WRIGHT-PIERCE

Engineering a Better Environment DRAFT

MEMORANDUM

TO:	Paul Deschaine	DATE:	May 18, 2016
FROM:	Chris Berg, PE	PROJECT NO.:	12857A
SUBJECT:	Preliminary Design Summary – Stratham Water Distribution System Stratham, New Hampshire		

The Town of Stratham engaged Wright-Pierce to preliminarily design a water distribution system along Portsmouth Ave from the Exeter/Stratham town line to Frying Pan Lane as well as a metering facility and booster pumping station. This memorandum presents the booster pump station design approach and the preliminary design of the distribution system for the proposed service area. The design for the service area will address domestic water supply and fire protection needs as well as the pump stations future use to fill a future tank on Bunker Hill.

Existing Conditions

Stratham and Exeter have executed a water purchase agreement (signed 1/11/16) for Strathamto purchase water from Exeter. There are multiple private fire protection systems in the Gateway Commercial District that may be integrated into the new water distribution system as it is constructed Stratham will be receiving water from the Exeter water distribution system at the Stratham/Exeter town line on Portsmouth Ave. Exeter water system pressure at this interconnection point ranges from 75 to 82 psi at a ground elevation of ~37 ft.

Design Approach

Water System Overview

Stratham will be connecting to the Exeter water system at the Exeter/Stratham town line with a 16-inch High density polyethylene (HDPE) transmission main. This main will be installed through three existing sleeves extending through the NHDOT ROW under Route 101 to a pump station located at 9 Stratham Heights Road. From there, 16-inch ductile iron water main will extend along Portsmouth Avenue to the intersection with Frying Pan Lane.

Proposed Pump Station Site

The pump station is proposed to be located at 9 Stratham Heights Road. The Town has selected this site for the pump station location due to its proximity to the Gateway Commercial District and its availability for use as it is a Town owned parcel of land. A Verizon communication building occupies the Southwest corner of the property located within a 76' x 60' easement that Verizon maintains. Additional survey will be required on this site and Stratham Heights Road to fully design this area. This survey was not completed as part of the scope of this work.

Exeter Metering Requirements

As part of the booster pump station facility, a separate metering room is required by the agreement to be built. This space will be operated and maintained by the Exeter DPW. This room will house the water meter and backflow preventer supplied by Exeter for their use in metering the water supplied to Stratham. We expect the water meter will be a Neptune Protectus III SS Fire Service Meter or similar and the backflow prevention device will be a Wilkins 375 RPZ Backflow Preventer or similar.

Pump Station Design Criteria

Water system demand estimates for the Gateway Commercial District area were developed to determine the pump design criteria requirements for the new station. The station is being designed to operate under two different operational conditions.

1) Closed loop, providing constant pressures to deliver water to the customers. Pumps to be sized for domestic and fire flow requirements.
2) Fill a future tank to be located on Bunker Hill, operations will be based on tank levels. This is the condition assumed to be in service once redevelopment occurs and demands increase.

Water Demands - The current development in the Gateway Commercial District is primarily commercial development and most of the available building lots have been developed, but not to build out condition. The potential for redevelopment or additional development in the area is significant but he timelime for this redevelopment is uncertain. At the Town's request, the domestic capacity of the pump station is designed using the current demand estimates. The pump station will be designed such that duty pumps can be replaced with incrementally larger pumps if demand increases before the tank is built and the operating condition of the BPS changes to tank filling mode. The anticipated demands from current development, is presented in Table 1.

Table 1 - Domestic Water Flow Design Criteria (Current Development)

Description	Town-Wide
ADD (gpd)	33,120
ADD (gpm)	23
MDD/ADD	1.8
MDD (gpm)	41
Peaking Factor	1.5
Peak Hour Demand (gpm)	62

For a closed, pressurized system, the pumping system will need to be designed to accommodate flows from an overnight low of a few gallons per minute to a peak hourly demand of approximately 62 gpm. Typically, low overnight flows can be handled with a small jockey pump or a hydropneumatic (diaphragm) tank. A rule-of-thumb for pressurized systems is that hydropneumatic tanks are not recommended for systems servicing more than 50 homes. Therefore, the hydropneumatic tank option was not considered for this application. The daily fluctuation in domestic water demand can be supplied using a single pump (with back-up) or a combination of two (or more) pumps operated in a lead-lag configuration.

The Exeter distribution system model was used to determine the suction pressure at the site of the proposed booster pump station. The model was run under MDD conditions, all Exeter pumps turned off, and storage tanks at their minimum water elevation. Under these conditions, the modeled static pressure at the location of the proposed pump station (elevation 58 feet MSL), on the 16-inch diameter water main that connects to the main system, was approximately 58 psi. A suction pressure of 55 psi will be used for design purposes.

The hydraulic grade line (HGL) at the proposed pump station site is calculated to be 185 feet MSL, based on a minimum available pressure of 55 psi and a pump station elevation of 58 feet MSL. The HGL at the highest service point (Frying Pan Lane, 100 feet MSL) in the proposed service zone for the Gateway Commercial District will need to be 238 feet MSL to provide a minimum of 60 psi. This results in a HGL difference of 53 feet (238 feet – 185 feet). The estimated frictional pipe headloss at the high flow of 62 gpm was calculated to be 0.015 feet based on approximately 3,500 linear feet of 16-inch diameter water main from the location of the proposed pump station to the location of the highest elevation in the service area. Since the headloss is so low, it was assumed negligible. Headloss from the metering room is calculated to be approximately 39 feet per the specifications of the metering equipment. Based on the aforementioned criteria and assumptions, the TDH for the proposed domestic service pumping system is calculated to be 92 feet (53 ft static head + 39 ft dynamic head). A summary of the domestic service pump design is presented in Table 2.

Table 2 - Domestic Service Pump Design

Description	Value
Maximum Design Flow (gpm)	62
Elevation at Proposed Pump Station (feet MSL)	58
Available Pressure – (psi) – feet	(55) 127
HGL at Pump Station (feet MSL)	185
Elevation at Highest Service (feet MSL)	100
Design Pressure at Highest Service – (psi) – feet	(60) 138
HGL at Highest Service (feet MSL)	238
HGL Difference (feet)	53
Piping Headloss at Peak Hour Flow (feet)	Negligible
Metering Station Headloss at Peak Hour Flow (feet)	39
Pump Design TDH – feet	92

Pumping alternatives were evaluated to compare duty-standby (one pump with back-up) and lead-lag (two-pump with back-up) pump configurations to provide the most efficient operation. For the one-pump configuration, the pump capacity would be designed to provide 62 gpm at 92 feet of TDH. For the two-pump configuration, each pump would be designed to provide 31 gpm each (one-half of the Peak Hour design flow). The motor horse power (HP) necessary for the one-pump option is 2 HP, while for the two-pump option is 1 HP for each pump.

A summary of the domestic service pump options is provided in Table 3.

Table 3 - Domestic Service Pump Options

Description	One-Pump	Two-Pump	
		Pump 1	Pump 2
Flow Range (gpm)	*16-62	*8-31	31-62
TDH (ft)	92	92	92
HP	2	1	1

*Note: low flows limited by ability of variable frequency drives assumed to be 25%, low overnight flows provided with smaller jockey pump.

Fire Flow

Based on flow and pressure limitations delineated in the water purchase agreement with Stratham, the maximum design available fire flow is approximately 1,500 gpm at 37 psi based on the letter dated October 2, 2015 to Lincoln Daley.

The water distribution system model was used to determine the maximum available flow at the site of the proposed booster pump station. The model was run with the Exeter system storage tanks at their minimum water elevation, pumps turned off, and under MDD conditions. Based on maintaining the recommended minimum suction pressure of 20 psi at the booster pump station, approximately 2,000 gpm is available at the site of the proposed booster pump station.

The HGL at the proposed pump station site was calculated to be 144 feet MSL, based on a pressure of 37 psi and a pump station elevation of 58 feet MSL. The HGL at the highest service in the service area (100 feet MSL) was previously calculated to be 238 feet MSL to provide a minimum of 60 psi at that location. The HGL difference is 94 feet (238 feet – 144 feet). The estimated pipe headloss during a flow of 1,500 gpm was calculated to be approximately 5 feet based on approximately 3,500 linear feet of 16-inch diameter water main from the location of the proposed pump station to the location of the highest elevation in the service area. Headloss from the metering facility is calculated to be approximately 49 feet per the specifications of the metering equipment. Based on the aforementioned criteria and assumptions, the TDH for the proposed fire flow service pumping system is calculated to be 148 feet for 1,500 gpm. A summary of the fire flow pump design parameters is presented in Table 4.

Table 4 - Fire Flow Pump Design

Description	@ 1,500 gpm
Elevation at Proposed Pump Station (feet MSL)	58
Available Pressure – (psi) – feet	(37) 86
HGL at Pump Station (feet MSL)	144
Elevation at Highest Service (feet MSL)	100
Design Pressure at Highest Service – (psi) – feet	(60) 138
HGL at Highest Service (feet MSL)	238
HGL Difference (feet)	94
Piping Headloss at fire flow rate (feet)	5
Metering Facility Headloss at fire flow rate (feet)	49
Pump Design TDH (feet)	148

Pump alternatives were evaluated to compare one pump and two pump configurations to provide the most efficient operation for providing 1,500 gpm fire flows. The motor HP necessary to provide the available fire flow demand of 1,500 gpm at 148 feet of TDH is 80 HP. If the system were to utilize two pumps providing 750 gpm each at 148 feet TDH, two 40 HP pumps would be required. A summary of high flow pumps options is presented in Table 5.

Table 5 - High Flow Pump Options

Criteria	**1,500 gpm**		
	One-Pump	Two-Pump	
		Pump 1	Pump 2
Flow Range (gpm)	375-1500	188-750	750-1500
TDH (ft)	148	148	148
HP	80	40	40

Note: low flows are limited by ability of variable frequency drives assumed to be 25%.

Conclusions and Recommendations

The design approach as established through this memorandum is to design a pumping system that provides for domestic Peak Hour demands and fire flows under MDD conditions. The Peak Hour demand is estimated to be 62 gpm and the station will be capable of supplying 1500 gpm at 60 psi at Frying Pan Lane for fire flow capacity.

In examining the pumping requirements for domestic service presented in Table 3 and the pumping requirements for providing 1,500 gpm for fire flow conditions, a combination of two domestic service pumps at 1 hp would provide 62 gpm at 92-feet TDH. Both of these pumps would be consistently online. Two high service pumps each at 80 hp would each provide the minimum fire flow of 1,500 gpm at 148-feet TDH. One of these pumps would be consistently online while the second would provide redundancy should the other pump fail or be off-line for maintenance. This also provides flexibility and redundancy for the future condition to fill the Bunker Hill Storage Tank between 375-1500 gpm through the use of a VFD.

Overnight low flows will be met using a single jockey pump capable of providing 5 gpm to 20 gpm. Using these low flows, a TDH of 86 feet was calculated assuming a static pressure of 55 psi at the pump station and a 60 psi pressure at the highest service point with a headloss of 32 feet from the metering facility equipment. Since flow is so low, frictional pipe headlosses can be assumed negligible. 0.54 HP is required to provide the needed overnight low flow and pressure at the highest service point, therefore a 1-HP pump would be sufficient for use as the jockey pump. This 1-HP pump can also be used as back up for the two 1-HP domestic service pumps should one of them fail or be off-line for maintenance. The domestic service pumps would also act as a back up for the jockey pump.

In summary, the pump scenario presented above would consist of five pumps; two 1-HP pumps for domestic service; two 80-HP pumps for fire flow service; and one 1-HP jockey pump to provide low overnight flows.

Architectural/Structural

The building has been preliminarily designed to be ~ 32’ x 20’ per the attached preliminary drawings. The building will have a cast in place frost wall foundation. The Town has expressed interest in constructing the facility using insulated, leave in place concrete form work to reduce construction time and reduce building maintenance. Exterior siding will be prefinished cement board siding. The building roof will be a standing seam metal roof.

The building interior is separated into two rooms. The main room in the pump station will house the pumps, controls and electrical equipment. The other room will house the Exeter water department supplied water meter and backflow prevention device.

Mechanical

Heating of the facility will be provided by propane fired unit heaters. Mechanical louvers will be provided for ventilation of the facility. During final design we will investigate the potential for extension of natural gas to the facility.

Operations and Controls

The controls for this pump station will be designed to operate under two different operational conditions.

1) Closed loop, constant pressures to deliver water to customers in the Gateway Commercial District. Pumps to be sized for domestic and fire flow requirements.
2) Fill a future storage tank with an overflow elevation of 130 ft to be located on Bunker Hill, pump operations will be based on tank levels.

Control of the pumps in the station will be automated based on feedback from pressure sensors in the current configuration and a level instrument once the Bunker Hill Tank is installed and operational paramenters change. The station will be provided with normal fault and alarm capabilities of a typical municipal water booster pump station including, pump run status, VFD status, VFD faults, bypass solenoid valve status, instantaneous and totalized flow, generator status, generator faults, intrusion alarm, temperature alarms, and flood alarms.

Electrical

Three phase power is present at the pole adjacent to this property. Power to the building will be supplied by a 400 amp service. Electrical equipment will be housed in the main building space within NEMA 12 rated enclosures. All pumps will be operated on variable frequency drives to enable the station to maintain constant pressure output within the expected flow range. The electrical service will be designed to allow for larger duty pumps if required. Emergency Power will be provided by 150 KW propane generator. This generator will be located outside of the building and will have a sound attenuating enclosure.

Cost Summary

Description	Cost
Pump Station	$630,000
Water Main	$2,270,000
Engineering and Contingency 30%	$1,350,000
***Estimated Total Project Cost**	**$3,830,000**

*This is a Class 3 Estimate (Budget Authorization or Control) based on AACE Standards December 2015 ENR 20 City Average Construction Cost Index is 10095