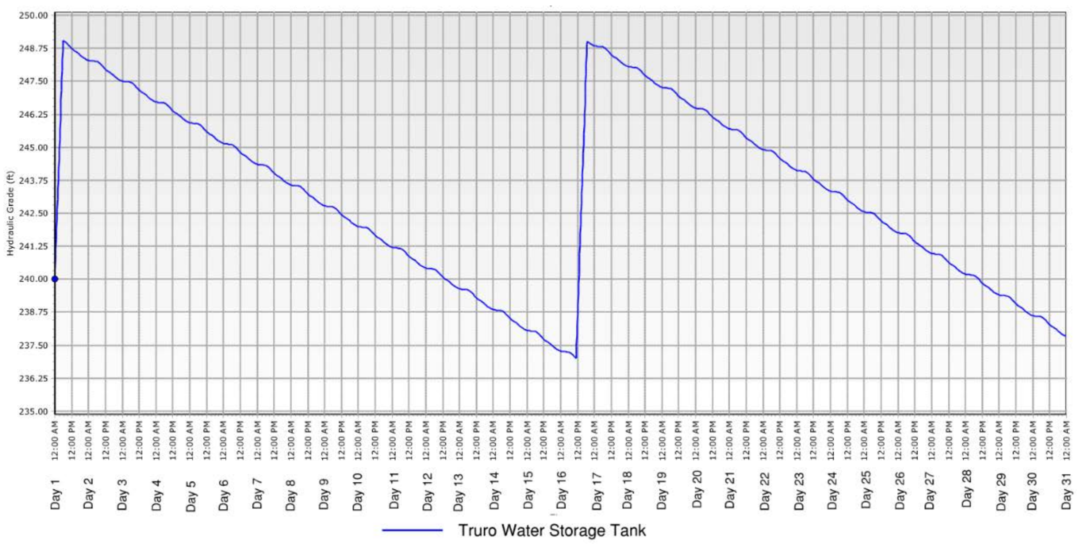


Figure 3-8: Existing MDD with New Tank – North Truro Tank Levels

Future Average Day Demand

<u>Cloverleaf + Pond Road Extension – Low Pressure Zone</u>

Under this scenario, pressures range between 33 and 104 psi throughout the entire distribution system when the Cloverleaf and Pond Rd. extension are located in the low-pressure zone. The high-pressure zone experiences pressures between 41 and 104 and the low-pressure zone experiences pressures between 33 and 91 psi.

As shown in Figure 3-9, the North Truro tank cycles over the course approximately 5.5 days (132 hours). This graphs shows a more desirable fill/draw cycle for tank operation as compared to the existing average day demand condition.

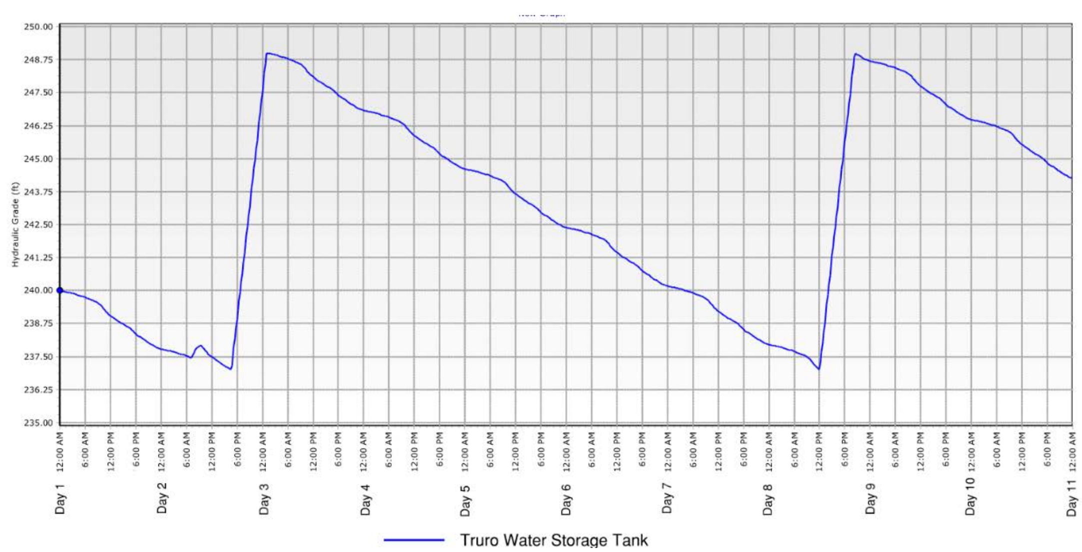


Figure 3-9: Future Conditions, Future ADD – North Truro Tank Levels

Cloverleaf + Pond Road Extension – High Pressure Zone

Under this scenario, pressures range between 33 and 104 psi throughout the entire distribution system when the Cloverleaf and Pond Rd. extension are located in the high pressure zone. The high-pressure zone experiences pressures between 41 and 104 and the low-pressure zone experiences pressures between 33 and 90 psi.

Similar to when Cloverleaf and Pond Road are located in the low-pressure zone, the tank cycles over the course of about 4.5 days (108 hours) when in the high-pressure zone.

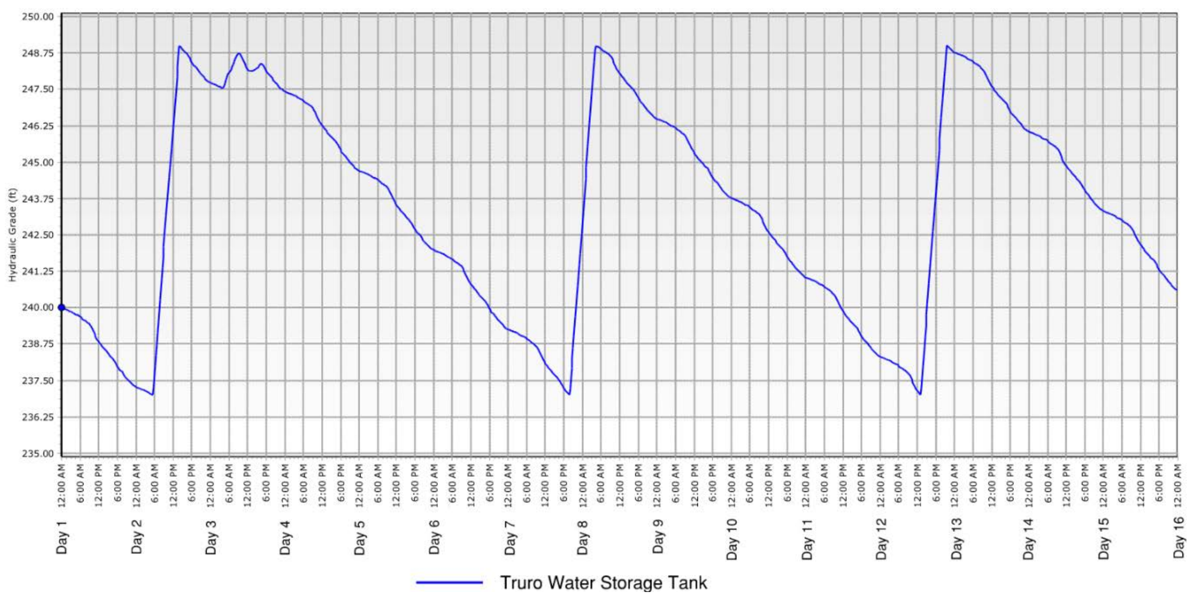


Figure 3-10: Future Conditions, Future ADD – North Truro Tank Levels

Future Maximum Day Demand

<u>Cloverleaf + Pond Road Extension – Low Pressure Zone</u>

Under this scenario, pressures range between 36 and 105 psi throughout the entire distribution system. The proposed high pressure zone experiences pressures between 49 and 105 psi and the low-pressure zone experiences pressures between 36 and 68 psi.

With higher maximum demand conditions in North Truro, the new storage tank cycles in 2 days (48 hours) in Figure 3-11.

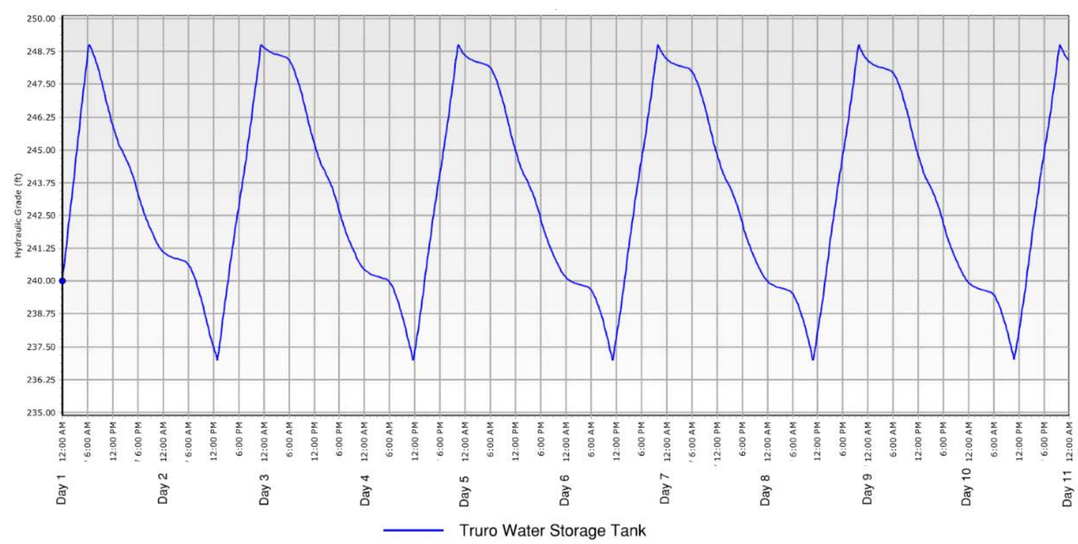


Figure 3-11: Future Conditions, Future MDD – North Truro Tank Levels

Cloverleaf + Pond Road Extension – High Pressure Zone

Under this scenario, pressures range between 36 and 105 psi throughout the entire distribution system. The proposed high pressure zone experiences pressures between 49 and 105 psi and the low-pressure zone experiences pressures between 36 and 67 psi.

The operation is similar when Cloverleaf and Pond Road extension are on the high-pressure zone with the new storage tank cycles in 1.5 days (36 hours) Figure 3-12.

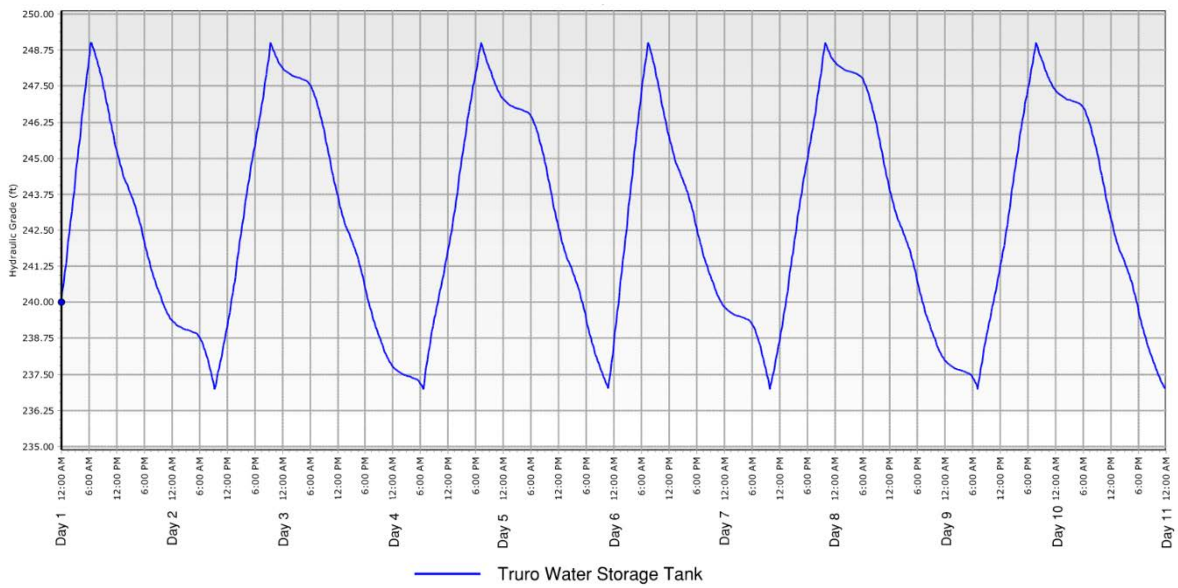


Figure 3-12: Future Conditions, Future MDD – North Truro Tank Levels

Future Conditions Model Results Summary

Table 3-11 provides a summary of the different demand scenarios with the new North Truro Tank. As shown in the table, under current day demands, the tank does not cycle regularly which would lead to water quality issues. The future demands shown in Table 3-11 will need to occur prior to or concurrently with the North Truro tank so that the tank cycles under fully in under 7 days with either the Cloverleaf and Pond Rd. develops in the low-pressure or high-pressure zone. It is preferred that these developments are on the high-pressure zone as the tank cycle time is the least.

Scenario	Demand	Pressure Range	Tank Fill / Drain Cycle	Location of Cloverleaf + Pond Road Extension
Current Average Day Demand Future Conditions	90,000 gpd	33 - 104 psi	23 days	-
Current Maximum Day Demand Future Conditions	228,600 gpd	36 - 104 psi	15.5 days	-
Future Average Day Demand Future Conditions	172,844 gpd	33 - 104 psi	5.5 days	LPZ
Future Maximum Day Demands Future Conditions	439,022 gpd	36 - 105 psi	2 days	LPZ
Future Average Day Demand Future Conditions	172,844 gpd	33 - 104 psi	4.5 days	HPZ
Future Maximum Day Demands Future Conditions	439,022 gpd	36 - 105 psi	1.5 days	HPZ

Table 3-11: Distribution System Conditions Hydraulic Analysis Summary

Future Maximum Day with Fire Flow

Three (3) fire flow simulations were run under future, maximum day demand conditions and with either the Cloverleaf and Pond Rd. extension located in the low-pressure zone or high-pressure zone. The fire flow used was 2,000 gpm for a 3-hour duration.

Fire flows with Cloverleaf and Pond Road on Low Pressure Zone

<u>Fire Demand at the Truro Central School (Cloverleaf and Pond Road Extension – Low Pressure Zone):</u> A fire flow of 2,000 gpm was simulated at the Truro Central School. During the simulated fire flow pressures ranged between 34 and 100 psi in the entire water system during the fire event (hours 2 p.m. – 5 p.m.).

The new North Truro storage tank is capable of supplying the 2,000 gpm fire and maximum day demands. As shown in the graph, the tank quickly drains for the 3-hour duration to a level of approximately 231-ft. This level is outside its typical operating level, but still part of its usable storage volume. The booster pump station would start up to help support the high demand when the tank level reaches 237-ft.

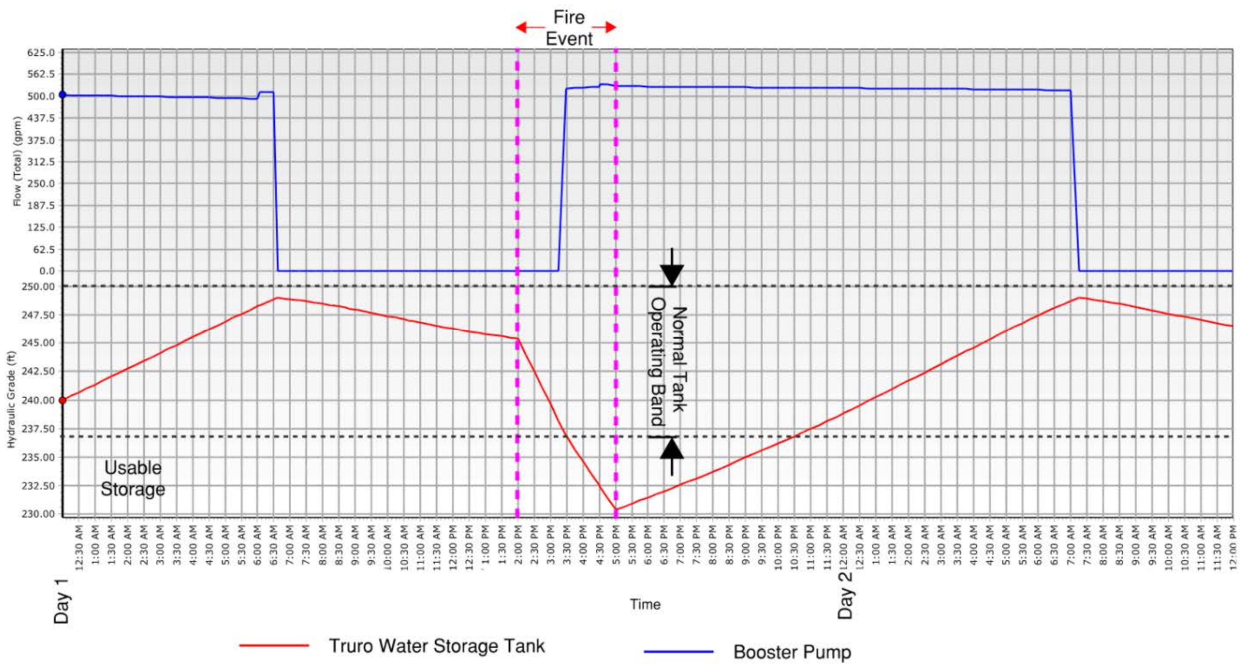


Figure 3-13: Fire Demand @ School (Cloverleaf and Pond Road in LPZ) – North Truro Tank Levels and Pump Flow

<u>Fire Demand at Clover Leaf Development (Cloverleaf and Pond Road Extension – Low Pressure Zone):</u> A fire flow of 2,000 gpm was simulated near the proposed Clover Leaf Development. Pressures ranged between 34 and 105 psi during the fire event throughout the entire system.

For this analysis the new Clover Leaf Development is outside the new tank high service area. Therefore, the North Truro water storage tank does not support the fire flow demand. Winslow and Mt. Gilboa tank support the MDD and fire demand that occurs at the Clover Leaf Development.

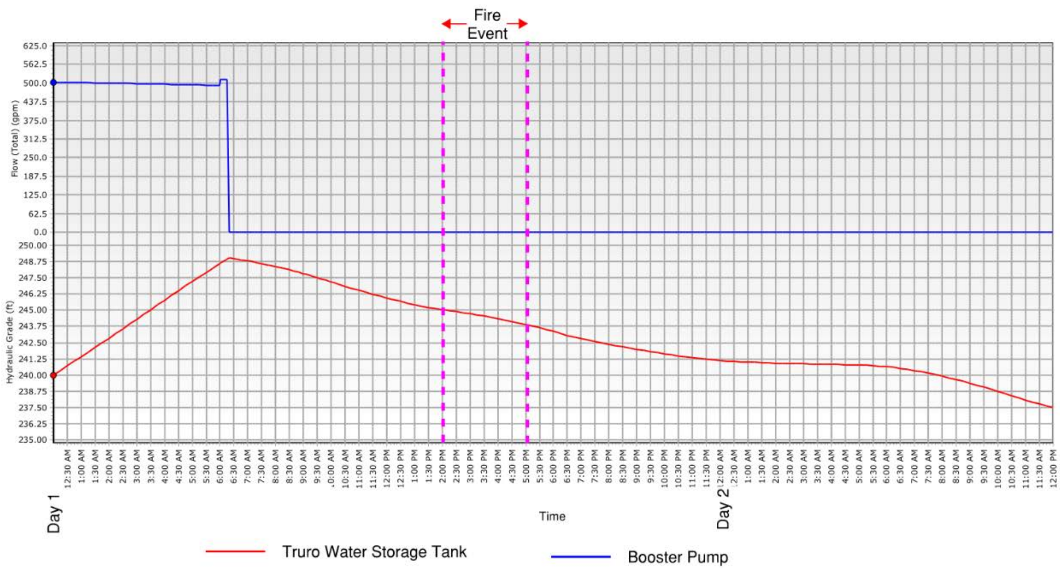


***Figure 3-14:* Fire Demand @ Clover Leaf (Cloverleaf and Pond Road Extension in LPZ) – North Truro Tank Levels and Pump Flow**

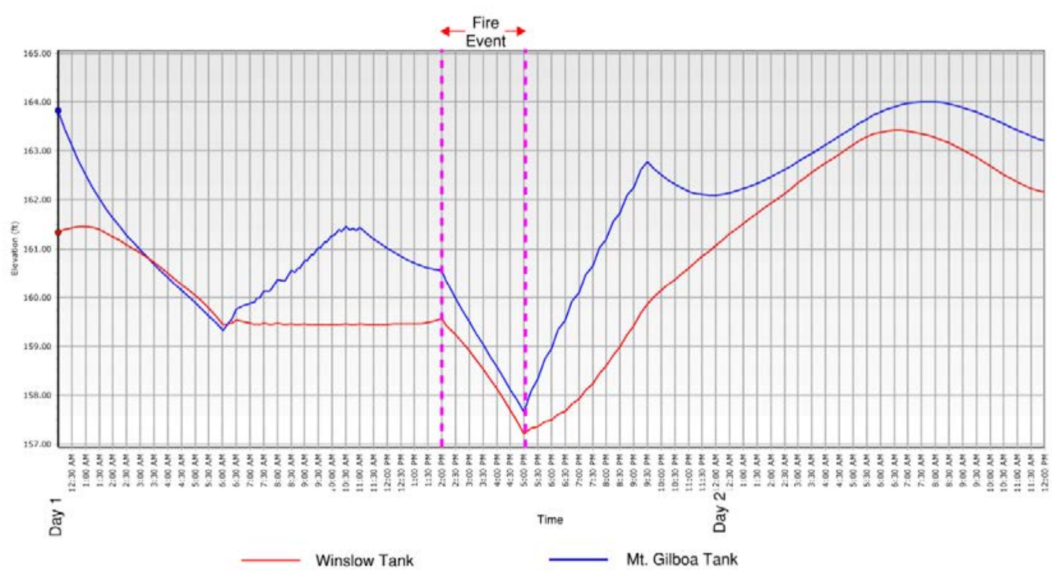


Figure 3-15: Fire Demand @ Clover Leaf – Winslow and Mt. Gilboa Tank Levels

<u>Fire Demand at Truro Trademen's Park (Cloverleaf and Pond Road Extension – Low Pressure Zone):</u>
Pressures ranged between 34 and 101 psi during the fire event.

The new storage tank is capable of supplying the 2,000 gpm fire and maximum day demands. As shown in the graph, the tank quickly drains for the 3-hour duration to a level of ~231-ft. This level is outside its typical operating level, but still part of its usable storage volume, dipping into the fire storage volume. The booster pump station would start up to help support the high demand when the tank level reaches 237-ft.

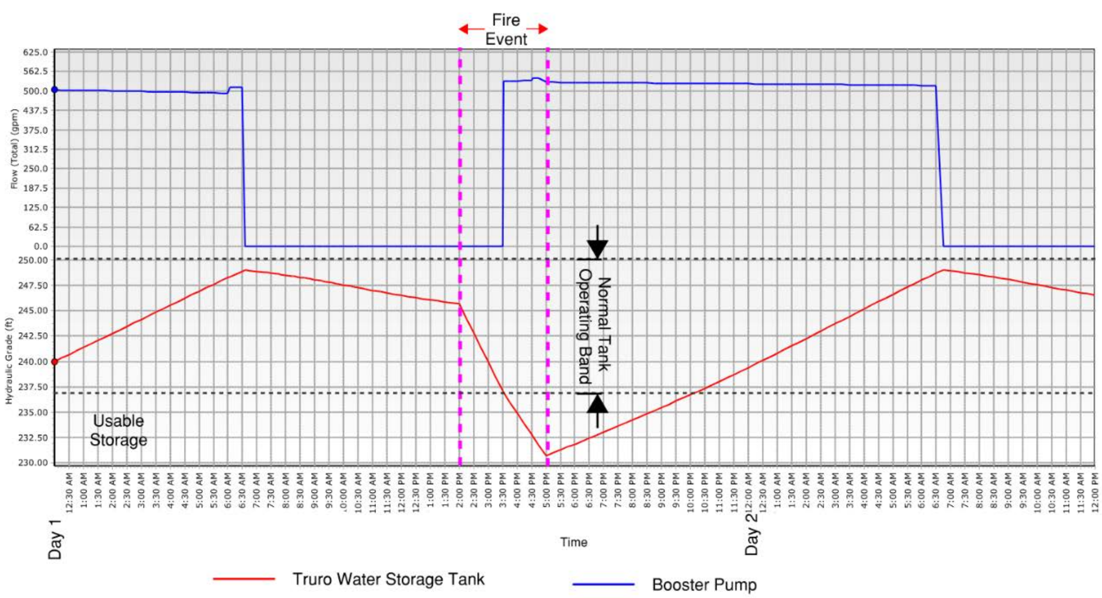


Figure 3-16: Fire Demand @ Commercial Plaza (Cloverleaf and Pond Road Extension in LPZ) – North Truro Tank Levels and Pump Flow

Fire flows with Cloverleaf and Pond Road on High Pressure Zone

<u>Fire Demand at the Truro Central School, Commercial Plaza, and Cloverleaf (Cloverleaf and Pond Road Extension – High Pressure Zone):</u> The new North Truro storage tank is able to supply the 3-hour fire duration of 2,000 gpm at maximum day demand when Cloverleaf and Pond Road Extension are in the high-pressure zone for all three (3) scenarios. As shown in Figure 3-17, the tank is full when the fire begins and then quickly empties to a level of 236-ft over the 2 hour duration. The booster pump would start up when the tank level reaches 229-ft and continues to run until the tank fills.

Pressures ranged between 34 – 100 psi in the entire system during the 3-hour fire duration.

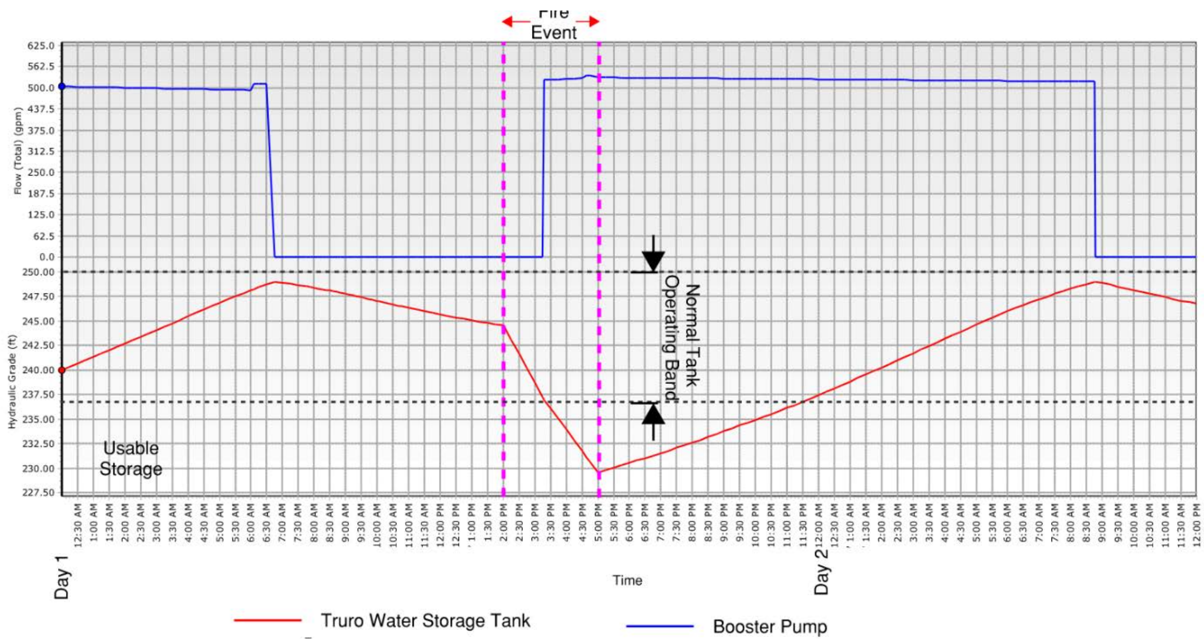


Figure 3-17: Fire Flow Analysis (Cloverleaf and Pond Road in HPZ) – North Truro Tank Levels and Pump Flow

Fire Flow Analysis Summary

Fire flow demands of 2,000 gpm for a 3-hour duration can be met when either the Cloverleaf and Pond Rd. developments are in the low-pressure zone or in the high-pressure zone. As shown in the summary table below, pressures in all fire flow scenarios are above the minimum 20 psi, however, the Truro tank needs to dip outside its normal operating band of 249 – 237 ft. in order to meet maximum day demands and the fire flow demand.

Fire Flow Scenario	Cloverleaf and Pond Road on LPZ			Cloverleaf and Pond Rd. on HPZ		
	Pressure Range	Fire Flow Served by	Tank, Min Level	Pressure Range	Fire Flow Sered By	Tank, Min Level
Fire Flow @ Truro Central School	34 -100 psi	Truro Tank	231 ft.	34 - 100 psi	Truro Tank	229 ft.
Fire Flow @ Cloverleaf Development	34 - 105 psi	Winslow & Mt. Gilboa Tank	157.5 ft. 157.75 ft.	34 - 100 psi	Truro Tank	229 ft.
Fire Flow @ Truro Trademen's Park	34 - 101 psi	Truro Tank	231 ft.	34 - 100 psi	Truro Tank	229 ft.

Table 3-12: Fire Flow Analysis Summary Table

3.3.3 Future Conditions Water Age

A water age analysis was performed to determine the average time water stays in the system prior to consumption. It is primarily a function of water demand, system operation, and system design. Water age can become a challenge when it is too high as it can lead to quality issues like taste and odor, color, sediment deposits and disinfection by-product (DBP) formation. The definition of “high” is system-specific, as the extent to which water age impacts water quality depends on numerous factors, including source water quality, treatment process efficacy, disinfectant type and dose, distribution system configuration, and system operation. Water age is typically elevated when water usage is low (most notable at dead end water mains) and is exacerbated when pipe sizes and storage tank volumes are large relative to demand. In general, the maximum acceptable water age will be defined for this (and any) system as the water age below which distribution system challenges, that directly or indirectly relate to reaction time (such as chlorine decay, disinfection by-product formation, microbial growth etc.) do not occur, as supported by the sampling data.

The purpose of this water age analysis was to determine the impacts of water age on the system with the new 0.6 MG water storage tank in North Truro. With the proposed North Truro Water Storage tank being filled by the proposed new pump station, the water storage tank has a strong fill/draw cycle encouraging tank turnover. The water age in the North Truro tank is approximately 7 days (163 hours) under a future maximum day demand condition discussed in Section 3.3.2.

Water age was also calculated for the water distribution system in the North Truro area. The following table summarizes this data.

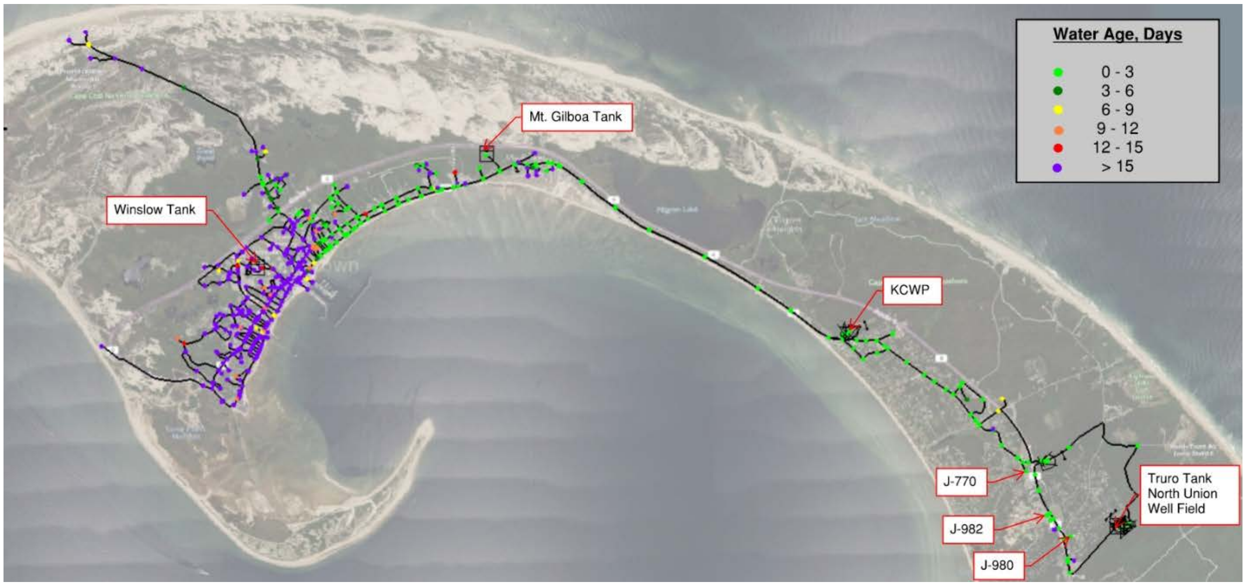


Figure 3-18: Future Conditions MDD –Water Age

Table 3-13. Future Conditions MDD – Water Age

Junction	Location	Avg. Water Age, Hrs	Avg. Water Age, Days
J-770	Shore Road	30	1.25
J-982	Route 6 – Commercial Plaza	7	0.29
J-980	Route 6 / S. Highland Road	8	0.33

The highest water age was experienced at locations of little to no water demand, or on dead end lines. Developing a routine flushing program or installing automatic flushing stations are a few ways to reduce a system's water age.

3.3.4 Pressure Reducing Valve

The addition of the North Truro Tank creates two (2) new pressure zones. A pressure reducing valve (PRV) vault can be installed to allow the high pressure zone to bleed water into the low pressure zone in instances of high demands in the Provincetown low service system (i.e. fire). The PRV vault should be located north of the proposed booster pump station. It is recommended that the siting and sizing of the PRV vault be investigated to identify an acceptable location. While PRV's can simply operate hydraulically based on pressures in the high service and low service system, it is recommended that electrical controls be added to the proposed PRVs so that these valves can assist with forcing turnover in the North Truro Water Storage Tank, if needed. The availability of an electrical service connection should be evaluated as part of the siting of the vault.

3.3.5 Budgetary Cost

A budgetary cost estimate for the new booster pump station, tank inlet/outlet pipe, installation of the PRV, and miscellaneous distribution system improvements is provided in Table 3-14. There is potential for cost savings if the existing booster pump station is retrofitted to accommodate the new pumps. The pump station cost assumes an approximate 800 sq. ft. building, two (2) 50 HP split case pumps, associated piping and valves, electrical work, and site work.

Table 3-14. Budgetary Distribution System Piping and Pump Station Cost

No.	Unit	Description	Estimated Quantity	Unit Price	Estimated Total Cost
1	LS	Booster Pump Station 800 sq. ft. building, two (2) 50 HP split case pumps, associated piping and valves, electrical work, and site work	1	$1,500,000	**$1,500,000**
2	LS	Pressure Reducing Valve Vault Below grade vault including two pressure reducing valves along with power for monitoring and controlling valve operation	1	$200,000	**$200,000**
3	LS	Water Storage Tank Connecting Pipe 5,500 feet of new 16”, 550 LF of new 12” and appurtenances to connect proposed water storge tank site to existing water distribution system. This connecting pipe will vary based on final water storage tank siting.	1	$1,788,000	**$1,788,000**
4	LS	Water Distribution System Improvements Cost assumes the new booster pump station is sited near the existing South Hollow pump station, which as requires an additional 6,500 lf of 12-inch to bring the Cloverleaf and Pond Street Areas to the high service area.	1	$1,950,000	**$1,950,000**
				ESTIMATED CONSTRUCTION COST	**$5,438,000**
				3.5% Mob, Demob, Bonds, Ins, etc.	**$190,330**
				40% CONTINGENCY	**$2,175,200**
				Subtotal Construction Cost	**$7,803,530**
				20% Design and Engineering Services During Construction	**$1,560,706**
				ESTIMATED TOTAL COST	**$9,364,236**

Notes:

1. Does not include any land acquisition or easements
2. Additional conceptual design for the booster pump station and pressure reducing valve vault is recommended prior to initiating design phase.
3. A higher contingency has been carried for these recommendations since the concepts are not as advanced as that of the water storage tank.

3.3.6 Conclusion

A new elevated water storage tank and associated booster pumping station are required to handle the anticipated increase in water demands in North Truro. Based on the hydraulic analysis, under future maximum day demands, the tank cycles over the course of 1 day and has a water age of approximately 8 days.

The addition of the new tank will split the Provincetown water distribution system into two (2) pressure zones with the division being at South Hollow Road. A PRV is recommended to be installed so that the high pressure zone could feed the low pressure zone in emergency situations.

Careful consideration is needed when constructing and putting the new 0.6 MG storage tank and booster pump into service. The existing average day and maximum day demands are too low to properly cycle the tank. For the new 0.6 MG tank to operate effectively without water quality issues, the proposed developments will need to occur, or operational changes will be required.

Appendix A Pedestal Spheroid Tank Brochure

Watersphereoid®

ELEVATED WATER STORAGE

www.cbi.com

CB&I

Modern sleek design

Visually pleasing contours blend well with surroundings

Attractive graphics enhance community identity

Why choose a Waterspheroid® elevated tank?

Proven to be the most popular of all single pedestal elevated water storage tank styles, the Waterspheroid elevated tank is available in storage capacities from 150,000 to 2,000,000 gallons. It offers low capital and maintenance costs, enhanced safety/security, convenient storage, and a small footprint that minimizes land requirements.

With its sleek design and pleasing contours the Waterspheroid tank is well suited for high visibility locations such as school grounds, commercial developments, residential neighborhoods, parks and other prominent locations.

We invented the Waterspheroid tank design, and we have built more single pedestal steel spheroidal elevated tanks than any other company, including the tallest and largest capacity tanks in service. We have the most experience in the industry in the art of forming the ball. We use larger steel plates than our competitors which leads to a smoother ball shape with fewer weld seams, minimizes potential areas of paint failure and reduces long-term paint maintenance of the tank.

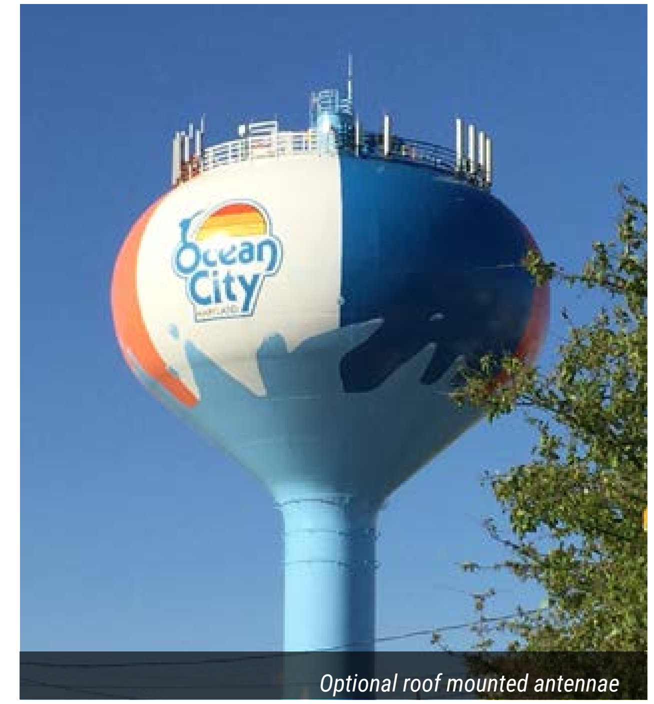
Additionally, we use double-curved, hot pressed knuckles between the bell and the shaft and between the shaft and the ball. Not only does this add to the smooth line aesthetics of the tank, it eliminates the potential lamellar tearing that could occur on tanks using dollar plates and coned sections in these areas.

Waterspheroid tanks are all-steel, all-welded structures that have proven reliability, serving thousands of municipalities and industries for decades. Properly maintained and operated, steel tanks offer an extremely long life, with some structures exceeding 100 years of service.

Since the construction of our first elevated tank in 1894, we have become a global leader in the design and construction of elevated water storage tanks. We pioneered the transition to welded steel tanks in the 1930s, invented the original Watersphere® tank in 1939, the larger Waterspheroid® tank in 1954, and have been improving the concept ever since. We also have been instrumental in the development of the AWWA standards, beginning with the first D100 Standard in 1941, continuing today through active organization and committee participation.

Taking the Lead with QHSES

McDermott is committed to setting a leading example in all areas of Quality, Health, Safety, Environment and Security, and encourages our partners, subcontractors and clients to join us in the pursuit of outstanding QHSES performance. Taking the Lead is a company-wide initiative that brings a single, united QHSES culture to our diverse workforce and organization, a culture where setting the right example in QHSES attitude and behavior is simply 'In our DNA.'



Optional roof mounted antennae


Unhindered maintenance access


Piping and valves in base

More pleasing appearance, lower maintenance and superior security than multi-column tanks

Selecting a Waterspheroid elevated tank

CB&I provides sample specifications and detail drawings for engineers and owners who are planning Waterspheroid projects. Contact our regional sales force to receive guidance on specifying your tank or visit **www.cbi.com/water** to view our standard specifications and drawings.

Aesthetic design

- Smooth contours
  - The most popular single pedestal style in use
  - Visually pleasing, modern design
- Blends well with surroundings
- Capitalizes on high visibility locations
  - Optional lettering and logos enhance community identity and pride
  - Custom ornamental and specialty paint designs available

Economics

- Low capital expenditure
- All-steel composition permits cost effective, year-round construction
- Small footprint permits "tight sites" and minimizes land cost
- Turnkey supply of foundation and painting offers cost and schedule savings
- Eliminates costly and unsightly fencing
- Height can be modified if pressure requirements change after installation
- At end of life cycle, tank can be demolished at minimal cost

Maintenance

- Style minimizes interior and exterior painted surface area and future maintenance
- Interior dry surfaces are weather protected and seldom need repainting
- Maintenance access to all exterior surfaces is unhindered

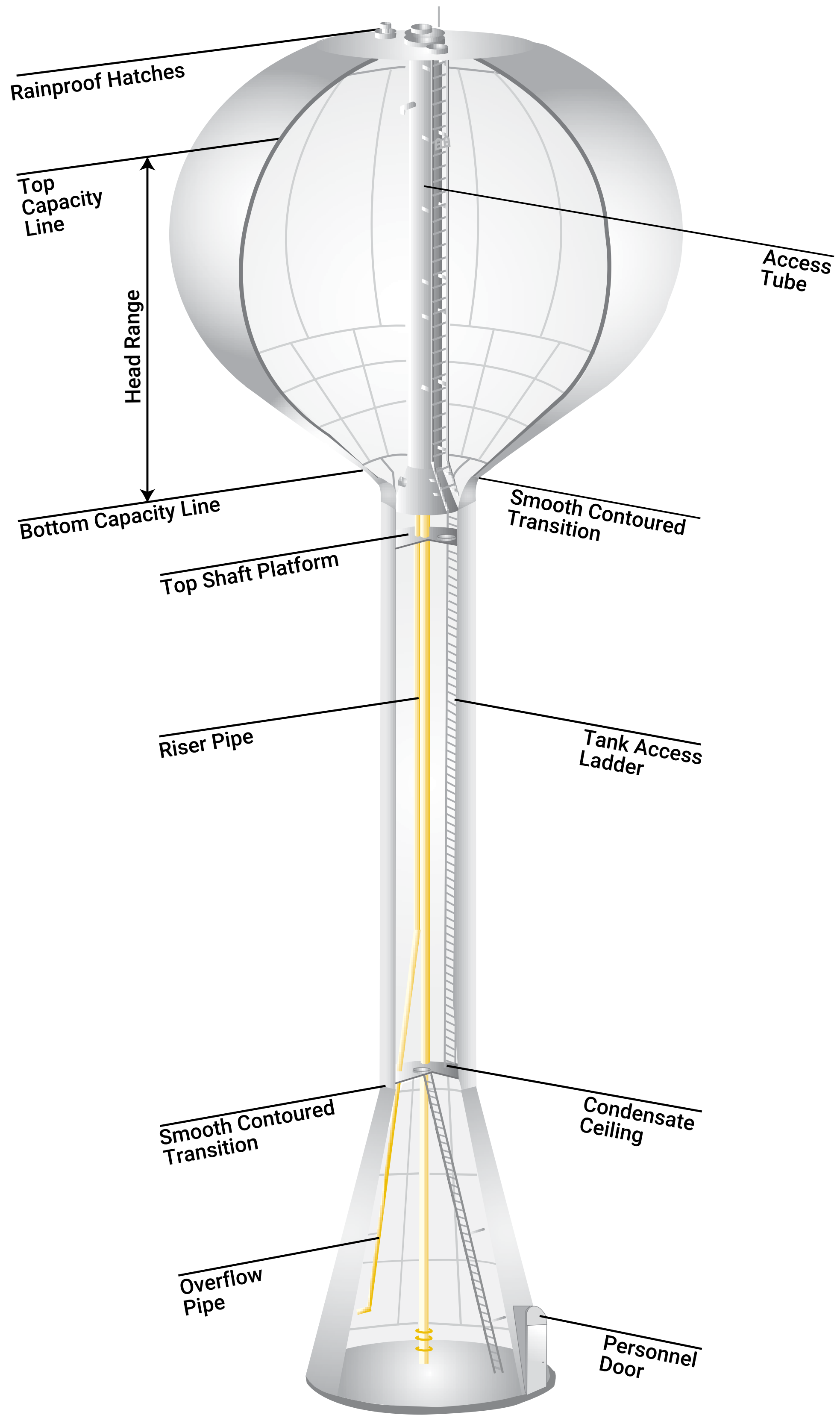
Safety and security

- Solid, flush threshold steel door with deadbolt lock restricts unauthorized entry
- Enclosed interior access ladders
  - Minimize vandalism and unsightly graffiti
  - Minimize unauthorized tank access
  - Facilitate climbing during inclement weather
- Proven performance in high wind events (tornadoes and hurricanes

Multi-purpose space inside bell

- Optionally insulated and heated
- Provides space for multiple uses, such as:
  - Tool and equipment storage
  - Pumps, valves, piping and controls
  - Telecommunication equipment
- Flush threshold personnel door allows easy access for storage

Standard features and options



Standard features

- One 36 in. wide by 80 in. high steel personnel door with flush threshold
- Concrete floor inside base
- Steel riser pipe with expansion joint
- Steel overflow pipe to grade with splash block
- Steel condensate ceiling with drain
- Ladders in pedestal and access tube
- Safety devices on ladders as required by state and federal regulations
- Steel top shaft platform with one 30 in. diameter man-way in top shaft platform
- One 30 in. diameter manway in condensate ceiling
- One 42 in. diameter access tube
- Painter's rings at top of pedestal
- One 24 in. diameter painter's ring hatch
- Two 30 in. diameter roof hatches
- One 24 in. diameter painter's ventilation roof hatch
- Minimum 1/4" thick steel roof plates
- Seal welding underside of roof
- Fail-safe roof vent
- Interior lighting in pedestal and access tube

Options

- Lettering, logos and decorative graphics
- Alternative style as composite elevated tank or Hydropillar®
- Ornamental and specialty styling
- FreshMix™ circulation system
- Double personnel door
- Overhead door
- Valve vault inside base
- Control room in base
- Dual risers
- Stainless steel riser
- Stainless steel overflow
- Riser insulation and heat tracing
- Intermediate platforms
- Seal welding of pedestal appurtenances
- Upsized 48 in. diameter or 60 in. diameter access tube
- Tank drain
- Internal tank ladder on access tube
- Roof handrail
- External security or decorative lighting
- FAA lighting
- Instrumentation
- Telemetry
- Cathodic protection
- Lightning protection
- Antenna penetrations and supports

Standard capacities and dimensions

Capacity U.S. Gallons	Spheroid Diameter ft-in.	Head Range ft-in.
150,000	35 - 0	30 - 0
200,000	39 - 10	30 - 0
250,000	42 - 10	32 - 6
300,000	46 - 6	32 - 6
400,000	50 - 8	37 - 6
500,000	55 - 10	37 - 6
600,000	58 - 2	40 - 0
750,000	64 - 8	40 - 0
1,000,000	74 - 8	40 - 0
1,250,000	79 - 2	45 - 0
1,500,000	86 - 0	46 - 0
2,000,000	93 - 0	52 - 0

Northville, MI – 1,000,000 gallons

Gonzales, LA – 1,000,000 gallons

Batavia, IL – 750,000 gallons

Shorewood, IL – 1,500,000 gallons

Wentzville, MO – 2,000,000 gallons

Custom paint options

CB&I is the world's leading designer and builder of storage facilities, tanks and terminals. With more than 59,000 structures completed throughout our 130-year history, CB&I has the global expertise and strategically located operations to provide our customers world-class storage solutions for even the most complex energy infrastructure projects.

Headquarters

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Houston, TX 77079
USA
Tel: +1 832 513-4000

www.cbi.com

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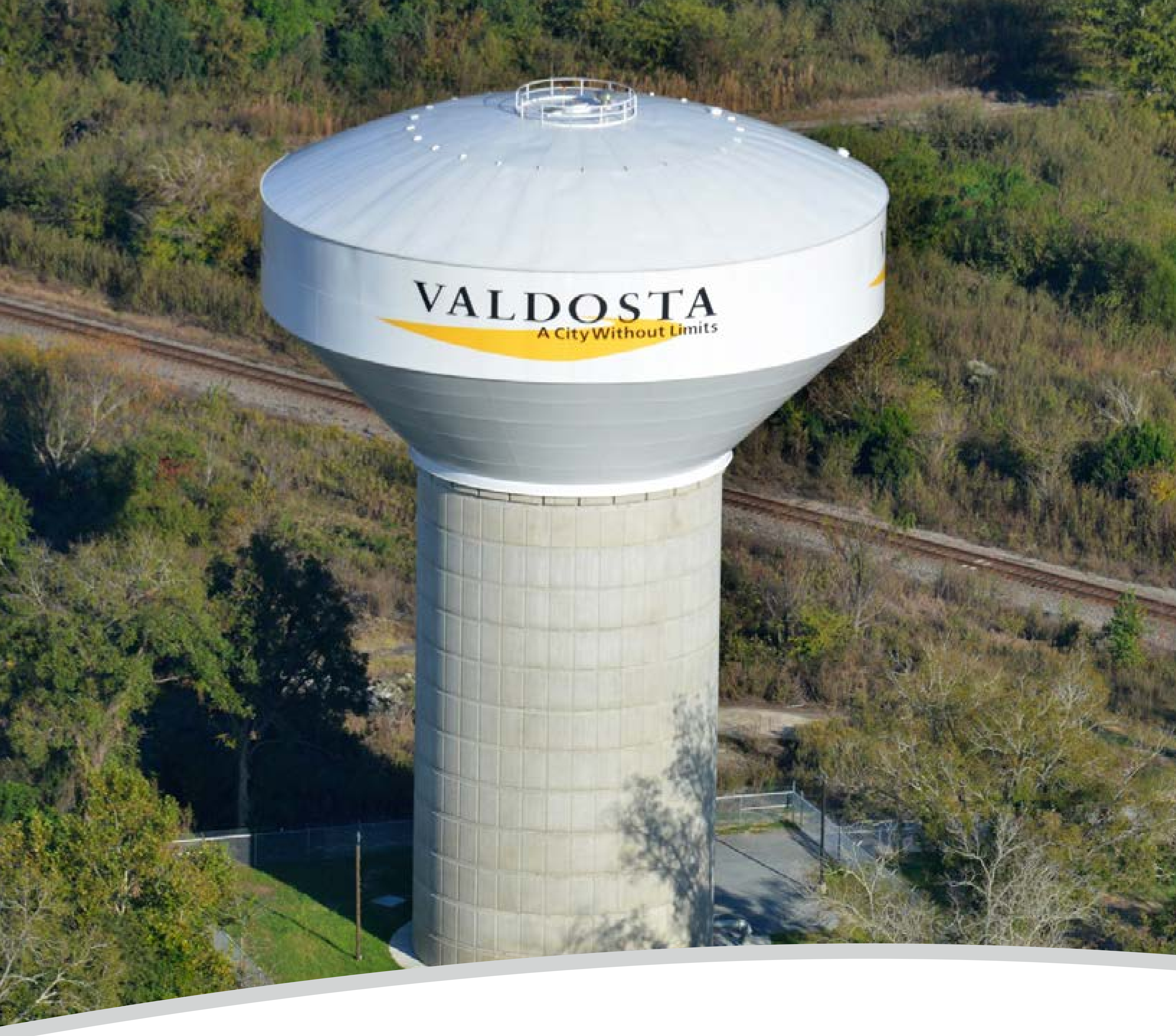
Appendix B Composite Tank Brochure



Composite Elevated Tank

WATER STORAGE

www.cbi.com

CB&I

Sizes range from 500,000 to 3,500,000 gallons. Above is a 1,500,000 gallon tank

Architectural lines blend well with surrounding structures and landscapes

Concrete support structure requires minimum maintenance on both inside and exterior

3,000,000 gallon tank in Souderton, PA

Why choose a composite elevated tank?

The tensile strength of steel has long been recognized as a characteristic most effective in producing leak-free water-retaining vessels. Reinforced concrete is one of the most efficient and economical materials to carry compressive loads. A composite elevated tank (CET) combines these materials to produce an efficient, long lasting structure.

A CET from CB&I can be a cost effective solution for large-capacity tanks. The low maintenance requirements of the interior and exterior of the support structure minimize long-term ownership costs.

We have designed and built hundreds of CETs of various capacities and heights since their introduction to the marketplace.

Our concrete forming system (forms, ties and bulkheads) minimizes pour lines and allows proper vibration of the concrete, reducing bug holes and honeycombing to obtain architectural grade concrete. We install a ¼ inch thick formed steel liner over the concrete dome, which minimizes voids between the concrete and steel and meets the AWWA D107 minimum thickness requirement for plates in contact with water.

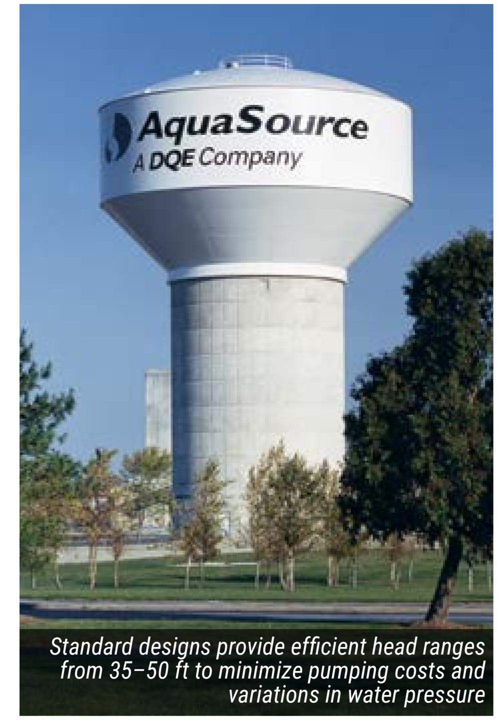
The self-supporting dome roof minimizes interior structural supports in the vapor area of the tank where condensation occurs. Since this is the most corrosion-prone area in the tank, future maintenance requirements are reduced.

The concrete support structure exterior is enhanced by an architectural pattern that blends well with surrounding structures. In addition, the exterior coating and logo on the steel tank can be custom designed to identify your municipality, company or product.

Since the construction of our first elevated tank in 1894, we have become a global leader in the design and construction of elevated water storage tanks. We pioneered the transition to welded steel tanks in the 1930s and built our first Composite Elevated Tank in 1986. We also have been instrumental in the development of the AWWA D107 Standard for composite elevated tanks.

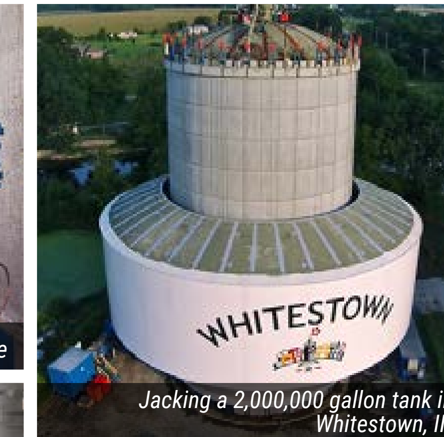
Taking the Lead with QHSES

CB&I is committed to setting a leading example in all areas of Quality, Health, Safety, Environment and Security, and encourages our partners, subcontractors and clients to join us in the pursuit of outstanding QHSES performance. Taking the Lead is a company-wide initiative that brings a single, united QHSES culture to our diverse workforce and organization, a culture where setting the right example in QHSES attitude and behavior is simply 'In our DNA.'



Standard designs provide efficient head ranges from 35–50 ft to minimize pumping costs and variations in water pressure


Piping and valves in support structure



Jacking a 2,000,000 gallon tank in Whitestown, IN


Piping and valves in support structure


Painting tank exterior prior to jacking

Selecting a composite elevated tank

CB&I sample specifications and detail drawings for engineers and owners who are planning elevated water storage projects. Contact our regional sales force to receive guidance on specifying your tank or visit **www.cbi.com/water** to view our standard specifications and drawings.

Maintenance

- Concrete support structure requires minimal maintenance
- Maintenance access to all exterior surfaces is unhindered
- Multi-purpose interior space
- Dual use as offices, meeting rooms, pump station, fire station, equipment and machinery storage, etc.
- Reinforced concrete support structure
  - Easily integrates with interior structural steel for multiple floors
  - Allows exterior windows
- Offset riser pipe maximizes available interior space

Economics

- Can be economical in larger capacities
- Effective cost is reduced when the value of the interior space is considered
- Turnkey supply of foundation and painting offers cost and schedule savings

Aesthetic design

- Clean modern appearance
- Vertical and horizontal architectural lines blend well with surrounding structures and landscapes
- Capitalizes on high visibility locations
  - Optional lettering and logos enhance community identity and pride
  - Optional custom architectural concrete support structure designs available

Safety and security

- Solid threshold steel door with deadbolt lock restricts unauthorized entry
- Overhead door
  - Quick entry and exit for trucks and large equipment
  - Easy access for larger storage items
- Enclosed interior access ladders
  - Minimizes vandalism and unsightly graffiti
  - Minimizes unauthorized tank access
  - Facilitates climbing during inclement weather

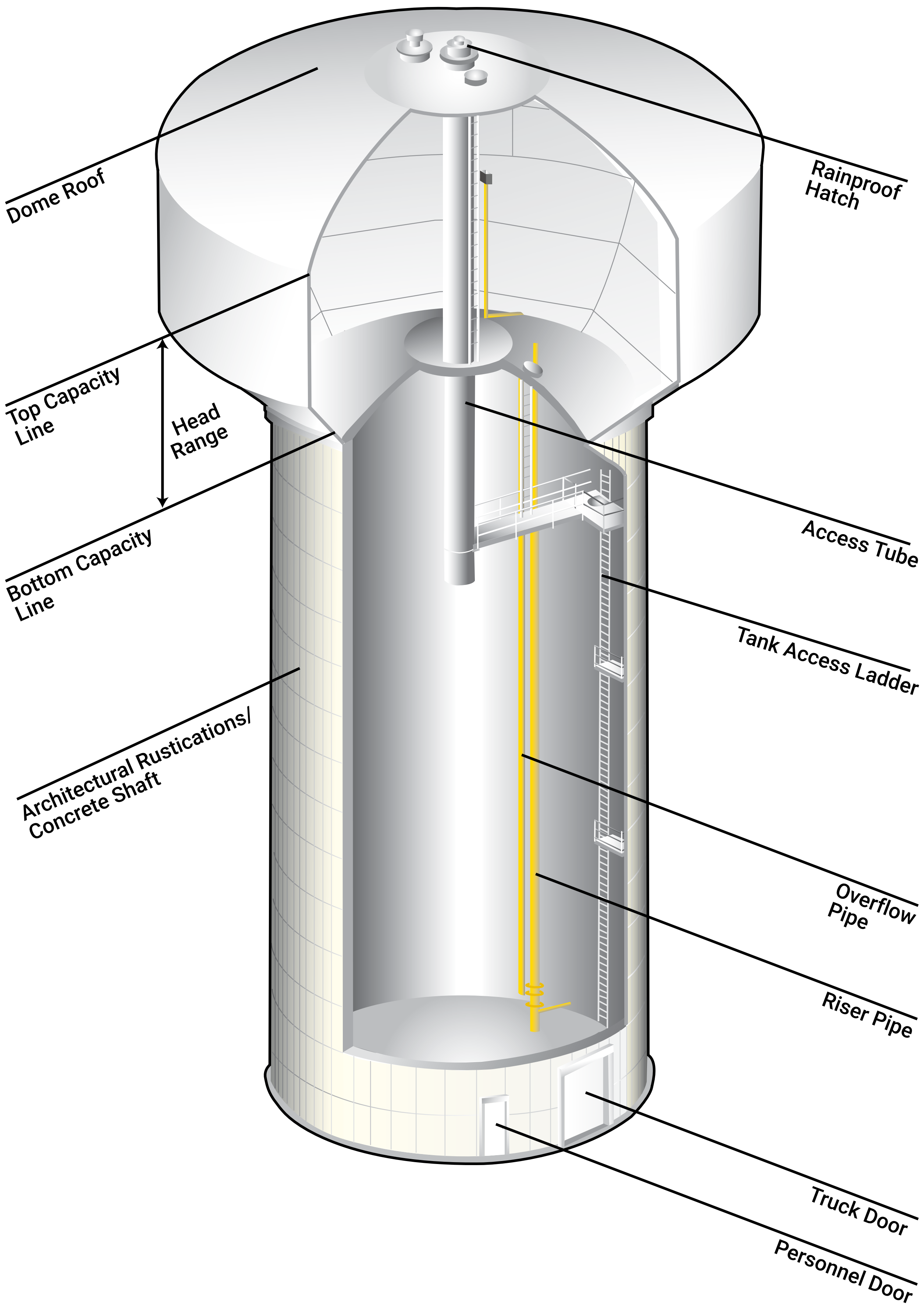
Optimum head range

- Standard design provides efficient head range
  - Minimizes pumping costs
  - Minimizes variation in water pressure
- Optional head ranges available

Dome roofs

- Improves appearance
- No ponding or bird baths
- Reduces topside corrosion and dirt streaks on tank exterior
- Minimizes snow and ice accumulation

Standard features and options



Standard features

- One 36" wide by 80" high personnel door with threshold
- Concrete floor inside base
- Stainless steel riser pipe with expansion joint
- Steel overflow pipe in tank with weir box
- Stainless steel overflow pipe to grade with splash block
- Galvanized ladders and platforms in support structure
- Safety devices on ladders as required by state and federal regulations
- Galvanized walkway with handrails from top of support structure to access tube hatch
- One 48" diameter access tube
- Painted ladder in access tube
- Painter's rings at top of support structure
- Tank drain
- One 24" wide by 36" high painter's ring hatch with louver
- One 30" tank bottom manway with access ladder to walkway
- Two 30" diameter roof hatches
- One 24" diameter painter's ventilation roof hatch
- Minimum 1/4" thick steel roof plates
- Seal welding underside of roof
- Interior lighting in support structure and access tube
- Lightning protection

Options

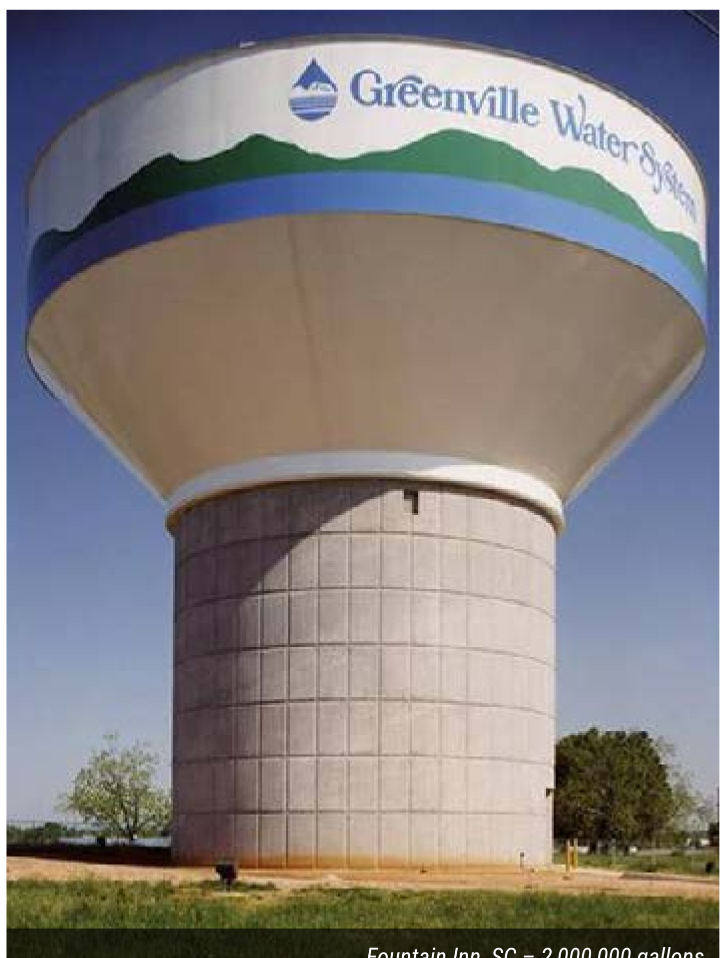
- Lettering, logos and decorative graphics
- Alternate style (as Waterspheroid® tank or Hydropillar)
- Architectural concrete support structure
- FreshMix® circulationsystem
- Structural framing, multiple floors and ceilings inside the support structure
- Additional openings in support structure (e.g., windows)
- Double personnel door
- Overhead doors
- Valve vault inside base
- Control room in support structure
- Dual risers
- Riser insulation and heat tracing
- Alternative ladder arrangements inside support structure
- Exterior access tube ladder
- Upsized 60 in. or 72 in. diameter access tube
- Internal tank ladder on access tube
- Exterior access tube ladder
- Roof handrail
- External security or decorative lighting
- FAA lighting
- Instrumentation
- Telemetry
- Cathodic protection
- Antenna penetrations and supports

Standard capacities and dimensions

Capacity U.S. Gallons	Tank Diameter* ft-in.	Head Range** ft-in.	Support Structure Diameter ft-in.
500,000	50 – 0	37 – 6	28 – 0
600,000	62 – 0	32 – 6	28 – 0
750,000	59 – 0	40 – 0	32 – 0
1,000,000	70 – 0	40 – 0	36 – 0
1,250,000	79 – 0	40 – 0	40 – 0
1,500,000	81 – 0	45 – 0	44 – 0
2,000,000	93 – 0	45 – 0	52 – 0
2,500,000	105 – 0	45 – 0	52 – 0
3,000,000	110 – 0	50 – 0	60 – 0
3,500,000	118 – 0	50 – 0	60 – 0

* Tank diameters based on listed/standard head ranges only.
** CB&I has other head ranges and support structure diameters available for each capacity tank. Please contact us if you need assistance.

Enterprise, AL – 1,500,000 gallons



Fountain Inn, SC – 2,000,000 gallons

League City, TX – 2,000,000 gallons

Charleston, SC – 1,500,000 gallons

Canton, MS – 1,500,000 gallons

Eden Prairie, MN – 2,000,000 gallons

Brownsburg, IN – 1,000,000 gallons

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Stantec is a global leader in sustainable engineering, architecture, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.

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Burlington, MA 01803
stantec.com

DRAFT - Walsh Property -Preliminary Hydrogeological Study

Truro, MA

Prepared for:
Town of Truro, MA

Prepared by:
Stantec Consulting Services Inc

October 3, 2025

Project/File:
195151014

Stantec Consulting Services Inc.

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1 Introduction

This memo presents the results of a groundwater flow and salinity fate and transport model, designed to evaluate the potential hydrogeologic impacts of developing a pumping well at the Walsh Property, and how these impacts could affect the nearby North Union Field (NUF) wells in Truro, MA.

Stantec Consulting Services Inc. (Stantec) was retained by the Town of Truro to conduct a *Preliminary Hydrogeological Study,* that included groundwater modeling to assess the feasibility of developing a groundwater resource and non-transient community public water supply (PWS) for the Walsh Property (**Figure 1)**. The Walsh property encompasses approximately 87 acres and is situated approximately 375 feet southeast of the Provincetown NUF wellfield.

It is understood that the Town of Truro desires to develop approximately 50 year-round residential dwellings on the Walsh Property, which may be served by a central water system. Septic waste will be treated and discharged into the subsurface via one or more drainfields. Work related to the treatment and discharge of wastewater is in process by another consultant.

As part of this *Preliminary Hydrogeological Study*, Stantec modified the existing United States Geological Survey (USGS) Cape Cod groundwater model which was previously refined over the nearby NUF wellfield as part of a separate study (McLane Environmental, LLC [McLane Environmental] [2011; 2018; 2024]). This modification was undertaken to evaluate the potential impacts of the proposed new water supply source at the Walsh Property on water quality and quantity.

This report describes the groundwater model development and the results of predictive simulations used to assess potential impacts from the development of water resources at the Walsh Property including: 1) changes in available groundwater production at the NUF wellfield due to drawdown associated with production at a potential Walsh water supply well; 2) changes in water quality due to wastewater inflows at a potential effluent recharge station; and 3); saltwater upconing due to pumping at the potential Walsh water supply well.

2 Background and Previous Groundwater Model Development

The groundwater model developed for this *Preliminary Hydrogeological Study* is based on previous groundwater models of the Lower Cape Cod aquifer and the NUF wellfield. This section provides background information about the USGS regional groundwater model of the Lower Cape Cod aquifer (Masterson, 2004), and the subsequent groundwater models of the NUF wellfield developed by McLane Environmental (2011; 2018; 2024) presented in **Table 1**.

Table 1. Groundwater Model Development Timeline

Model	Description	Source
USGS regional model	Regional USGS SEAWAT groundwater model of the Lower Cape Cod aquifer	(Masterson, 2011)
↓		
Apex NUF model (2011)	Model developed to support groundwater source permitting for two pumping wells at the NUF wellfield (NUF-TP-1; NUF-TP-2)	(McLane Environmental, 2011)
↓		
Apex NUF model (2018)	2011 model updated and recalibrated to fit observations collected during five years of well field operation	(McLane Environmental, 2018)
↓		
Apex NUF model (2024) *latest version*	2018 model updated to fit observations collected through 2023. Recalibration not warranted based on good data fit.	(McLane Environmental, 2024)
↓		
Truro model	Model developed by Stantec to evaluate new water supply source and septic treatment system for the Walsh Property	-

2.1 USGS Regional Groundwater Model of the Lower Cape Cod Aquifer

A numerical groundwater flow model was developed by the USGS to simulate freshwater and saltwater flow in the Lower Cape Cod aquifer, Massachusetts (Masterson, 2004). This model, herein referred to as the regional USGS model, is based on the USGS computer program SEAWAT (Guo and Langevin, 2002), which simulates variable-density, transient groundwater flow in three dimensions. The numerical model uses a finite-difference grid of 320 rows and 110 columns, with each cell measuring 400 ft per side. The model includes 23 layers, between 15 and 25 feet thick, from the water table in layer 1, to the freshwater-saltwater transition zone 500 ft below the National Geodetic Vertical Datum (NGVD) 29. The unconsolidated sand, gravel, silt, and clay sediments that make up the Lower Cape Cod aquifer system reach down to the bedrock; however, in most areas, the bedrock lies at a greater depth than the freshwater-saltwater interface. The lateral boundaries of the model are the coastal discharge areas that extend out into Cape Cod Bay and the Atlantic Ocean in the top three layers of the model.

2.2 Apex NUF Wellfield Groundwater Model

McLane Environmental developed a groundwater model to support groundwater source permitting for two new Provincetown public water supply wells (NUF-TP-1 and NUF-TP-2; **Figure 1**) and determine a Wellfield Safe Yield (McLane Environmental, 2011). The groundwater model was based on the regional USGS model (Masterson, 2004), described in **Section 2.1**. To reduce computing time, a smaller area of the regional USGS model, centered on the NUF well field, was extracted using Telescopic Mesh Refinement (TMR) techniques (McLane Environmental, 2011), and the model grid was refined in the vicinity of the NUF well field to provide better resolution of potential saltwater upconing around the NUF pumping wells. The model grid spacing ranged from 316 × 272 feet in the outer areas of the model, to 27

× 31 feet in the vicinity of the NUF production wells, with 107 rows and columns, for a total of 11,449 model cells covering approximately 30 square miles (**Figure 2**). Model input parameters (recharge, initial heads, initial concentrations, general head boundaries, constant head, and constant concentration) were essentially unchanged from the USGS model. Aquifer properties in the vicinity of the NUF well field (horizontal and vertical hydraulic conductivity, storativity, specific yield, layer thickness) were adjusted during model calibration to match pumping test results. The resulting groundwater model, herein referred to as the Apex NUF groundwater model, was capable of reporting calculated sodium and chloride levels in observation wells, and in the two public water supply wells as those concentrations changed over time in response to wellfield pumping.

The Apex NUF groundwater model was updated and recalibrated in 2018, then reviewed again in 2024, to fit observations at the wellfield between 2012 and 2023 (McLane Environmental, 2018, 2024). In 2018, the Apex NUF groundwater model was recalibrated to fit concentrations of sodium and chloride measured at the wellfield during the first five years of pumping (McLane Environmental, 2018). According to McLane Environmental, the calibrated model more accurately matched the observed data collected during the first five years of wellfield pumping, and reproduced salinity increases and saltwater upconing in deep observation wells. In 2024, the Apex NUF groundwater model was updated to include five additional years of wellfield observations. According to McLane Environmental, model recalibration in 2024 was not warranted because the 2018 model produced a reasonable match to observed sodium and chloride concentrations (McLane Environmental, 2024).

Average pumping rates from the two production wells (NUF-TP-1 and NUF-TP-2) simulated in the latest Apex NUF groundwater model are presented in **Table 2**. Pumping rates are grouped by summer (May through October) and winter (November through April) rates, to account for seasonal variations that result from increased water demand in the summer. Beginning in 2019, production well NUF-TP-2 was pumped at a higher rate than NUF-TP-1 to balance sodium and chloride concentrations produced at the wellfield (McLane Environmental, 2018; 2024). Approximately 36% of total wellfield pumping is from NUF-TP-1, and approximately 64% is from NUF-TP-2.

Table 2. Average Production Well Pumping Rates used in Apex NUF Model

Production Well[1]	Avg. Pumping Rate (gpd)			Avg. Pumping Rate (gpm)		
	Annual	Winter[2]	Summer[2]	Annual	Winter[2]	Summer[2]
NUF-TP-1	99,808	65,951	133,665	69	46	93
NUF-TP-2	177,638	120,008	235,268	123	83	163

<u>Notes and Acronyms:</u>
[1] Production well NUF-TP-2 is pumped at a higher rate than NUF-TP-1 in an effort to balance sodium and chloride concentrations produced at the wellfield. This recommended shift in pumping was implemented in 2019, with approximately 35% of total wellfield pumping at NUF-TP-1 and 65% of total wellfield pumping at NUF-TP-2 (McLane Environmental, 2024)
[2] Pumping rates grouped for winter (November through April) and summer (May through October) to account for seasonal variations that result from increased water demand in the summer.
avg. - average
gpd – gallons per day
gpm – gallons per minute

Stantec used the latest version of the Apex NUF wellfield groundwater model, updated in 2024, to develop the groundwater model for the Walsh Property, herein referred to as the Truro model (**Table 1**).

3 Walsh Property Groundwater Model Development

Stantec modified the Apex NUF groundwater model to assess potential effects of adding a groundwater pumping well and related effluent recharge station to support the development of a public water supply for the Walsh Property. The evaluated pumping well location (Walsh-SE) was assigned to the center of a parcel along the southeast side of the Walsh Property, (see **Figure 1** inset map). The assessed Walsh-SE well location is 1,328 feet south-southeast from NUF-TP-1, and 1,238 feet south-southeast from NUF-TP-2. The assessed effluent recharge drain field design was provided by GHD, another consultant who is working with the Town to further develop this conceptual design. The drain field consists of four 65 square foot (ft²) sand beds in the southwest corner of the 9 Great Hollow Road parcel, with one sand bed not used, for a total of 12,675 ft² of recharge drain field area (**Figure 1**). The assessed effluent recharge station is 0.8 miles southwest of the NUF wellfield. This drainfield design work by GHD is in the concept level at the time of this memorandum. The information was provided by GHD for incorporation into Stantec's work on the water supply well feasibility.

The existing Apex NUF model grid was refined to add resolution to the area around the assessed pumping well location (Walsh-SE), and 9 Great Hollow Road effluent recharge drain field (**Figure 3**). Model grid spacing was refined to 28 ft × 28 ft in the model cell containing the Walsh-SE pumping well and increases outwards until the model cells reached 272 ft × 316 ft in size, which corresponds with the maximum cell size used in the Apex NUF model. The grid spacing was adjusted to ensure that the size difference between adjacent cells did not exceed 150%. In the vicinity of the 9 Great Hollow Road effluent recharge drain field, model grid spacing was refined to 26 ft × 31 ft in the northwest corner of the drain field and increases outwards until the model cells reached 272 ft × 316 ft in size. The refined model grid covers the same area as the original Apex NUF model (approximately 30 miles²), with a total of 120 rows,124 columns, and 14,880 model cells.

No additional hydrogeologic data for the area was collected; therefore, model input parameters were unchanged from the Apex NUF model, including initial conditions, boundary conditions, and hydraulic properties. Apart from grid refinement, the main differences between the Apex NUF model and the updated groundwater model, referred to as the Truro model in this report, are as follows:

- The potential Walsh-SE pumping well location was added as a Boundary Condition using the MODFLOW Well Package to model cell row 82, column 82 in layer 4, matching the NUF wellfield setup. The average annual pumping rate at Walsh-SE was modeled at 10,000 gpd, 30,000 gpd, and 45,000 gpd to analyze the effects of increasing water usage as development approaches full buildout (45,000 gpd). To reflect seasonal changes in water demand, transient pumping rates from one of the NUF wellfield production wells (NUF-TP-2) (**Table 2**) were multiplied by a scalar, depending on the desired average annual pumping rate (10,000 gpd, 30,000 gpd, or 45,000 gpd) at Walsh-SE. Seasonal pumping rates at Walsh-SE, compared to the NUF wellfield production wells, are presented in **Table 3**. The groundwater withdrawal rate from the NUF wellfield is 6-to-28 times larger than the pumping rates evaluated at Walsh-SE.

- The potential 9 Great Hollow Road effluent recharge drain field was added as a new recharge zone (zone 6) to nine model cells in layer 1 using the MODFLOW Recharge (RCH) package. The area of the model recharge cells was 12,961 ft^2, a 2% areal difference between the 12,675 ft^2 of recharge drain field created by the three 65 × 65 ft^2 sand beds. The effluent recharge rate was modeled at 60,000 gpd and 100,000 gpd, to analyze increasing effluent recharge as development approaches full buildout. The desired effluent recharge rate, (60,000 gpd or 100,000 gpd) was divided by the model grid cell area (12,961 ft^2), to determine the recharge rate for the drainfield. To account for natural recharge from precipitation, the original overall aquifer (zone 1) recharge rate (0.004932 ft/day), was added to the drainfield recharge. The overall recharge concentration (0.003745678 pounds per cubic foot [lbs/ft^3]) was applied to the new drainfield recharge cells.

Table 3. Average Production Well Pumping Rates used in Truro Model

Production Well[1]	Avg. Pumping Rate (gpd)			Avg. Pumping Rate (gpm)		
	Annual	Winter[2]	Summer[2]	Annual	Winter[2]	Summer[2]
NUF-TP-1	99,808	65,951	133,665	69	46	93
NUF-TP-2	177,638	120,008	235,268	123	83	163
Walsh-SE	10,000	6,756	13,244	7	5	9
	30,000	20,267	39,733	21	14	28
	45,000	30,401	59,599	31	21	41

Notes and Acronyms:
[1] Production well NUF-TP-2 is pumped at a higher rate than NUF-TP-1 in an effort to balance sodium and chloride concentrations produced at the wellfield. This recommended shift in pumping was implemented in 2019, with approximately 35% of total wellfield pumping at NUF-TP-1 and 65% of total wellfield pumping at NUF-TP-2 (McLane Environmental, 2024)
[2] Pumping rates grouped for winter (November through April) and summer (May through October) to account for seasonal variations that result from increased water demand in the summer.
avg. - average
gpd – gallons per day
gpm – gallons per minute

Five model predictive scenarios using the Truro model were evaluated to assess potential effects of adding a groundwater pumping well and effluent recharge station to develop a public water supply for the Walsh Property, as summarized in **Table 4**. The range of pumping rates (10,000 gpd – 45,000 gpd) and effluent recharge rates (60,000 gpd – 100,000 gpd) was chosen to evaluate the effects of increasing water usage as development approaches full buildout. Each model simulation was run for a duration of 100 years, with six-month stress periods to account for seasonal variations in pumping rates (**Table 3**).

Table 4 Model Runs

Model Run	Walsh-SE Avg. Pumping Rate		9 Great Hollow Road Avg. Effluent Recharge Rate	
	gpd	gpm	gpd	gpm
01	30,000	20.8	60,000	41.7
02	30,000	20.8	100,000	69.4
03	45,000	31.3	100,000	69.4
04	10,000	6.9	60,000	41.7
05	45,000	31.3	60,000	41.7

Notes and Acronyms:
avg. - average
gpd – gallons per day
gpm – gallons per minute

Model outputs were post-processed to convert model output concentrations of total dissolved solids (TDS) into concentrations of sodium and chloride, following the methodology used in the Apex NUF model (McLane Environmental, 2018). The initial fresh water TDS concentration of 0.0037 lbs/ft^3 was used to estimate conversion ratios for TDS to sodium and chloride corresponding to 31 mg/L chloride and 15 mg/L sodium according to McLane (2018). TDS concentrations were converted to sodium and chloride using **Equation 1** and **Equation 2** below where the concentrations of sodium, chloride, and TDS (C_{Sodium}, $C_{Chloride}$, and C_{TDS}) are in units of milligrams per liter (mg/L). Predicted sodium, chloride, and TDS concentrations were compared to Massachusetts Department of Environmental Protection (Mass. DEP) drinking water standards (MassDEP, 2020) - 20 mg/L, 250 mg/L, and 500 mg/L respectively.

Equation 1

$$C_{Sodium} = C_{TDS} \times 0.2531$$

Equation 2

$$C_{Chloride} = C_{TDS} \times 0.5230$$

To evaluate the potential impact area of effluent recharge from the 9 Great Hollow Road drain field, particle tracking was performed using MODPATH (Pollock, 1994). MODPATH uses model output heads and flow budget information from the SEAWAT simulation to calculate advective particle pathlines. One particle was assigned to the top of the water table in layer 1 in each of the nine model cells used to represent effluent recharge, and its progression was tracked for 100 years to calculate the location and travel time of these particles over the duration of the simulation.

To determine the capture zone of the potential Walsh-SE pumping well, additional model runs were performed to simulate conditions under a prescribed 180-day drought period (no recharge). One particle was placed in each model cell at the top of the water table in layer 1 and tracked for 100 years until the particles stopped at a model boundary (e.g. a groundwater divide or coastal discharge location) or were extracted at a pumping well. This method was used, rather than reverse particle tracking, to be consistent with methods used in the Apex NUF groundwater model (McLane Environmental, 2011). The zone of capture was evaluated for each of the three modeled average pumping rates from the Walsh-SE well: 10,000 gpd, 30,000 gpd, and 45,000 gpd.

4 Model Results

This section presents model results from each of the five model predictive scenarios, as compared to the Apex NUF groundwater model. Predicted drawdown at the pumping wells is presented in **Section 4.1**, summarized in **Table 5**, and shown as a time series in **Figure 4**. Predicted TDS, sodium, and chloride results are presented in **Section 4.2**. Predicted TDS concentrations are summarized in **Table 6** and **Figure 5**. Predicted sodium and chloride concentrations are summarized in **Table 7** and **Table 8,** respectively, and shown as time series in **Figure 6** and **Figure 7,** respectively. Particle tracking to assess the potential impact area of the effluent recharge drains is presented in **Section 4.3** and shown in **Figure 8**. The modeled capture zones for the Walsh-SE well are shown in **Figure 9**.

4.1 Predicted Groundwater Drawdown

Groundwater drawdown predicted in each of the five modeled scenarios was similar to the Apex NUF model and suggested that the addition of a pumping well on the Walsh Property would have minimal impacts on drawdown or flow at the NUF wellfield. With the addition of the Walsh-SE pumping well, maximum drawdowns at the NUF wellfield only increased 1.8% (from 4.52 ft to 4.60 ft drawdown) at NUF-TP-2, and 1.7% (from 4.13 ft to 4.20 ft drawdown) at NUF-TP-1 in the highest pumping scenario (-45,000 gpd from Walsh-SE) (**Table 5**).

In the lowest pumping scenario (-10,000 gpd from Walsh-SE), the observed drawdown at the NUF wellfield was negligible. Maximum groundwater drawdown predicted at the Walsh-SE well (1.02 – 1.88 ft) was less than the predicted drawdowns at the NUF well field (4.13 – 4.60 ft) (**Figure 4**). Higher groundwater drawdown is expected at the NUF wellfield, relative to Walsh-SE, because groundwater withdrawal rates are six to 28 times larger than those modeled at Walsh-SE (**Table 3**).

Table 5. Predicted Drawdown in Pumping Wells

Model Scenario[1]	Max. Predicted Drawdown (ft)			Avg. Predicted Drawdown (ft)					
				Year 0 - 100[3]			Year 90 - 100[3]		
	Walsh-SE	NUF-TP-1	NUF-TP-2	Walsh-SE	NUF-TP-1	NUF-TP-2	Walsh-SE	NUF-TP-1	NUF-TP-2
Apex NUF[2]	-	4.13	4.52		2.49	3.19	-	2.50	3.24
01	1.51	4.17	4.57	1.12	2.54	3.23	1.14	2.55	3.28
02	1.51	4.17	4.57	1.12	2.54	3.23	1.14	2.55	3.28
03	1.88	4.20	4.60	1.37	2.57	3.26	1.40	2.57	3.31
04	1.02	4.13	4.52	0.78	2.50	3.19	0.79	2.51	3.24
05	1.88	4.20	4.60	1.37	2.57	3.26	1.40	2.57	3.31

Notes and Acronyms:
[1]See **Table 4** for a description of model runs, pumping rates, and effluent recharge rates
[2]Source: (McLane Environmental, 2024)
[3]Table presents results averaged over the entire duration of the predictive model (year 0 to 100) and at the end of the predictive model (year 90 to 100)
avg. - average
ft – feet
max - maximum

4.2 Predicted TDS, Sodium, and Chloride Concentrations

TDS, sodium, and chloride concentrations predicted by each of the five model runs indicate a slight increase in salinity and saltwater upconing at the NUF wellfield, in response to groundwater pumping at the Walsh-SE well. Compared to the Apex NUF groundwater model, maximum TDS, sodium, and chloride concentrations in NUF-TP-2 at the end of the 100 year simulation period increased between 3.6% in the lowest pumping scenario (-10,000 gpd from Walsh-SE), 13% in the moderate pumping scenario (-30,000 gpd from Walsh-SE), to 20% in the highest pumping scenario (-45,000 gpd from Walsh-SE) (**Table 6**, **Table 7**, **Table 8**). However, TDS, sodium, and chloride concentrations remained relatively unchanged at NUF-TP-1. This is likely due to higher pumping rates at NUF-TP-2, which is pumped at nearly double the rate of NUF-TP-1 (McLane Environmental, 2018; 2024), and the proximity of NUF-TP-2 to Walsh-SE. None of the maximum predicted TDS or chloride concentrations at the NUF wellfield, or Walsh-SE pumping well location exceed MassDEP drinking water standards (500 mg/L for TDS; 250 mg/L for chloride), see **Figure 5** and **Figure 7** respectively (MassDEP, 2020; 310 CMR 22.07D). Similar to the results of the Apex NUF model predictions, concentrations of sodium exceed the MassDEP drinking water limit of 20 mg/L after 20 years of pumping at the NUF wellfield (**Figure 6**). It should be noted that the MassDEP recommended limit of 20 mg/L is based on the US FDA classification of "virtually sodium free" which is 5 mg of sodium per 8-ounce serving (MassDEP, 1994). The U.S. EPA recommends sodium concentrations between 30 mg/L and 60 mg/L based on taste (U.S. EPA, 2003), and the U.S. FDA classifies "very low sodium" as 35 mg of sodium per 8-ounce serving which equates to 197 mg/L (U.S. FDA, 2018) – a much higher concentration than either NUF-1 or NUF-2 is predicted to reach in 100 years of operation.

Concentrations of TDS, sodium, and chloride predicted at the Walsh-SE pumping well were lower than those predicted at the NUF wellfield. The maximum TDS concentration predicted at the Walsh-SE well was 59.8 mg/L (**Table 6**), with a corresponding sodium concentration of 15.1 mg/L (**Table 7**), and chloride concentration of 31.3 mg/L (**Table 8**). These concentrations are similar to modeled freshwater concentrations used in the Apex NUF model (McLane Environmental, 2018) and indicate very little saltwater upconing at the assessed Walsh-SE pumping well after 100 years of pumping.

Table 6. Predicted TDS Concentration in Pumping Wells

Model Scenario[1]	Max. Predicted TDS Concentration (mg/L)			Avg. Predicted TDS Concentration (mg/L)					
				Year 0 - 100[3]			Year 90 - 100[3]		
	Walsh-SE	NUF-TP-1	NUF-TP-2	Walsh-SE	NUF-TP-1	NUF-TP-2	Walsh-SE	NUF-TP-1	NUF-TP-2
Apex NUF[2]	-	158.72	144.59	-	115.41	102.98	-	150.70	134.93
01	59.82	158.15	164.77	59.74	113.29	112.49	59.76	149.75	153.22
02	59.82	158.14	164.76	59.74	113.28	112.48	59.76	149.74	153.21
03	59.82	157.35	176.10	59.78	112.20	118.14	59.81	148.86	163.28
04	59.81	159.78	149.95	59.64	115.24	105.07	59.64	151.81	140.08
05	59.82	157.36	176.11	59.78	112.20	118.14	59.81	148.87	163.29

Notes and Acronyms:
[1]See **Table 4** for a description of model runs, pumping rates, and effluent recharge rates
[2]Source: (McLane Environmental, 2024)
[3]Table presents results averaged over the entire duration of the predictive model (year 0 to 100) and at the end of the predictive model (year 90 to 100)
avg. - average
max – maximum
mg/L – milligrams per Liter
TDS – total dissolved solids

Table 7. Predicted Sodium Concentration in Pumping Wells

Model Scenario[1]	Max. Predicted Sodium Concentration (mg/L)			Avg. Predicted Sodium Concentration (mg/L)					
				Year 0 - 100[3]			Year 90 - 100[3]		
	Walsh-SE	NUF-TP-1	NUF-TP-2	Walsh-SE	NUF-TP-1	NUF-TP-2	Walsh-SE	NUF-TP-1	NUF-TP-2
Apex NUF[2]	-	40.17	36.59	-	29.21	26.06	-	38.14	34.15
01	15.14	40.02	41.70	15.12	28.67	28.47	15.13	37.90	38.78
02	15.14	40.02	41.70	15.12	28.67	28.47	15.13	37.90	38.78
03	15.14	39.82	44.57	15.13	28.40	29.90	15.14	37.68	41.33
04	15.14	40.44	37.95	15.09	29.17	26.59	15.09	38.42	35.45
05	15.14	39.83	44.57	15.13	28.40	29.90	15.14	37.68	41.33

Notes and Acronyms:
[1]See **Table 4** for a description of model runs, pumping rates, and effluent recharge rates
[2]Source: (McLane Environmental, 2024) [3]Table presents results averaged over the entire duration of the predictive model (year 0 to 100) and at the end of the predictive model (year 90 to 100)
avg. - average
mg/L – milligrams per Liter

Table 8. Predicted Chloride Concentration in Pumping Wells

Model Scenario[1]	Max. Predicted Chloride Concentration (mg/L)			Avg. Predicted Chloride Concentration (mg/L)					
				Year 0 - 100[3]			Year 90 - 100[3]		
	Walsh-SE	NUF-TP-1	NUF-TP-2	Walsh-SE	NUF-TP-1	NUF-TP-2	Walsh-SE	NUF-TP-1	NUF-TP-2
Apex NUF[2]	-	83.02	75.63	-	60.36	53.86	-	78.82	70.57
01	31.29	82.72	86.18	31.25	59.25	58.84	31.26	78.32	80.14
02	31.29	82.72	86.18	31.25	59.25	58.83	31.26	78.32	80.14
03	31.29	82.30	92.11	31.27	58.69	61.79	31.28	77.86	85.41
04	31.28	83.57	78.43	31.19	60.28	54.95	31.20	79.40	73.27
05	31.29	82.31	92.11	31.27	58.69	61.79	31.28	77.86	85.41

Notes and Acronyms:
[1]See **Table 4** for a description of model runs, pumping rates, and effluent recharge rates
[2]Source: (McLane Environmental, 2024)
[3]Table presents results averaged over the entire duration of the predictive model (year 0 to 100) and at the end of the predictive model (year 90 to 100)
avg. - average
max – maximum
mg/L – milligrams per Liter

4.3 Particle Tracking Results

Based on the modeled groundwater flow direction and particle tracking results, modeled recharge from the effluent recharge drain field at the 9 Great Hollow Road parcel is predicted to flow west-southwest from the point of discharge towards Cape Cod Bay (**Figure 8**). The anticipated travel time from the point of discharge to Cape Cod Bay ranges between approximately 6 and 18 years. The results of particle tracking indicate that capture of drainfield discharge by the Walsh-SE pumping well, or the NUF wellfield, is not likely.

Modeled capture zones for each of the modeled average pumping rates at the Walsh-SE well (10,000 gpd, 30,000 gpd, and 45,000 gpd) are presented in **Figure 9**. The predicted zone of capture was smallest in modeling scenarios where Walsh-SE was pumped at an average rate of 10,000 gpd and largest in modeling scenarios where Walsh-SE was pumped at an average rate of 45,000 gpd (**Figure 9**). The zone of capture for Walsh-SE is smaller than the NUF wellfield capture area predicted by the Apex NUF model (McLane, 2011). This is likely due to higher pumping rates at the NUF wellfield; The combined modeled groundwater withdrawal rate from the NUF wellfield in the Apex NUF model is 28 times larger than the modeled Walsh-SE pumping rate of 10,000 gpd, and 6.2 times larger than the Walsh-SE pumping rate of 45,000 gpd.

5 Conclusions

On behalf of the Town of Truro, Massachusetts, Stantec modified the existing groundwater model for the NUF wellfield developed by McLane Environmental (2011; 2018; 2024) to assess potential effects of adding a groundwater pumping well to develop a public water supply for the Walsh Property. A potential pumping well (Walsh-SE) was located at the center of a parcel on the southeast side of the Walsh Property, approximately 1300 feet south-southeast of the NUF well field. Average modeled pumping rates from the Walsh-SE well were evaluated between 10,000 gpd and 45,000 gpd. A potential effluent recharge station included three 65 × 65 ft recharge sand beds in the southwest corner of the 9 Great Hollow Road parcel, located approximately 0.8 miles southwest of the NUF well field. Modeled effluent recharge rates were between 60,000 and 100,000 gpd. The location, design and rates for the effluent recharge were provided by GHD, another consultant working with the Town of Truro on the wastewater related aspects of the Walsh Property. This analysis is in the preliminary conceptual phase. Five model predictive scenarios incorporating different pumping and effluent recharge rates were run for a period of 100 years each to evaluate potential effects on drawdown and water quality at the NUF wellfield.

Model results suggested that the addition of the Walsh-SE well would have minimal impacts on drawdown or flow at the NUF wellfield (< 2% increase in maximum drawdown) while slightly increased salinity and saltwater upconing was predicted at the NUF-TP-2 well. Compared to the Apex NUF groundwater model, maximum TDS, sodium, and chloride concentrations at NUF-TP-2 increased 3.6%, 13%, and 20% when the pumping rate at the Walsh-SE well was set to 10,000 gpd, 30,000 gpd, and 45,000 gpd, respectively, at the end of the 100-year simulation period. Pumping well NUF-TP-2 is pumped at nearly double the rate of NUF-TP-1, and is also closer to Walsh-SE, which may explain why salinity at NUF-TP-1 was relatively unchanged in response to pumping at the Walsh-SE well. The maximum sodium and chloride concentrations predicted at the Walsh-SE well were 15.1 mg/L and 31.3 mg/L respectively, which is similar to the freshwater values and indicates little-to-no upconing at the Walsh-SE well. The maximum predicted drawdown at the Walsh-SE well was between 1 foot for the minimum pumping scenario (10,000 gpd), and 1.9 feet for the maximum pumping scenario (45,000 gpd).

Particle tracking results indicate that modeled discharge from the effluent recharge drain field at 9 Great Hollow Road is expected to migrate to the west-southwest toward Cape Cod Bay with an estimated travel time ranging from 6 to 18 years. Particle tracking indicates that capture by the Walsh-SE pumping well or NUF wellfield is unlikely. The predicted capture zone for the Walsh-SE well was much smaller than the NUF wellfield, likely due to lower pumping rates. The size of the capture zone increased in modeled scenarios when the average pumping rate at Walsh-SE was 45,000 gpd, instead of 30,000 gpd or 10,000 gpd.

6 References

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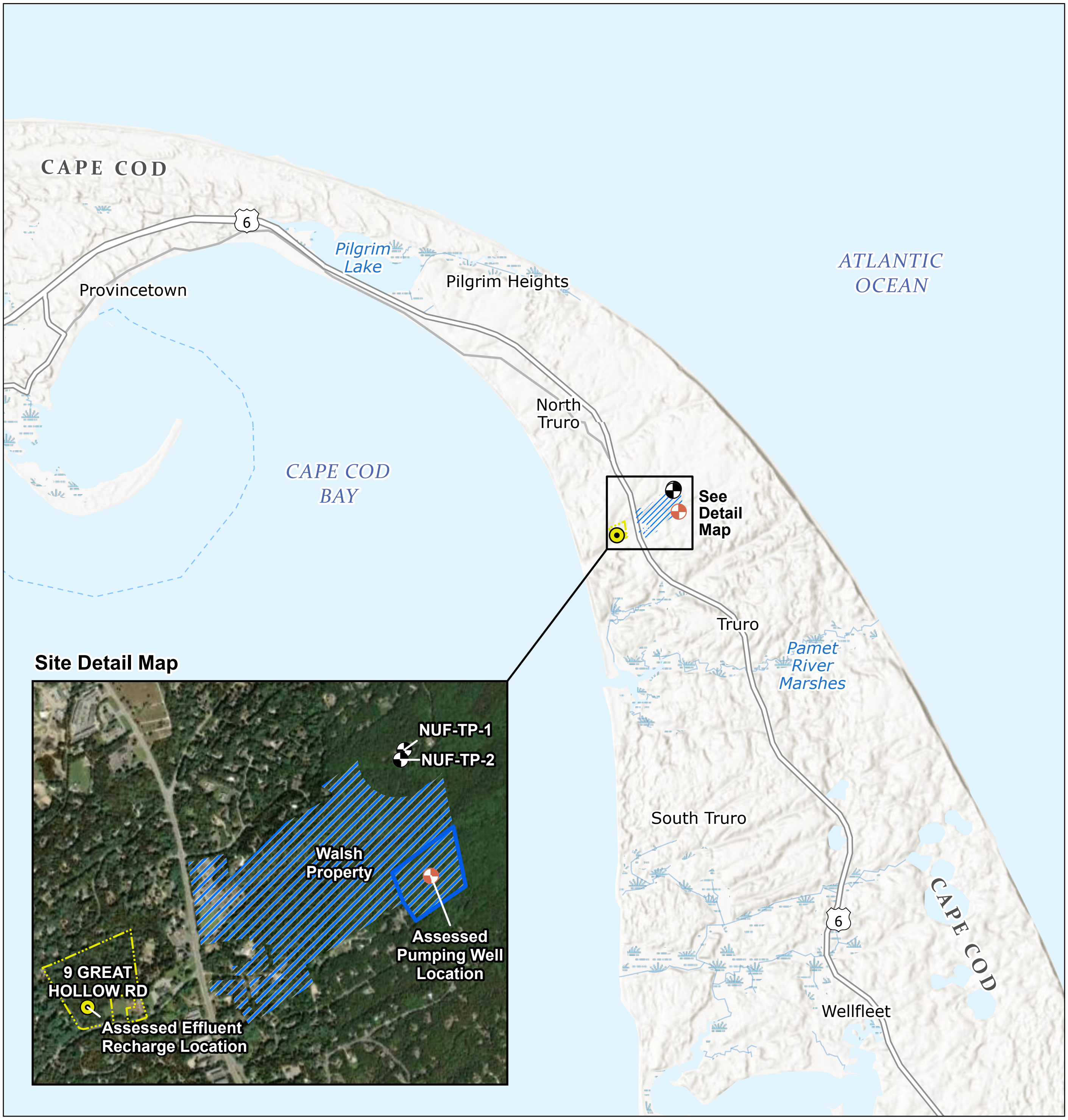
Figures



Legend

- North Union Field (NUF) Wells
- Assessed Pumping Well Location
- Assessed Effluent Recharge Location
- Assessed Effluent Recharge Parcel
- Walsh Property
- Walsh Property - Zero Quail Road Parcel

0 0.5 1 1.5 2 Miles

(At original document size of 8.5 x 11) 1:100,000

N

Stantec

Project Location
Truro
Barnstable County, MA

Prepared by NS on 9/26/2025
TR by RR on 9/26/2025
IR Review by CC on 9/26/2025

Client/Project
Client: Town of Truro
Project: 195151014 - Truro

Figure No.
1

DRAFT

Title
Site Overview Map

Notes
1. Coordinate System: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001
2. Data Sources: NUF Wells (McLane Environmental, 2011; 2018); Truro Parcel Data (MassGIS, 2025)
3. Background: World Terrain Base: Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS
World Terrain Base: Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS
World Hillshade: Esri, NASA, NGA, USGS, FEMA
World Imagery: Maxar
World Hillshade: Esri, USGS;

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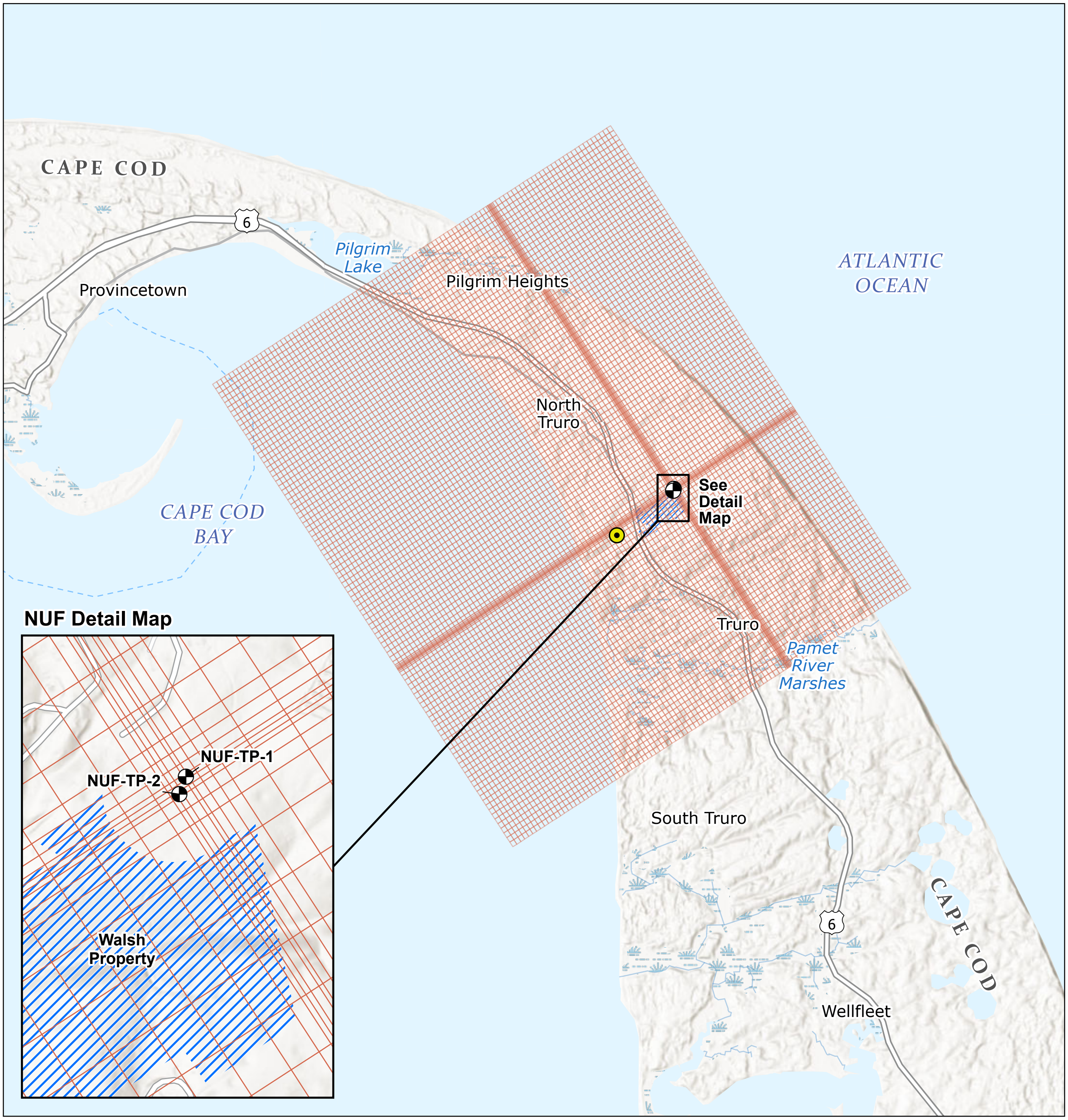

Legend

- North Union Field (NUF) Wells
- Walsh Property
- Apex NUF Groundwater Model Grid and Extent

0 0.5 1 1.5 2 Miles

(At original document size of 8.5 x 11) 1:100,000

N

Stantec

Project Location
Truro
Barnstable County, MA

Prepared by NS on 9/26/2025
TR by RR on 9/26/2025
IR Review by CC on 9/26/2025

Client/Project
Client: Town of Truro
Project: 195151014 - Truro

Figure No.
2

DRAFT

Title
Apex NUF Groundwater Model Extent

Notes
1. Coordinate System: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001
2. Data Sources: NUF Wells (McLane Environmental, 2011; 2018); Truro Parcel Data (MassGIS, 2025)
3. Background: World Terrain Base: Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS
World Terrain Base: Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS
World Hillshade: Esri, NASA, NGA, USGS, FEMA
World Terrain Base: Esri Community Maps Contributors, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS
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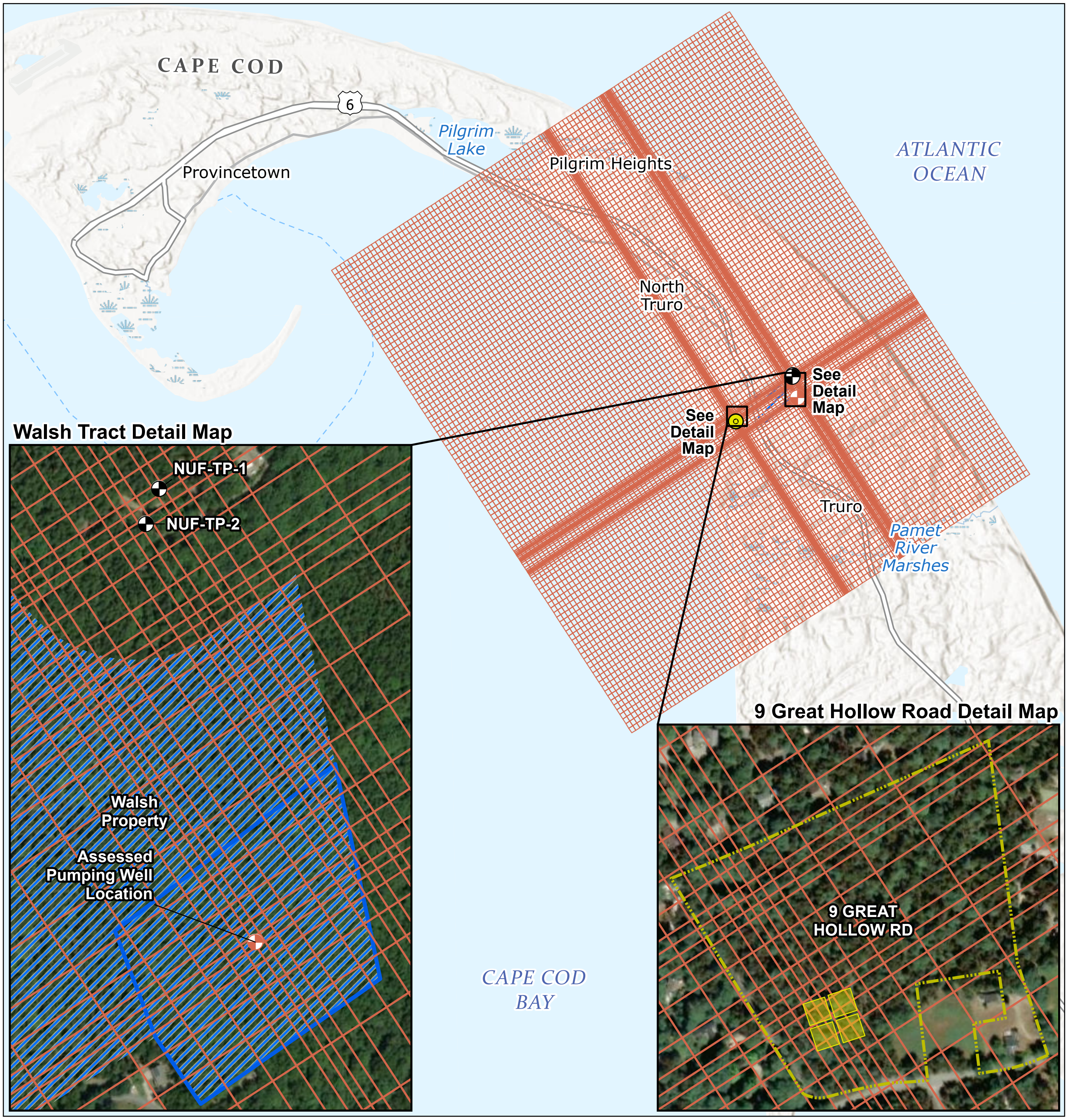

Legend

- North Union Field (NUF) Wells
- Assessed Pumping Well Location
- Assessed Effluent Recharge Location
- Assessed Effluent Recharge Area
- Assessed Effluent Recharge Parcel
- Stantec Groundwater Model Grid
- Walsh Property
- Walsh Property - Zero Quail Road Parcel

0 0.5 1 1.5 2 Miles

(At original document size of 8.5 x 11) 1:100,000

N

Stantec

Project Location
Truro
Barnstable County, MA

Prepared by NS on 9/26/2025
TR by RR on 9/26/2025
IR Review by CC on 9/26/2025

Client/Project
Client: Town of Truro
Project: 195151014 - Truro

Figure No.
3

DRAFT

Title
Groundwater Model Grid and Extent

Notes
1. Coordinate System: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001
2. Data Sources: NUF Wells (McLane Environmental, 2011; 2018); Truro Parcel Data (MassGIS, 2025)
3. Background: World Terrain Base: Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS
World Terrain Base: Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS
World Imagery: Maxar
World Hillshade: Esri, NASA, NGA, USGS
World Hillshade: Esri, USGS;

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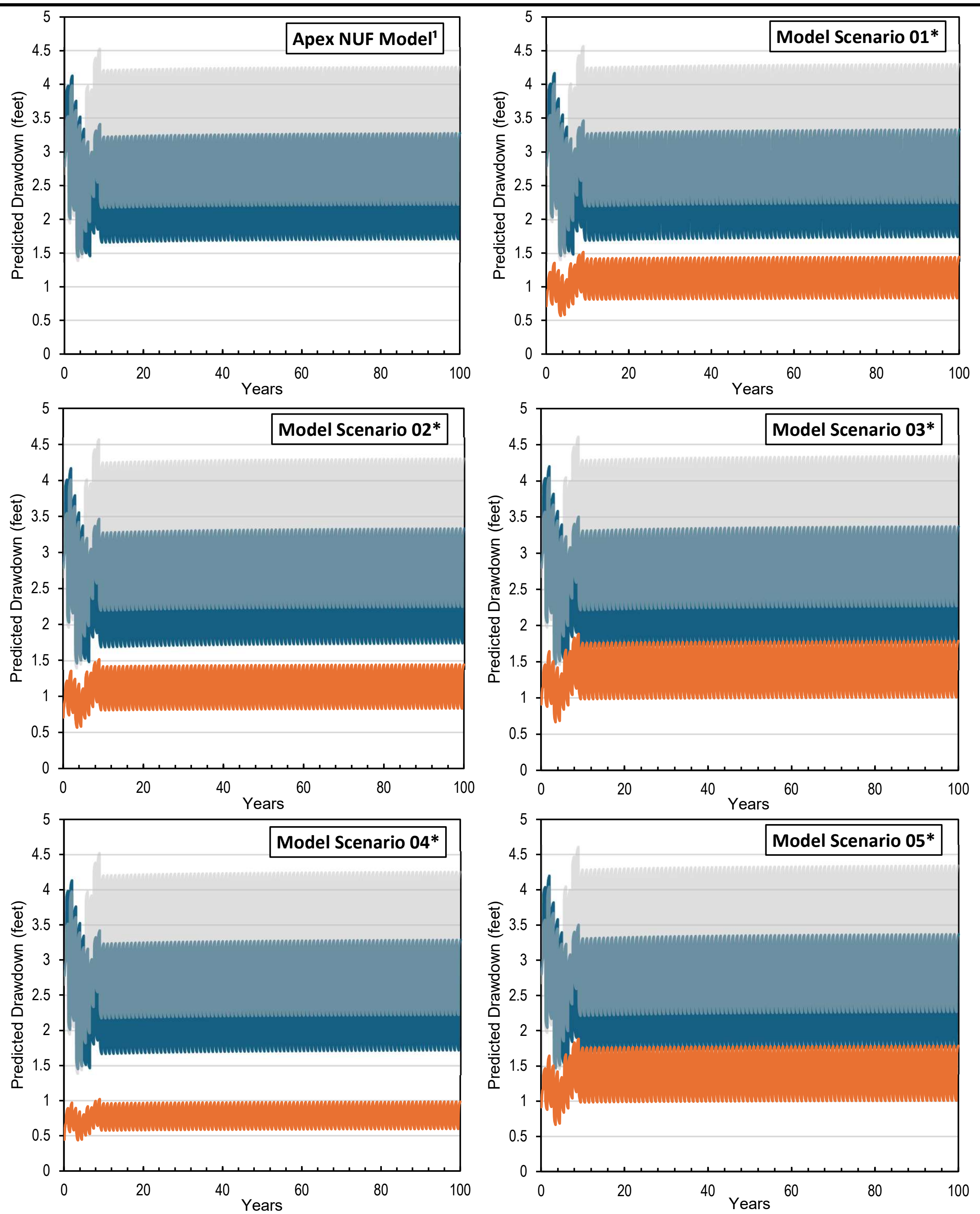


Legend

- NUF-TP1
- NUF-TP2
- Walsh-SE

Notes

[1] Source: (McLane Environmental, 2024)

*Stantec Model Runs

Run	Walsh-SE Pump Rate (gpd)	Effluent Recharge Rate (gpd)
01	30,000	60,000
02	30,000	100,000
03	45,000	100,000
04	10,000	60,000
05	45,000	60,000

Acronyms

gpd - gallons per day

Stantec

Town of Truro

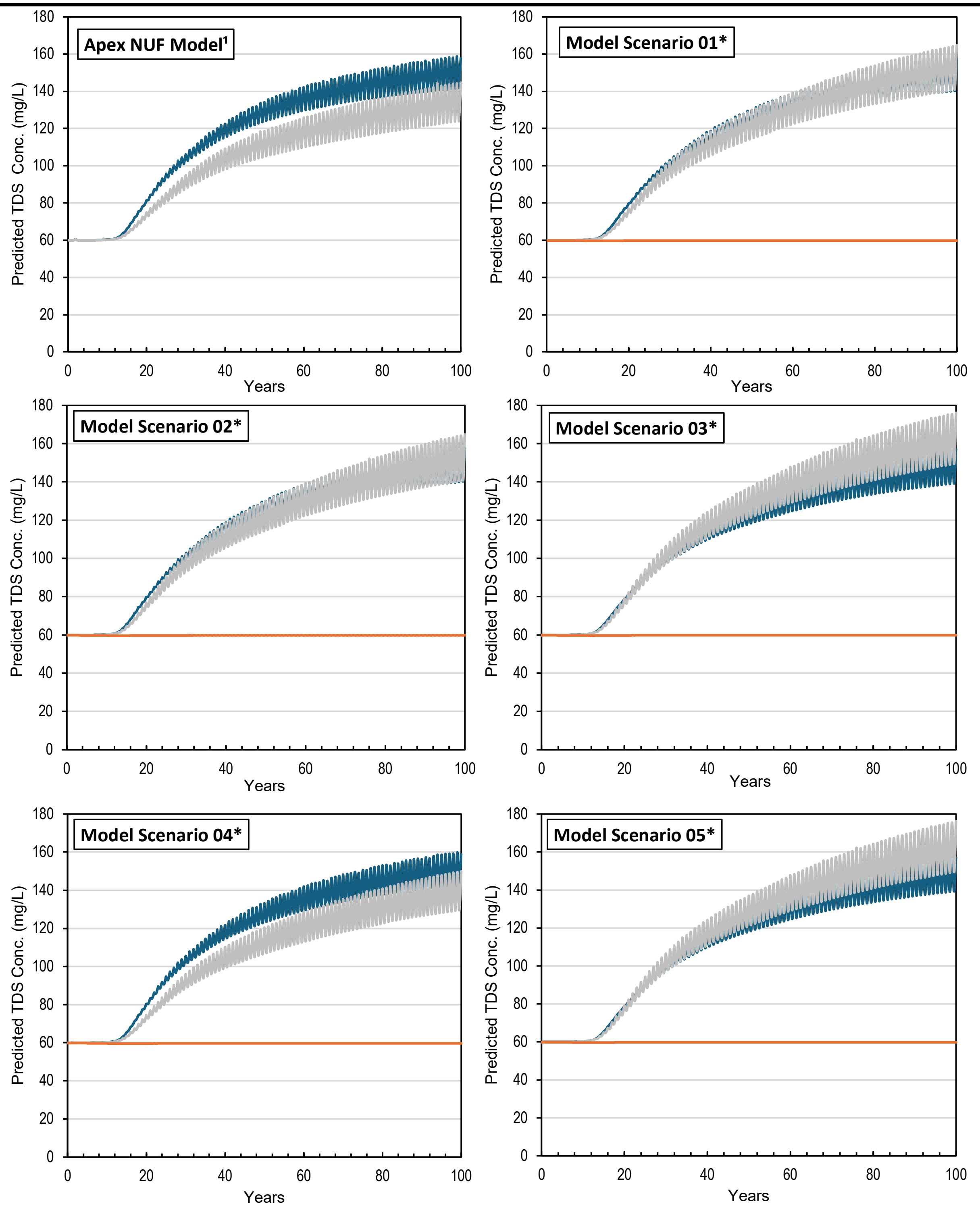
Walsh Property - Preliminary Hydrogeological Study

DRAWN BY: NS	PROJECT: Truro
1ST REVIEW:RR	PROJECT NO: 195151014
2ND REVIEW: CC	DATE: 09/26/2025

Figure 4

Predicted Drawdown at Pumping Wells

\\us0552-ppfss01\shared_projects\195151014\4_planning\Hydrogeological\02_Data\[Model_Results_Figs.xlsm]4



Legend

- NUF-TP1
- NUF-TP2
- Walsh-SE

Notes

[1] Source: (McLane Environmental, 2024)

[2]TDS limit (500 mg/L) not shown due to scale (MassDEP, 2020)

*Stantec Model Runs

Run	Walsh-SE Pump Rate (gpd)	Effluent Recharge Rate (gpd)
01	30,000	60,000
02	30,000	100,000
03	45,000	100,000
04	10,000	60,000
05	45,000	60,000

Acronyms

Conc. - concentration
gpd - gallons per day
mg/L - milligrams per Liter
TDS - total dissolved solids

Stantec

Town of Truro

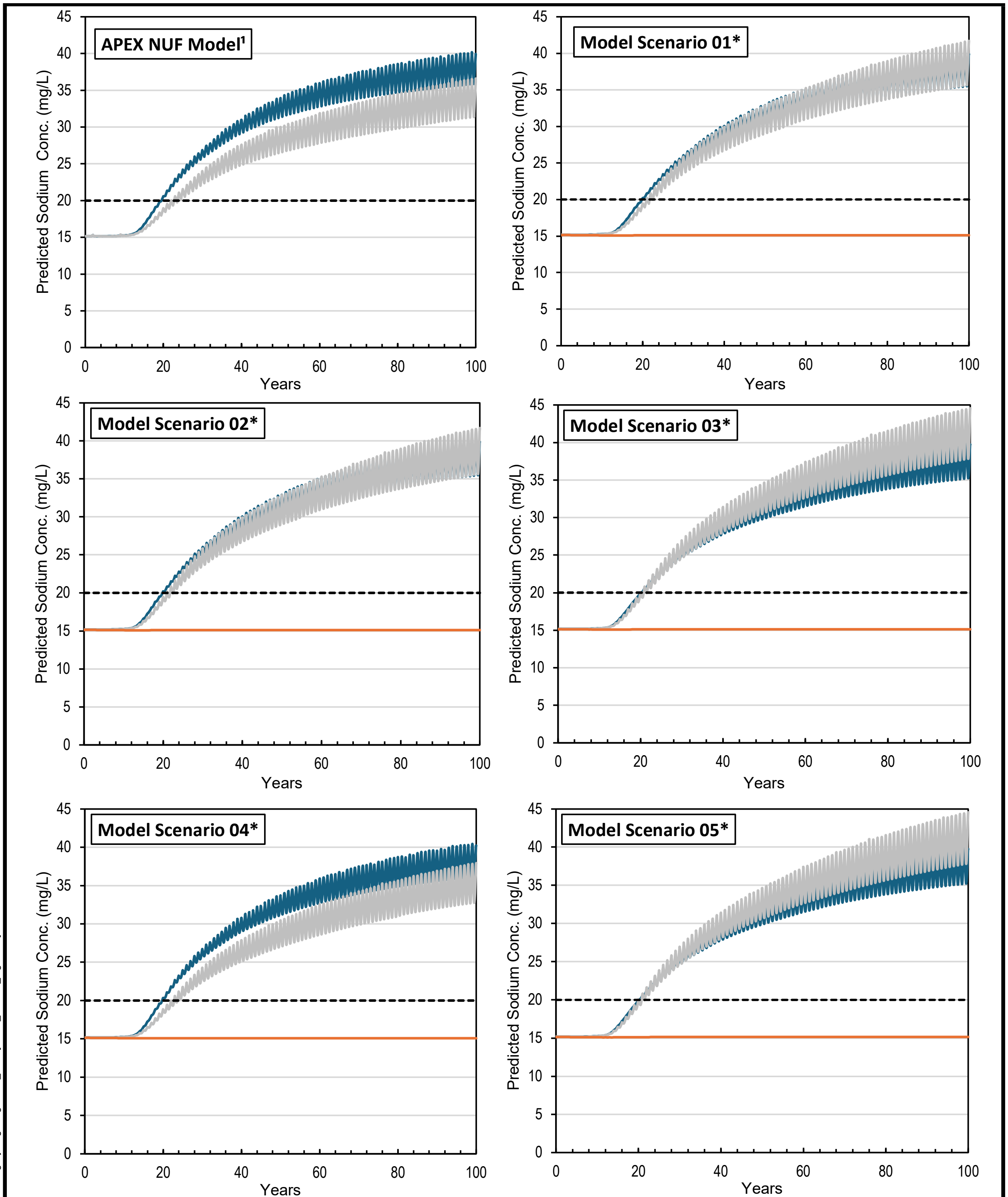
Walsh Property - Preliminary Hydrogeological Study

DRAWN BY: NS	PROJECT: Truro
1ST REVIEW:RR	PROJECT NO: 195151014
2ND REVIEW: CC	DATE: 09/26/2025

Figure 5

Predicted TDS Concentrations at Pumping Wells

\\us0552-ppfss01\shared_projects\195151014\4_planning\Hydrogeological\02_Data\Model_Results_Figs.xlsm]5



Legend

- NUF-TP1
- NUF-TP2
- Walsh-SE
- Mass DEP Sodium Limit²

Notes

¹ Source: (McLane Environmental, 2024)

*Run	Walsh-SE Pump Rate (gpd)	Effluent Recharge Rate (gpd)
01	30,000	60,000
02	30,000	100,000
03	45,000	100,000
04	10,000	60,000
05	45,000	60,000

² Source: (Mass DEP, 2020)

Acronyms

Conc. - concentration
gpd - gallons per day
Mass. DEP - Massachusetts Department of Environmental Protection
mg/L - milligrams per Liter

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Town of Truro

Walsh Property - Preliminary Hydrogeological Study

DRAWN BY: NS	PROJECT: Truro
1ST REVIEW:RR	PROJECT NO: 195151014
2ND REVIEW: CC	DATE: 09/26/2025

Figure 6

Predicted Sodium Concentrations at Pumping Wells

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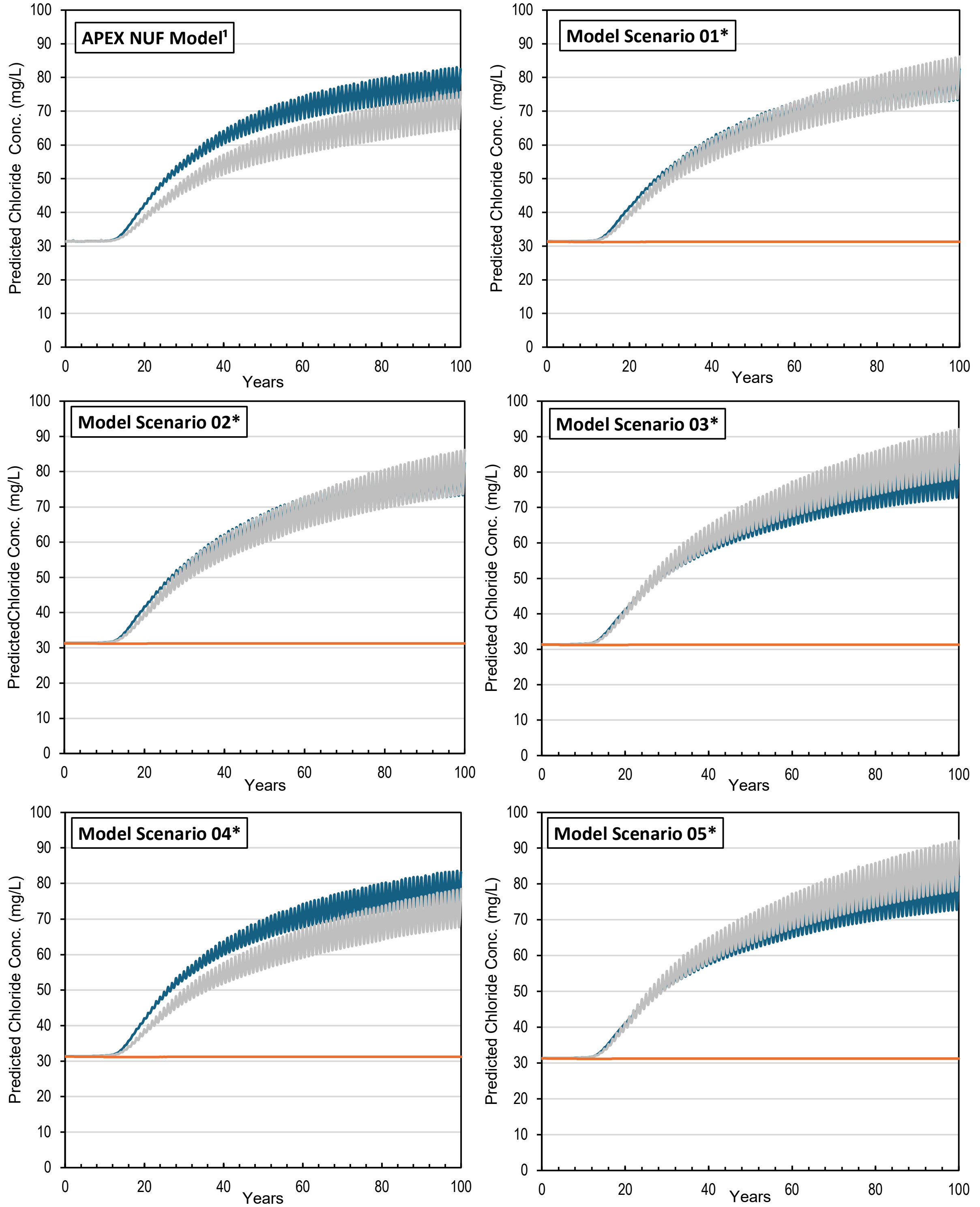

Legend

- NUF-TP1
- NUF-TP2
- Walsh-SE

Notes

[1] Source: (McLane Environmental, 2024)

[2] Chloride limit (250 mg/L) not shown on graphs due to scale (MassDEP, 2020)

Acronyms

Conc. - concentration

gpd - gallons per day

mg/L - milligrams per Liter

*Stantec Model Runs

Run	Walsh-SE Pump Rate (gpd)	Effluent Recharge Rate (gpd)
01	30,000	60,000
02	30,000	100,000
03	45,000	100,000
04	10,000	60,000
05	45,000	60,000

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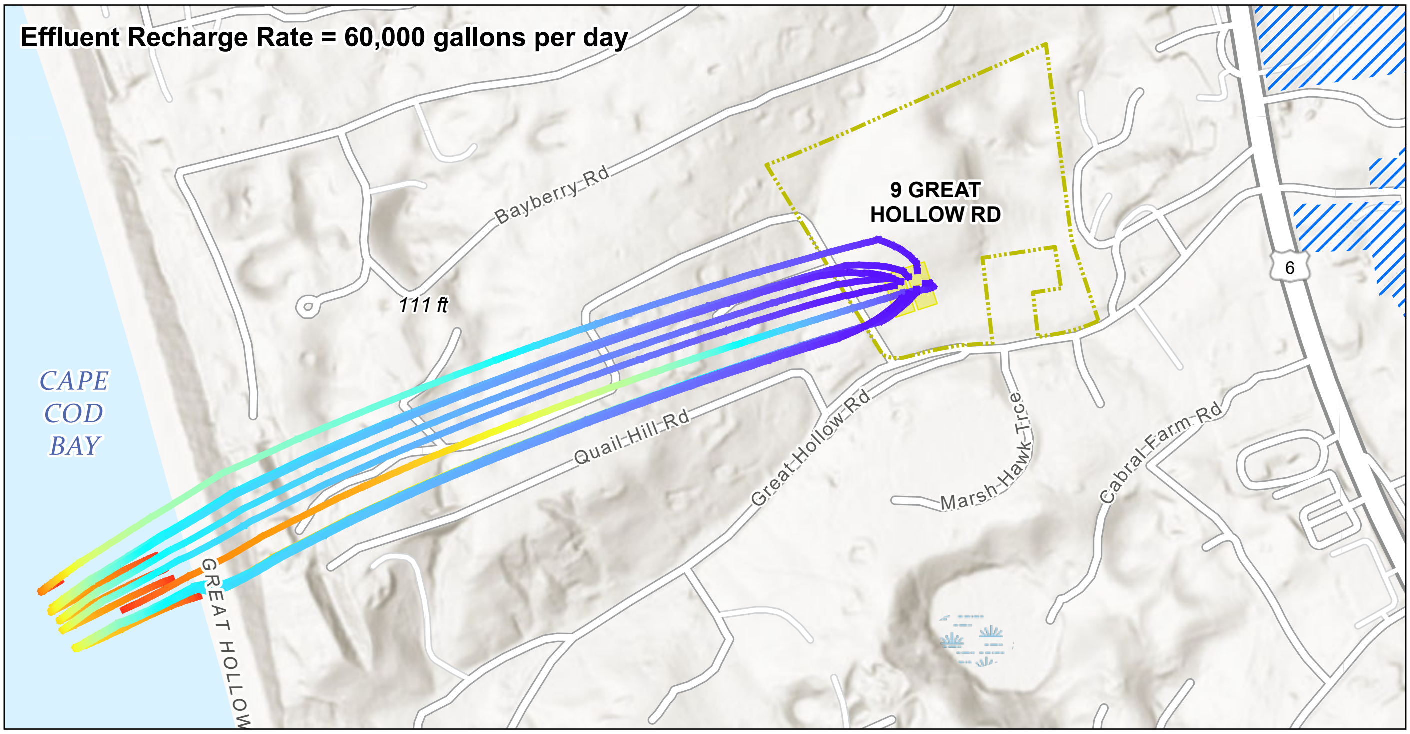
Town of Truro

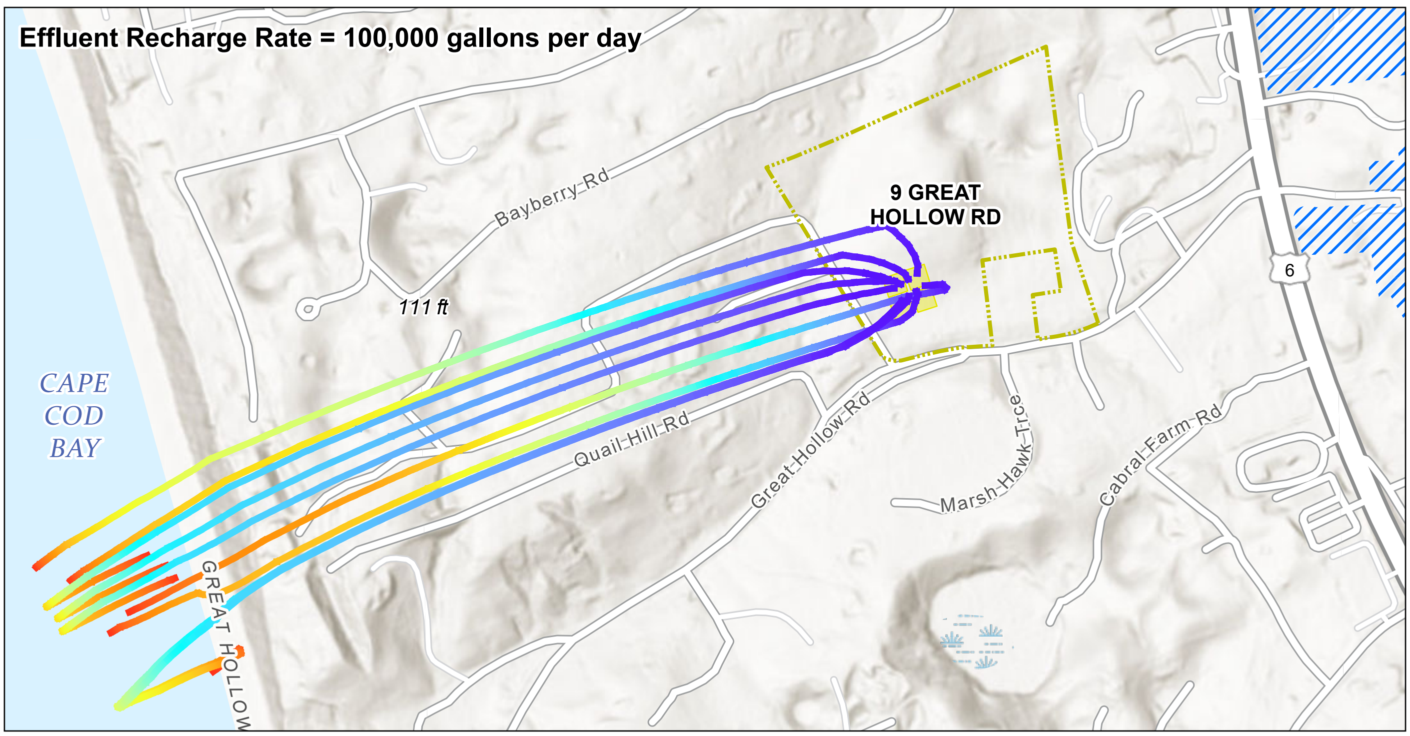
Walsh Property - Preliminary Hydrogeological Study

DRAWN BY: NS	PROJECT: Truro
1ST REVIEW:RR	PROJECT NO: 195151014
2ND REVIEW: CC	DATE: 09/26/2025

Figure 7

Predicted Chloride Concentrations at Pumping Wells





Legend

Effluent Recharge Particle Travel Time (years)

0.0

20

Assessed Effluent Recharge Parcel

Assessed Effluent Recharge Area

Walsh Property

0 200 400 600 800 Feet

(At original document size of 8.5 x 11) 1:7,500

N

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Project Location
Truro
Barnstable County, MA

Prepared by NS on 9/26/2025
TR by RR on 9/26/2025
IR Review by CC on 9/26/2025

Client/Project
Client: Town of Truro
Project: 195151014 - Truro

Figure No.
8

DRAFT

Title
Particle Tracking at Effluent Recharge Drain Field

Notes
1. Coordinate System: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001
2. Data Sources: NUF Wells (McLane Environmental, 2011; 2018); Truro Parcel Data (MassGIS, 2025)
3. Background: World Terrain Reference: Esri Community Maps Contributors, MassGIS, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS
World Terrain Base: Esri Community Maps Contributors, MassGIS, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS
World Terrain Base: Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS
World Hillshade: Sources: Esri, Maxar, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap, and the GIS user community
World Hillshade: Esri, NASA, NGA, USGS, FEMA
World Hillshade: Esri, USGS;

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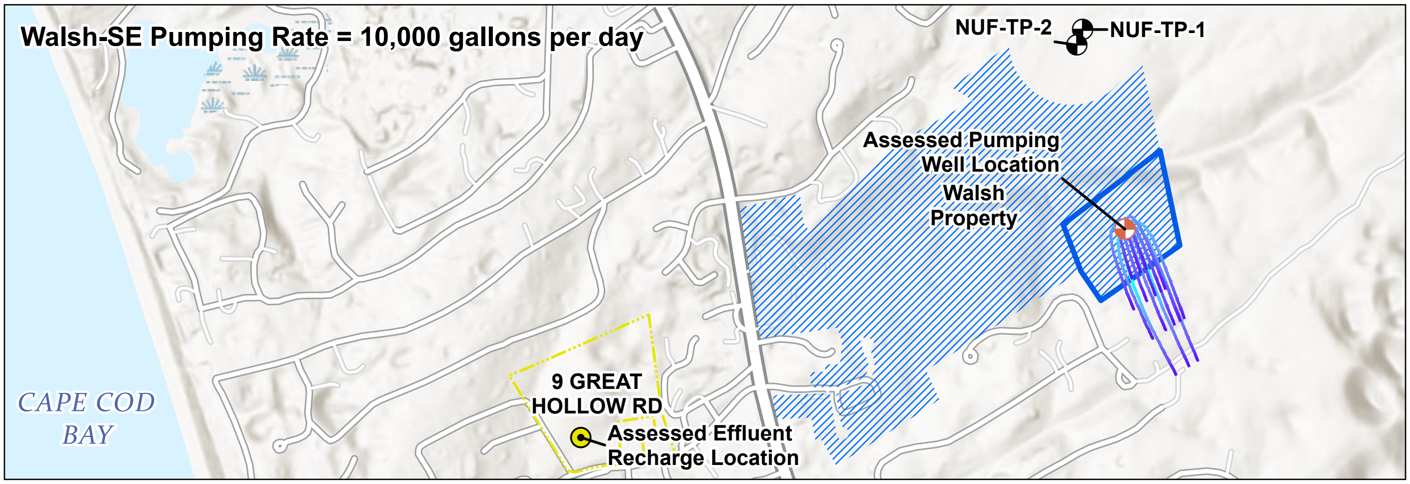

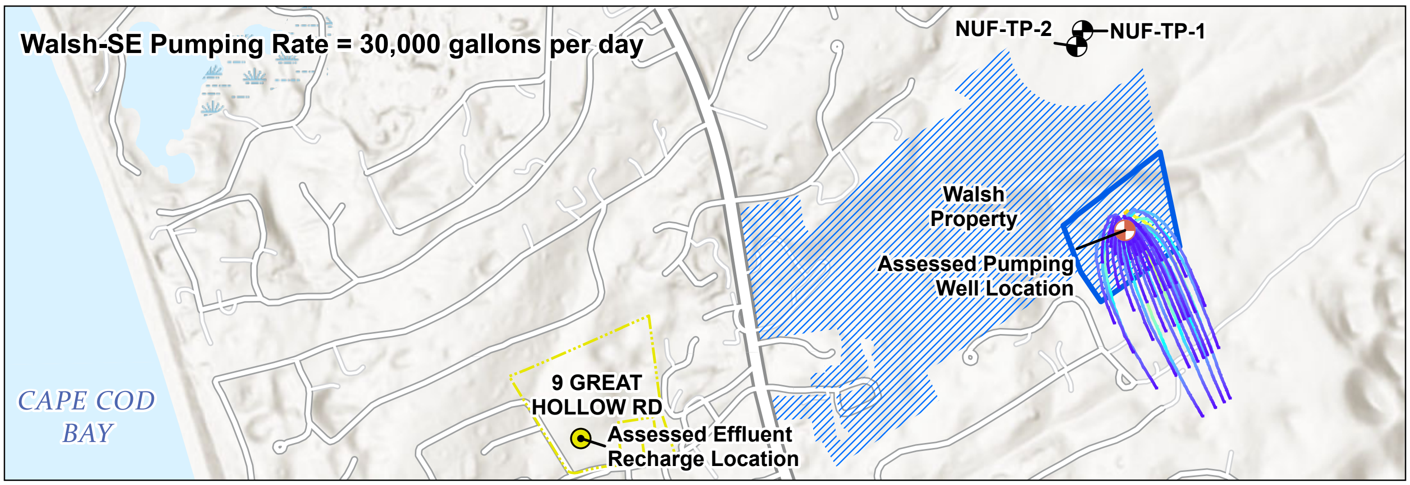

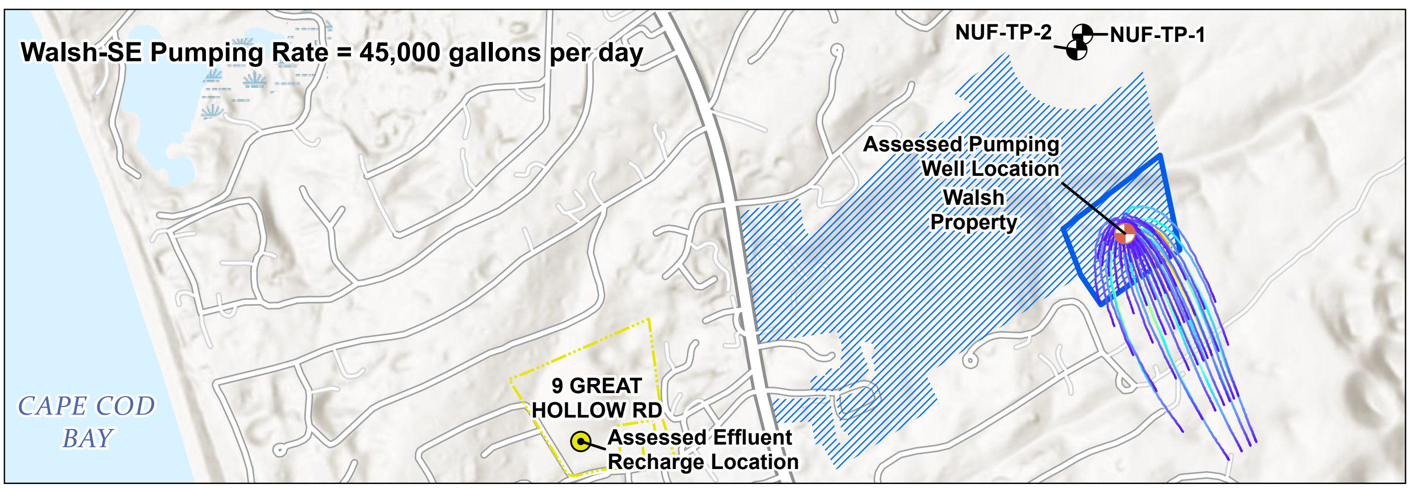

Legend

- North Union Field (NUF) Wells
- Assessed Pumping Well Location
- Assessed Effluent Recharge Location
- Assessed Effluent Recharge Parcel
- Walsh Property
- Walsh Property - Zero Quail Road Parcel

Walsh-SE Pumping Well Capture Zone (years)

0.0

32

0 250 500 750 1,000 Feet

(At original document size of 8.5 x 11) 1:15,000

N

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Project Location
Truro
Barnstable County, MA

Prepared by NS on 9/26/2025
TR by RR on 9/26/2025
IR Review by CC on 9/26/2025

Client/Project
Client: Town of Truro
Project: 195151014 - Truro

Figure No.
9

DRAFT

Title
Predicted Walsh-SE Pumping Well Capture Zone

Notes
1. Coordinate System: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001
2. Data Sources: NUF Wells (McLane Environmental, 2011; 2018); Truro Parcel Data (MassGIS, 2025); MassDEP Zone II Wellhead Protection Areas (MassGIS, 2025)
3. Background: World Terrain Base: Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS
World Hillshade: Esri, NASA, NGA, USGS, FEMA
World Terrain Base: Esri Community Maps Contributors, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS
World Hillshade: Esri, USGS;

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