

MEMORANDUM

Date: March 27, 2023

- To Mark Haddad, Town Manager, Town of Groton
- **From** Tyler W. Schmidt, PE, Environmental Partners Robert J. Rafferty, PE, Environmental Partners
- **CC** Tom Orcutt, Water Superintendent, Town of Groton

SubjectInitial Hydraulics Assessment and Cost Estimate for the Groton Water SystemExtension to the Groton Dunstable Regional High School

Environmental Partners (EP) was contacted by the Town of Groton (Town) on January 13, 2023, in an emergency on-call capacity. Testing of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in the drinking water at the Groton Dunstable Regional School District (District) discovered levels well above the MassDEP PFAS6 Maximum Containment Level (MCL) of 20 parts per trillion (ppt). EP was tasked with evaluating the economic feasibility and hydraulics of an emergency interconnection with the Town of Pepperell via North Street and the District's emergency access road or trucking in potable water via tanker. EP delivered this memorandum on February 3, 2023.

Furthermore, EP was tasked with completing an initial hydraulics review and planning level cost estimate of a water main extension from the Groton Water System to the District. The goal of the assessment was to evaluate whether sufficient water could be provided to the District without the need for additional pumping infrastructure. As part of this analysis, EP assumed the District would maintain its existing 15,000-gallon cistern and fire pump to satisfy its fire demands. The new water main would refill the cistern at a lower flow rate in the event of a fire.

The Town of Pepperell is preparing a separate memorandum and cost estimate for interconnection with the Dunstable and Pepperell water systems. The interconnection is being evaluated along two alignments. One along Route 113 that would not provide water service to the District, and another along Groton Street, Kemp Street, and North Street that would provide water service to the District. EP met with Groton and Pepperell, who operates the Dunstable water system, on March 22, 2023, to discuss the three options and to establish baseline cost estimate assumptions so the three options can be evaluated equally. The cost estimates should not be viewed as detailed design level opinions of probable costs, instead they should be viewed as a means to compare order of magnitude costs to advance the conversations between the three communities and aid in deciding between options. The minutes of that meeting are attached to this Memorandum as Attachment I.

MassDEP Waste Site Cleanup Group has recently sent the District a Notice of Responsibility (NOR) (Transmittal #2-0021961) regarding PFAS contamination in several surrounding private wells abutting the District's property. MassDEP has determined the PFAS contamination originated on the District's Property due to a fire that broke out when the running track was being installed in August 2003. The fire was extinguished by the Groton Fire Department with Aqueous Film-Forming Foam (AFFF), a known PFAS. As a result of MassDEP's determination, any water main extension that resolves the PFAS contamination at the school must also provide water to the impacted properties on Groton Street and Kemp Street.

System Demands

EP analyzed data from the various flow meters within the District's Water System. There are separate flow meters for raw water, irrigation water, and treated water used for domestic consumption. Flow data was obtained from 2019 – 2022 to account for a 4-year spread of consumption data from prepandemic to post-pandemic conditions. The District's existing well has a pumping capacity of 100 gpm. The design flow rates for the district total approximately 40 gpm for domestic water demand and 250 gpm for irrigation demand.

Groton Water System Expansion to the GDRHS

Groton maintains a water system that, at its closest point, is within approximately 3.5 miles of the District at the corner of Common Street and Hollis Street. The water main at this intersection is a 12-inch Ductile Iron (DI) pipe. The Groton Water System Hydraulic Grade Line (HGL) is controlled by the Chestnut Hill water storage tank level. The tank overflow elevation is at 516 feet, and it operates between 514 feet and 508 feet.

Water Main Alignment

Figure 1 below shows the proposed alignment. The water main would connect to the existing 12-inch DI at the intersection of Hollis Street and Common Street. It would replace an existing 4-inch main that runs down Hollis Street. The main would then continue down Chicopee Row for approximately 3 miles to the Groton - Dunstable border. In Dunstable, the main will follow Groton Street and Kemp Street and then re-enter Groton on North Street. The water main will then loop through the District's emergency access road and reconnect with the main on Chicopee Row.

Figure 1: Groton-GDRHS Water Main Extension



The minimum requirement to meet the water demands of the District, and service the impacted properties on Groton Street and Kemp Street, is shown in Figure 1 as Option A. Option B includes extending this alignment 1.2 miles down North Street and the District's emergency access road to loop the water main to the District's service. Option B will remove any dead ends and help with longer-term system maintenance.

Figure 2 below contains a road elevation profile of the alignment up to the GDRHS. The net decrease in elevation from the connection point at the intersection of Common Street and Hollis Street to the District's connection is approximately 93 feet (342' to 249'). The highest point along the alignment is on Chicopee Row at an elevation of approximately 382 feet.



Hydraulics

EP utilized Groton's existing Hydraulic Model developed by CEI Engineers and most recently updated in 2020. EP cannot confirm if the model has been calibrated or if the data included in the model are accurate for current conditions.

Using the hydraulic model as is, EP ran scenarios to determine if the interconnection could supply the District with up to 250 gpm without the need for secondary pumping. Hydraulic modeling data was also used to optimize the main size. EP modeled the system for two pipe sizes: a 6-inch DI pipe and an 8-inch DI pipe. The results of the modeling are shown in Table 1 below.

	Minimum	ŀ	lydraulic Lo	Remaining Pressure at			
	Groton System	System	Friction	Minor	Discharge	Total	GDRHS Treatment
	HGL (ft.)	losses	Losses	Losses	Losses Elev.		Facility ¹
6" DI	508′	0.43′	123′	3'	249′	375.43′	57.46 PSI
8″ DI	508′	0.43′	30′	1′	249′	280.43	98.56 PSI

Table 1: Groton - GDRHS Water Main Hydraulic Analysis

Notes: ¹Hydraulic losses include:

System losses when a water demand of 250 gpm is added to the Groton water system. Friction losses when water flows through a pipe friction is generated on the wetted perimeter. Minor losses through bends, fittings, valves, and other appurtenances. Change in elevation from the Groton storage tank to the GDRHS.

²Conversion: 1 PSI = 2.31 feet of head.

Without additional pumping, both a 6-inch and 8-inch water main can provide the maximum flow of 250 gpm under system conditions that can reasonably be anticipated. The District should continue to expect to utilize its 15,000-gallon cistern and existing pump for fire flow. The hydraulic calculations completed for this analysis are included in Attachment I.

Summary

EP determined it is hydraulically conducive for the District to connect to the Groton Water System. Both a 6-inch DI and 8-inch DI water main will suffice for the domestic and irrigation demands anticipated. However, additional analysis is needed to determine water age and the potential need for a chlorine booster station along this extension. Furthermore, EP recommends the extension include fire hydrants along the alignment in order to expand the Town's municipal fire protection area. In this instance, fire flow demands should be analyzed, and a water main size no less than 8 inches is recommended.

For the comparison of planning level costs with the Pepperell-Dunstable options, EP assumed the water main along Chicopee Row would be a 12-inch Ductile Iron and the water main loop through Dunstable and the GDRHS would be an 8-inch water main. This will provide the town with maximum flexibility for fire flow or future system expansion. EP also assumed a chlorine booster station would be required along the alignment to alleviate water age concerns. The chlorine booster station would be an above-ground pre-cast structure housing chemical feed and safety systems. The planning level cost of the chlorine booster station is \$750,000.

The planning level cost estimate for construction of the water main is approximately \$12,430,000. The overall cost of the water main extension, with an included 20% construction contingency and 15% engineering services estimate, is approximately \$16,775,000. The detailed breakdown is included in Attachment III. Cost estimate assumptions are detailed in Attachment I. The estimated construction cost is comparable to the initial Tighe & Bond estimate of \$8.0 million, with the addition of the looped water main and the chlorine booster station, which were not included in the (T&B) estimate. Further value engineering should be conducted to minimize the overall cost for whichever option is selected.

Attachments

- 1. Attachment I Dunstable Water System Extension & Cost Estimate Assumptions Meeting Minutes
- 2. Attachment II Groton GDRHS Water Main Hydraulic Calculations
- 3. Attachment III Planning Level Cost Estimate for the Groton Water Main Extension

ATTACHMENT I

Dunstable Water System Extension & Cost Estimate Assumptions Meeting Minutes



MEETING MINUTES

Date:	Wednesday, March 22, 2023, at 10:00 AM
Location:	Groton Town Hall, Second Floor Conference Room
Meeting Title:	Dunstable Water System Extension & Hydraulic Parameters
Prepared By:	Tyler Schmidt, PE, Environmental Partners
Attendants:	Tom Orcutt, Water Superintendent, Town of Groton Paul Brinkman, DPW Business Manager, Town of Pepperell Bob Rafferty, PE, Principal/Project Manager, Environmental Partners Tyler Schmidt, PE, Senior Project Engineer, Environmental Partners

The Dunstable Water System Extension meeting was held at the above-indicated date, time, and location. **Bold** text denotes items added to the agenda that were discussed during the meeting.

BACKGROUND

A meeting will be held at the above-listed day and time to discuss the hydraulic parameters of a possible water system extension from Dunstable to the Groton Dunstable Regional School District. The extension, as proposed in a Tighe & Bond Memorandum dated November 16, 2022, involves running a 12-inch water main down Groton Street to Kemp Street and North Street to the emergency Access Road of the Groton Dunstable Regional High School (GDRHS). A future interconnection will be completed between the Towns of Dunstable and Pepperell along this alignment.

The meeting focused on two options.

- Option 1 was a Pepperell-Dunstable 12-inch water system interconnection from Route 113 in Dunstable down Groton Street and North Street into Jersey Street. Two 8-inch branches will serve the GDRHS and the Kemp Street/Groton Street PFAS-impacted properties.
- Option 2 was a 12-inch Groton water main extension up Chicopee Row to the GDRHS and an 8-inch loop along the school's emergency access road to the Kemp Street/Groton Street PFAS-impacted properties.

FLOW TEST & HYDRAULICS

- EP will need to schedule a flow test of the Dunstable Water System. The ideal location of the test will be the closest hydrant to the proposed system connection point at the intersection of Groton Street and Route 113 (Pleasant Street).
 - Is the hydrant at this intersection operable?
 - What is the Water Main Size at this location?
 - What is the water tank operating range in this pressure zone?
 - Is there an existing hydraulic model for Dunstable's Water System?
 - Flow Test
 - EP is available for a flow Test Thursday Afternoon (after 1:30 PM) and Friday all day.

- The Dunstable water system is not currently capable of meeting fire flow due to the limited size of its water storage tank and current well pump capacity.
 - A flow test will not yield any measurable results. All parties should assume an additional booster pump station will be required to make the hydraulics of the system expansion work. The booster system will include supplemental chemical feed systems as deemed necessary.
- Paul will send EP an email with the operating hydraulic parameters of the Dunstable water system [email received later on Wednesday, 3/22/2023].

COST ESTIMATE AND EVALUATION CONSISTENCY

- EP is preparing a memorandum and cost estimate for a potential Groton Water Main Extension running up Chicopee Row to the GDRHS and the Kemp Street Properties. Furthermore, Pepperell is preparing a cost estimate for extending its water main via Jersey Street and North Street to connect to the Dunstable extension. To ensure consistency between proposed options, EP is looking to establish equal assumptions for unit costs and contingencies.
 - Optional water main loop around the GDRHS.
 - EP will include the loop for the Groton option with an 8-inch DI Pipe
 - Pepperell will not include a loop for their option but will extend an 8-inch main down Groton Street to the Groton town line.
 - For the Dunstable option, should EP include costs for connection to Pepperell in the Estimate? The alignment would extend up North Street and connect to Jersey Street.
 - Pepperell is including all direct construction costs for the Pepperell Dunstable option from Route 113 to Jersey Street. These costs may include upsizing the existing 8-inch pipe on Jersey Street to sustain a new connection. This upsizing could be done via a future project.
 - Pepperell is also preparing a separate cost estimate from Dunstable to Pepperell, running exclusively down route 113, not including the GDRHS and Kemp Street, to get comparative costs of connecting the two systems independent of this PFAS emergency at the GDRHS.
 - For all options, should a 12-inch water main be the target size to estimate? (Ideal for extending municipal fire protection)
 - 12-inch water main along the main alignment with 8-inch branches. See updated figure for final pipe sizes
 - Please see the attached example cost estimate breakdown with EP assumptions for review and discussion.
 - See the updated planning level cost estimate breakdown for comparative cost analysis.

INTER-BASIN TRANSFER & OTHER NEEDED SYSTEM IMPROVEMENTS

- For options that will trigger an Interbasin transfer permit requirement. This has the potential to
 increase costs indirectly due to mitigation measures enforced as a condition of obtaining the
 permit.
 - At this stage, these costs cannot reasonably be quantified in dollar value, but possible mitigation options should be documented for future discussion.
 - All options may require Interbasin transfer permits and offsets.
 - The Groton option will likely result in a Determination of Insignificance offset by the installation and continuous operation of a previously agreed sluice gate at the outlet of Lost Lake.

- The Pepperell-Dunstable option has the potential to cause a more significant delay, given the volume of water Pepperell may take from Dunstable. Pepperell is prepared to phase the project into two parts to offset this increased risk.
 - Part 1 will be a Dunstable water system extension to the GDRHS and Kemp Street properties. The Interbasin transfer impact will match that of the Groton option without an identified offset measure.
 - Part 2 would be the interconnection Pepperell which could trigger additional Interbasin transfer delays.
- If improvements beyond the scope of the water main extensions are required, such as additional treatment, pumping capacity, storage capacity, or other improvements.
 - Baseline assumption to include chlorine booster station?
 - Groton Option will include a chlorine booster station estimated at \$750,000.
 - The Pepperell-Dunstable option will include a pump/chlorine booster station and upgrades to the two existing Dunstable well pumps, each upgrade estimated at \$750,000.
 - Other required improvements?
 - No other improvements will be included in the cost analysis at this time.
- Implementation timeline assumptions
 - Inter-basin Transfer Permit
 - Timelines mentioned above. With the Pepperell-Dunstable option broken into two parts, the permitting timeline with the Groton Option is considered to be similar.
 - o WMA Permit Renewals
 - Dunstable needs to file for a WMA permit. This permitting timeline is expected to be parallel to the Interbasin transfer without any additional expected delays.
 - o Other system improvements
 - No other improvements were discussed.

ATTACHMENTS

- 1. Water Main Alternatives Figure
 - a. Updated to reflect meeting discussion.
- 2. Example Water Main Cost Estimate
 - a. Updated to reflect meeting discussion.





Figure #1 Water Main Connection Alternatives for Groton-Dunstable High School

> Groton, MA 3/23/2023

0 1,000 2,000 Feet

l:\Groton.306\22012854 - GDRHS Emergency Water\03 Design\02 GIS\GDRHS Locus Map



Item No.	Description	Units	QTY Assumptions	Unit Price Assumptions	Extended Amount		
1	MOBILIZATION AND DEMOBILIZATION						
1a	Mobilization and Demobilization	ALLOW	1	5% of all other items (rounded to nearest thousand)			
2	DUCTILE-IRON WATER MAINS						
2a	6-inch Ductile-Iron Water Main, Class 52 Pipe	LF	25 LF per Fire Hydrant	\$200.00			
2b	8-inch Ductile-Iron Water Main, Class 52 Pipe	LF	Lengths as agreed in updated Figure 1	\$225.00			
2c	12-inch Ductile-Iron Water Main, Class 52 Pipe	LF	Lengths as agreed in updated Figure 1	\$250.00			
3	FIRE HYDRANTS			•			
3a	Fire Hydrants	EA.	One Hydrant Every 450 LF (excludes 1 mile emergency access road)	\$6,500.00			
4	DUCTILE-IRON FITTINGS						
4a	Ductile-Iron Fittings	-Iron Fittings LB. 1 LB per 5 LF of water main (any size)		\$2.00			
5	GATE VALVES AND BOXES						
5a	6-inch Gate Valves and Boxes	EA.	One for every Fire Hydrant	\$1,750.00			
5b	8-inch Gate Valves and Boxes	EA.	One at every intersection, one at the GDRHS	\$2,000.00			
5c	12-inch Gate Valves and Boxes	EA.	Two at every intersection, one at every hydrant	\$2,500.00			
6	CORPORATION STOPS						
6a	1-inch Corporation Stops	EA.	Combined with items 6,7,8 into a single water services item	Combined with items 6,7,8 at \$3,500.00 each service			
7	WATER SERVICE TUBING						
7a	1-inch PE Water Service Tubing	LF	Combined with items 6,7,8 into a single water services item	Combined with items 6,7,8 at \$3,500.00 each service			
8	CURB STOPS AND BOXES						
8a	1-inch Curb Stops and Boxes	EA.	Combined with items 6,7,8 into a single water services item	Combined with items 6,7,8 at \$3,500.00 each service			
9	EARTHWORK						
9a	Exploratory Excavation (Test Pits)	CY					
9b	Excavation of Unsuitable Materials Below Trench Grade (5%)	CY					
9c	Rock Excavation (5%)	CY	Combined with all Earthwork items, estimated at 25% water main trench volume	Combined with all Earthwork items at \$40.00 per CY			
9d	Select Fill (10%)	CY					
9e	Additional Select Fill Around Water Main (5%)	CY					
10	TEMPORARY PAVEMENT						
10a	Temporary Trench Pavement (3.5" Depth)	SY	5' width impact for water main, 3' width impact services x Length / 9 x (1.15 SF) (excludes 1 mile emergency access road)	\$60.00			
11	PERMANENT PAVEMENT	•					
11a	Trench Width Mill w/12-inch cutbacks (2" Depth)	SY	7' width impact for water main, 6' with impact for services x Length / 9 x(1.15 SF) (excludes 1 mile emergency access road)	\$25.00			
12	ENVIRONMENTAL PROTECTION		(, , , , , , , , , , , , , , , , , , ,				
12a	Restoration of Growth	SY					
12b	Silt Sack	EA.	Combined into one lump sum Environmental protection item	1% of all other items excluding Mobilization			
12c	Filter Sock	LF		C C			
13	TRAFFIC CONTROL			•	•		
13a	Uniformed Police Officer Allowance	ALLOW	1	\$65/hr. x 10 hr. days X # const days x 2 Officers (See Note 1)			
13b	Variable Message Boards (8 weeks 2 signs)	BOARD-WEEKS	Converted into an overall traffic management item with a unit of days (see note 1)	\$250 per day			
14	MISCELLANEOUS ITEMS		Include Chlorine/Pump Booster Stations per each at the cost	of \$750,000.00 ea.			
				Subtotal			
Notes				Engineering (15% of Subtotal)			

Number of construction days estimated at average production (including mob/demob/services/testing/paving) at 80 LF of total WM (any size) per day (excludes 1-mile emergency access road 1 for PD and traffic management)

Board weeks = (# of construction days / 5 days a week + 4 weeks - to account for 1 month pre mob alert) * # of Message Boards (2 boards per main road along alignment) 2



Contingency (20% of Subtotal)

Total

ATTACHMENT II

Groton – GDRHS Water Main Extension Hydraulic Calculations



HYDRAULIC CALCULATIONS

PROJECT NAME

GDRHS Emergency Interconnect	BY:	TWS	DATE:	1/28/2023	
PROJECT NUMBER:	P22012854	CHKD BY:	RJR	DATE:	2/3/2023

PURPOSE: Expand the Groton Water System 3.5 miles to provide domestic and irrigation water to the Groton Dunstable Regional High School (GDRHS). The expansion will be via DIP pipe installed on Hollis Street and Chicopee Row. Groton has a 12-inch DI Pipe at the intersection of Hollis Street and Common Street. The GDRHS has an existing Iron & Manganese Treatment system that will be removed and replaced with the new water service. the GDRHS shall retain the 15,000 gallon cistern and its existing fire pump for fire flow.

DESIGN GOALS/PRINCIPLES: Ensure the pressure difference is hydraulically conducive to supplying GDRHS with sufficient flow without the need for secondary pumping. Furthermore, size the pipe to adequately provide emergency water without hydraulic limitations.

DEFINITIONS:

- **1** GPM Gallons per Minute
- 2 MGD Million Gallons per Day
- 3 GPD Gallons per Day
- 4 GPH Gallons per Hour
- 5 FPS Feet per Second
- 6 HGL Hydraulic Grade Line
- 7 TDH Total Dynamic Head

ASSUMPTIONS:

- **1** Groton tank levels fluctuate daily. The tanks operate between 508'-516' (overflow), Two scenarios were analyzed to determine the best and worse case of an interconnection.
 - **1A.** Best case scenario Groton HGL at max (516')
 - **1B.** Worst case scenario Groton HGL at min (508')

CONVERSION & OTHER FACTORS:

Description	Value	Units	Notes
1 gallon =	8.34	pounds	
1 foot =	12	inches	
1 cubic foot =	7.48	gallons	
1PSI =	2.31	Feet Head	
Atmospheric Pressure =	14.7	PSI	
Vapor Pressure =	0.51	PSI	
Gravity Acceleration =	32.17	ft./s ²	
Unit Weight of Water (γ) =	62.4	lbs./ft ³	

Key User Input Value - no calculation



HYDRAULIC CALCULATIONS

PROJECT NAME

GDRHS Emergency Interconnect	BY:	TWS	DATE:	1/28/2023	
PROJECT NUMBER:	P22012854	CHKD BY:	RJR	DATE:	2/3/2023

DESIGN PARAMETERS - EMERGENCY SUPPLY FROM GROTON TO GDRHS

Description	Value	Units	Value	Units	Notes
Max Flow	250	gpm	0.36	MGD	Peak Hour Demand of GDRHS as calculated in Memo
Min Flow	40	gpm	0.06	MGD	Average Daily Domestic Demand at GDRHS as calculated in Memo

*Conversion from gpm to MGD: (1440 min/ day), (10^6 gal/ MG)

PEPPRELL WATER SYSTEM INPUTS:

Description	Value	Units	Notes
Minimum HGL	508	Feet	tank minimum operating level
Maximum HGL	516	Feet	tank overflow level
Elevation at Flow Hydrant	342	Feet	See Assumption No. 1 above
Minimum Static Pressure	71.9	PSI	Calculation: P=(HGL-z)γ, conversion 144 in ² /ft ¹
Maximum Static Pressure	75.4	PSI	Calculation: P=(HGL-z)γ, conversion 144 in²/ft²

Note: Static pressure test at hydrant should be conducted to confirm results.

GROTON MODELED FLOW TEST RESULTS



Flow	Pressure
0	73
500	72
1000	71
1500	68
2000	64
2500	60
3000	55
3500	48
4000	41
4500	33
5000	25
5500	15
6000	4

Note: Actual Flow test should be conducted to validate model assumptions.



HYDRAULIC CALCULATIONS

PROJECT NAME

GDRHS Emergency Interconnect	BY:	TWS	DATE:	1/28/2023	
PROJECT NUMBER:	P22012854	CHKD BY:	RJR	DATE:	2/3/2023

GROTON FLOW TEST RESULTS @ 250 GPM TOTAL

Description	Value	Units	Notes	
Diameter Outlet	4	in	Adjusted the flow test data above to simulate a 250 GPM flow condition. Flow	
Coefficient	0.8		was changed to 250 GPM, Residual pressure was adjusted until calculated	
Static Pressure	73.0	PSI	(Flow test result). The lowest measurable drop was 1 PSI before the 2020 (target was reached.	
Residual Pressure	72.813	PSI		
Adjusted Flow	250	gpm	Target flow of to 250 GPM	
Available Flow @ 64 PSI	2025.1	gpm	Calculation: Flow x (Static - 69).54 / (Static - Residual)^.54	
Change in Pressure	0.187	PSI	Say 0.2 PSI Pressure Drop	

GROTON FLOW TEST RESULTS @ 40 GPM TOTAL

Description	Value	Units	Notes	
Diameter Outlet	4	in	Adjusted the flow test data above to simulate a 40 GPM flow condition. Flow	
Coefficient	0.8		was changed to 40 GPM, Residual pressure was adjusted until calculated	
Static Pressure	73.0	PSI	(Flow test result). The lowest measurable drop was 1 PSI before the 2020	
Residual Pressure	72.994	PSI	target was reached.	
Adjusted Flow	40	gpm	Target flow of to 20 GPM	
Available Flow @ 64 PSI	2075.6	gpm	Calculation: Flow x (Static - 69).54 / (Static - Residual).54	
Change in Pressure	0.006	PSI	Say 0 PSI Pressure Drop	



HYDRAULIC CALCULATIONS

PROJECT NAME

Friction Losses

GDRHS Emergency Interconnect	BY:	TWS	DATE:	1/28/2023	
PROJECT NUMBER:	P22012854	CHKD BY:	RJR	DATE:	2/3/2023

Minor Losses		6" DI Pip	e & Fittings	8" DI Pipe & Fittings		
Fittings: K Value		No. of Fittings	Sum of K Values	No. of Fittings	Sum of K Values	Notes
Entrance Loss	1.00		0	0	0	
90° Bend	0.30	7	2.1	7	2.1	on GDRHS access rd. (2), WTP (5)
45° Bend	0.25	18	4.5	18	4.5	
22.5°Bend	0.20	10	2	10	2	
11.25° Bend	0.15		0	0	0	
T Bend	0.75	2	1.5	2	1.5	one at Hollis entrance one at school entrance
T Run	0.40	8	3.2	8	3.2	one for every side street
Gate Valve	0.30	30	9	30	9	every tee and every 1000 feet
Plug Valve	1.00		0	0	0	
Reducer	0.25		0	0	0	
Increaser	0.31		0	0	0	
Check Valve	2.50	1	2.5	1	2.5	one at the school
Y Bend	0.50		0	0	0	
Y Run	0.05		0	0	0	
Outlet Loss	1.00	1	1	1	1	discharge to tanks
	Total		25.8		25.8	

Note: DI Pipe modeled below for connections in the GDRHS WTP building assumed 50 LF total

		6-Inch Main		8-inch Main		Notes
		6" DI	6" HDPE	8" DI	8" HDPE	Notes
Internal Diamete	er (ft.)	0.50	0.45	0.67	0.58	I.D. for Class 250 DI = 6" & 8"
Cross-Sectional	Area (SqFt)	0.20	0.16	0.35	0.26	I.D. for SDR 11 HDPE = 5.349" & 6.963
Length (ft.)		18480	0	18480	0	Lengths measured from profile in memo
C Value		120	150	120	150	
Flow	Rate		ЫІ (E+)		HI (Et)	Notes
GPM	CFS			IIE (FC)		Notes
40	0.09	4.15	0.00	1.02	0.00	$4.72 x L x Q^{1.85}$
250	0.56	123.05	0.00	30.31	0.00	$H = \frac{1.85}{C^{1.85} x d^{4.87}}$



HYDRAULIC CALCULATIONS

PROJECT NAME

GDRHS Emergency Interconnect	BY:	TWS	DATE:	1/28/2023	
PROJECT NUMBER:	P22012854	CHKD BY:	RJR	DATE:	2/3/2023

Headlosses

Flow Rate (CFS)	Minor Losses		Friction Losses*		Groton System	Change in	6-inch Total	8-inch Total
	6-inch	8-inch	6-inch	8-inch	Losses**	Hyd to Storage Tanks***	Losses	Losses
0.09	0	0	4	1	0.43	-93	-88	-92
0.56	3	1	123	30	0.01	-93	33	-62

Notes

* Friction Loss formula: Minor Losses, $h_m = K \frac{v^2}{2g}$

** Groton system curve losses are calculated from the pressure drops at 40 GPM (low flow) and 250 GPM (high flow) events calculated above from the flow test data.

*** Hollis St = 342'. GDRHS WTP Building Elev. = 239' plus 10' for the elevated storage tanks. = change in elevation of 93'

Summary

	Bes	t Case	Wor	st Case	Notor
Description	Value	Units	Value	Units	Notes
Groton Static HGL	516	Feet	508	Feet	
Elevation at Feed Hyd	342	Feet	342	Feet	
Difference	174	Feet	166	Feet	

6-inch Water Main

Remaining Pressure @

40	GPM	113.57	PSI	110.10	PSI	Values in PSI
250	GPM	60.91	PSI	57.45	PSI	Values in PSI

8-inch Water Main

Remaining Pressure @

40	GPM	114.94	PSI	111.48	PSI	Values in PSI
250	GPM	102.01	PSI	98.55	PSI	Values in PSI

CONCLUSIONS:

- **1** 6-inch DI pipe is adequate to satisfy 250 gpm flow and still maintain 57.46 psi excess pressure.
- **2** 8-inch DI pipe is adequate to satisfy 250 gpm flow and still maintain 98.56 psi excess pressure.

ATTACHMENTS:

1 None



HYDRAULIC CALCULATIONS

PROJECT NAME

GDRHS Emergency Interconnect	BY:	TWS	DATE:	1/28/2023	
PROJECT NUMBER:	P22012854	CHKD BY:	RJR	DATE:	2/3/2023

REFERENCES:

Performance Pipe HDPE SDR 11 Pipe Size Chart https://api.ferguson.com/dar-step-service/Query?ASSET ID=6288942&USE TYPE=SPECIFICATION&PRODUCT ID=1756390

ATTACHMENT III

Planning Level Cost Estimate for the Groton Water Main Extension

Item No.	Description	Units	Quantities	Unit Price	Extended Amount
1	MOBILIZATION AND DEMOBILIZATION				
1	Mobilization and Demobilization	ALLOW	1	\$590,000.00	\$590,000.00
2	DUCTILE-IRON WATER MAINS				
2a	6-inch Ductile-Iron Water Main, Class 52 Pipe	LF	1,300	\$200.00	\$260,000.00
2b	8-inch Ductile-Iron Water Main, Class 52 Pipe	LF	13,200	\$225.00	\$2,970,000.00
2c	12-inch Ductile-Iron Water Main, Class 52 Pipe	LF	15,500	\$250.00	\$3,875,000.00
3	FIRE HYDRANTS				
3a	Fire Hydrants	EA.	52	\$6,500.00	\$338,000.00
4	DUCTILE-IRON FITTINGS				
4a	Ductile-Iron Fittings	LB.	6,000	\$2.00	\$12,000.00
5	GATE VALVES AND BOXES				
5a	6-inch Gate Valves and Boxes	EA.	52	\$1,750.00	\$91,000.00
5b	8-inch Gate Valves and Boxes	EA.	18	\$2,500.00	\$45,000.00
5c	12-inch Gate Valves and Boxes	EA.	35	\$3,500.00	\$122,500.00
6	Service Connections				
6a	Service Connections (Corp/Curb/1" PE Tubing)	EA.	95	\$3,500.00	\$332,500.00
7	EARTHWORK				
7a	Earthwork (Test Pit/Rock/Unsutables/Select Full)	CY	8330	\$40.00	\$333,200.00
8	TEMPORARY PAVEMENT				
8a	Temporary Trench Pavement (3.5" Depth)	SY	19,402	\$60.00	\$1,164,145.00
9	PERMANENT PAVEMENT				
9a	Trench Width Mill w/12-inch cutbacks (2" Depth)	SY	27,676	\$35.00	\$968,660.97
10	ENVIRONMENTAL PROTECTION				
10a	Environmental Protection (Silt Sack/Filter Sock) 1% of items 2 through 12	LS	1	\$120,000.00	\$120,000.00
11	TRAFFIC CONTROL				
11a	Uniformed Police Officer Allowance (10 hr. days x \$65 per hr x 2 officers)	ALLOW	1	\$380,900.00	\$380,900.00
11b	Traffic Management	DAYS	293	\$250.00	\$73,250.00
12	MISCELLANEOUS ITEMS				
12a	Chlorine Booster Station	LS	1	\$750,000.00	\$750,000.00
				Subtotal	\$12,426,155.97
				Enigneering (15%)	\$1,863,923.40
				Contingency (20%)	\$2,485,231.19
				Total	\$16,775,310.56

