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Technical Memorandum

To: Brian Goetz, Deputy Director of Public Works, City of Portsmouth
From: Keith A. Pratt, P.E., Gene Forbes, P.E., and Tim Noble, E.I.T.
Date: May 31, 2019
Subject: **Breakfast Hill Road Water Main Extension – Additional Rye Evaluation
Supplement to the Draft 30% Design Report dated March 29, 2019**

Interim Rye Water District (RWD) Connection

RWD: Background

The City of Portsmouth has a wholesale water agreement with the Rye Water District (RWD) to buy water at a wholesale rate to provide service to Bethany Church and the properties on Seavey Way, which are Greenland properties and Portsmouth's water franchise area. Improvements to provide water service to the Breakfast Hill service area would require a revision of the existing wholesale agreement and a vote by the Rye Water District Commissioners as well as an approval by Portsmouth's City Council.

This work is a supplement to the Preliminary Design and Basis of Design Report dated March 29, 2019 and is being completed in accordance with Amendment No. 1 to our contract dated October 27, 2018. Existing water infrastructure from Rye's water tank serving a portion of Portsmouth's franchise area at the Bethany Church and Seavey Way make it potentially possible to expand the RWD system from Seavey Way to the Breakfast Hill Road area. A transmission main could be extended along Breakfast Hill Road with branched piping to serve the adjacent neighborhoods. The extension from Rye would be designed and constructed to accommodate future conversion to Portsmouth's water system. For purposes of this evaluation, this option was limited to the east side of the PSNH easement. This revised service area is shown in Figure 1.

RWD: System-Wide Water Demand

Rye Water District water demand and water supply information was obtained from discussions with RWD staff and a review of the past year flow records. This information was used to evaluate Rye Water District's ability to provide additional water service to portions of the Breakfast Hill service area. For this evaluation, demands for the service area were limited to the properties east of the PSNH easement and include existing developed properties, as well as consideration for approved new construction within the Seavey Road development (See Figure 1). Water demands for irrigation are estimated for all properties within the expanded service area, with the exception of the Breakfast Hill Golf course where it is assumed their irrigation needs will be met with existing private wells. Rye Water

District's demands are summarized below both with and without the study area's irrigation needs and are summarized below in Tables 1 and 2:

Table 1. Rye Water District System Wide Demand Evaluation without Breakfast Hill Irrigation Included

	Average Day Demand Conditions	Maximum Day Demand Conditions
Existing RWD Demand	420,000 GPD	1,035,000 GPD
Breakfast Hill Service Area (east of PSNH) Demand (w/o irrigation)	10,000 GPD	20,000 GPD
Total	430,000 GPD	1,055,000 GPD

Table 2. Rye Water District System Wide Demand Evaluation with Breakfast Hill Irrigation Included

	Average Day Demand Conditions	Maximum Day Demand Conditions
Existing RWD Demand	420,000 GPD	1,035,000 GPD
Breakfast Hill Service Area (east of PSNH) Demand (w/ irrigation)	10,000 GPD	60,000 GPD
Total	430,000 GPD	1,095,000 GPD

Note: Maximum Day Demands assume an irrigation peaking factor of 5.7, based on historic irrigation trends in the City of Portsmouth Water System.

Existing demands are based on records provided by Rye Water District for what they believe best represent average and maximum day demands. Well pumping records for July 2018 and August 2018 are the basis for maximum day demands and include all irrigation demands in the existing system. Average day demand is based on the average of the four (4) months of data provided (July 18, August 18, January 19, and February 19). Five percent (5%) was added to the average since limited data was available.

RWD: Water Supply – System Wide Evaluation

Water is supplied to the Rye system by three wells with a reported combined capacity of approximately 1,135 gpm or 1.63 MGD. The capacities of the three (3) wells are summarized below. In Table 3:

Table 3. Rye Water District Supply Capacity

Water Supply Well	Capacity (gpm)	Capacity (MGD)
Garland Well	470 gpm	0.67 MGD
Bailey Well	325 gpm	0.47 MGD
Cedar Run Well	340 gpm	0.49 MGD
Total Capacity	1,135 gpm	1.63 MGD

Per NHDES guidelines, the average daily demand needs to be met with the largest well out of service (Garland Well). The remaining well capacity from the two smaller wells is approximately 665 gpm, or 0.96 MGD. RWD’s ability to sustain additional demands from the Breakfast Hill service area with irrigation is summarized below in Table 4:

Table 4. Rye Water District System Wide Supply/Demand Evaluation

Demand (MGD)		Sustained Supply Capacity (Garland Well out of service)			Maximum Supply Capacity		
		Supply (MGD)	Excess (MGD)	Margin of Safety	Supply (MGD)	Excess (MGD)	Margin of Safety
ADD	0.40	0.96	0.56	2.4	1.63	1.23	4.08
MDD w/o irrig.	1.05	N/A ¹	N/A ¹	N/A ¹	1.63	0.58	1.55
MDD w/irrig.	1.10	N/A ¹	N/A ¹	N/A ¹	1.63	0.53	1.48

Note 1: Cells are labeled “N/A” because NHDES does not require maximum daily demands to be met with the largest well out of service.

As shown in Table 4, the RWD has sufficient capacity to provide both average and maximum daily demands to the Breakfast Hill limited service area, while still providing a surplus capacity for new and existing customers in Rye.

RWD: Water Supply – System Wide Evaluation with Cedar Run Well Offline

The Rye Water District has identified that the Cedar Run Well is currently offline due to secondary water quality concerns and is only used as a back-up water supply source. The above water supply evaluation is repeated below with the Cedar Run Well offline.

Table 5. Rye Water District Supply Capacity with Cedar Run Well Offline

Water Supply Well	Capacity (gpm)	Capacity (MGD)
Garland Well	470 gpm	0.67 MGD
Bailey Well	325 gpm	0.47 MGD
Total Capacity	795 gpm	1.14 MGD

Per NHDES guidelines, the average daily demand needs to be met with the largest well out of service (Garland Well). The remaining well capacity from the Bailey Well is approximately 325 gpm, or 0.47 MGD. RWD’s ability to sustain additional demands from the Breakfast Hill service area with irrigation is summarized below in Table 6:

Table 6. Rye Water District System Wide Supply/Demand Evaluation with Cedar Run Well Offline

Demand (MGD)		Sustained Supply Capacity (Garland Well out of service)			Maximum Supply Capacity		
		Supply (MGD)	Excess (MGD)	Margin of Safety	Supply (MGD)	Excess (MGD)	Margin of Safety
ADD	0.40	0.47	0.07	1.18	1.14	0.74	2.85
MDD w/o irrig.	1.05	N/A ¹	N/A ¹	N/A ¹	1.14	0.09	1.09
MDD w/irrig.	1.10	N/A ¹	N/A ¹	N/A ¹	1.14	0.04	1.04

Note 1: Cells are labeled “N/A” because NHDES does not require maximum daily demands to be met with the largest well out of service.

As shown in Table 6, the RWD has sufficient capacity to provide both average and maximum daily demands to the Breakfast Hill limited service area. However, surplus capacity is limited when the Cedar Run Well is offline.

RWD: Water Supply – High Pressure Zone Evaluation

Extending RWD’s water system to the Breakfast Hill limited service area would be an extension of the high-pressure zone. RWD’s high pressure zone’s demands with the addition of the Breakfast Hill service area with and without irrigation demands are summarized below in Table 7 and Table 8:

Table 7. Rye Water District High-Pressure Zone Demand
Evaluation without Breakfast Hill Irrigation Included

	Average Day Demand Conditions	Maximum Day Demand Conditions
Existing RWD Demand	100,000 GPD	280,000 GPD
Breakfast Hill Service Area (east of PSNH) Demand (w/o irrigation)	10,000 GPD	20,000 GPD
Total	110,000 GPD	300,000 GPD

Table 8. Rye Water District High-Pressure Zone Demand
Evaluation with Breakfast Hill Irrigation Included

	Average Day Demand Conditions	Maximum Day Demand Conditions
Existing RWD Demand	100,000 GPD	280,000 GPD
Breakfast Hill Service Area (east of PSNH) Demand (w/ irrigation)	10,000 GPD	60,000 GPD
Total	110,000 GPD	340,000 GPD

Note: Maximum Day Demands assume an irrigation peaking factor of 5.7, based on historic irrigation trends in the City of Portsmouth Water System.

Existing demands for the high-pressure zone are also based on records provided by Rye Water District for what they believe best represent average and maximum day demands. Pumping records for July 2018 and August 2018 are the basis for maximum day demands and include all irrigation demands in the existing system. Average day demand is based on the average of the four (4) months of data provided (July 18, August 18, January 19, and February 19). Five percent (5%) was added to the average since limited data was available.

RWD: Water Supply– High Pressure Zone Evaluation

The high-pressure zone does not have any water supply sources and is limited by the capacity of the booster pumping station. The booster pumping station has two booster pumps with a capacity of approximately 300 gpm each (~0.43 MGD). The above capacity evaluation is repeated for the high-pressure zone with each booster pump considered a supply source. Thus, per NHDES guidelines, with one pump out of service the capacity to meet average daily demand is limited to approximately 0.43 MGD. Maximum daily demand must be met with all equipment on line (0.86 MGD). RWD’s ability to sustain additional demands from the Breakfast Hill service area is summarized below in Table 9:

Table 9. Rye Water District High Pressure Zone Supply/Demand Evaluation

Demand (MGD)		Sustained Supply Capacity			Maximum Supply Capacity		
		Supply (MGD)	Excess (MGD)	Margin of Safety	Supply (MGD)	Excess (MGD)	Margin of Safety
ADD	0.11	0.43	0.32	3.9	0.86	0.75	7.8
MDD w/o irrig.	0.30	0.43	0.13	1.4	0.86	0.56	2.9
MDD w/irrig.	0.34	0.43	0.09	1.2	0.86	0.52	2.5

As shown in Table 9, the RWD high-pressure zone has sufficient capacity to provide both average and maximum daily demands to the Breakfast Hill limited service area, while still providing a surplus capacity for new and existing customers in Rye.

RWD: Hydraulic Grade Line/Pressures Evaluation

The high-pressure zone for the tank near Breakfast Hill Road where the water main expansion would extend from has an HGL of 245-ft, which is the high-pressure zone. Based on the range of elevations within the Breakfast Hill service area, this grade line provides adequate pressures for water service. The range of estimated pressures are tabulated below in Table 10:

Table 10. Rye Water District Pressure Evaluation

Area	Low Elevation (ft.)	High Pressure (PSI)	High Elevation (ft.)	Low Pressure (PSI)
Breakfast Hill Road	71	75	140	45
Neighborhoods	54	83	100	63

Note: The RWD system's HGL is 15-ft (6 psi) higher than the proposed HGL will be if/when Portsmouth serves the service area. This should be discussed with new users so they can plan for the change in pressure.

RWD: Storage Evaluation

Rye Water District's storage capacity was evaluated for adequacy. Extending the RWD system to the Breakfast Hill service area could potentially require an increase in necessary storage volume for the system. This evaluation will compare the calculated need with the existing available storage.

A storage tank analysis report completed by Wright-Pierce in 2013 was provided by Rye Water District to assist in this evaluation. The report based total available storage on "active storage", which is the useable storage the system has while maintaining minimum operating pressures. There are two (2) pressure zones in the RWD system. The main pressure zone is fed by two (2) tanks and all three (3) wells and operates at an HGL of 171-ft. This system has an interconnect with the Portsmouth main pressure zone (also at an HGL of 171-ft). RWD's high-pressure zone (HGL = 245-ft) is served by their Breakfast Hill Tank. Water is transmitted to the tank via a two (2) pump booster pump system. One (1) of the pumps is operated by a variable frequency drive (VFD). The available storage evaluation completed in 2013 by Wright Pierce concluded that the active storage volume available in the high-pressure zone at Breakfast Hill is 0.60 MG.

However, conversations with RWD staff indicated that from a practical operating perspective, they are limited in their ability to operate within the full range of elevations anticipated in the Wright Pierce study. Staff reported that, at best, there is approximately a 30-foot operating range and an associated volume of up to 12,000 gallons per foot. This would result in a more limited active volume estimate of 0.36 MG.

Following the same methodology used in section 6.2 of the Draft 2019 Portsmouth Water System Master Plan Supplement for evaluating storage needs in a stand-alone pressure zone, storage requirements are summarized in Table 11 as follows:

Table 11. Rye Water District High-Pressure Zone Storage Capacity Evaluation

Storage Component	Storage Volume	Basis
Equalization	0.025 MG	Based on 25% of service area average day demands (0.10 MGD)
Fire	0.27 MG	Based on 1,500 gpm fire flows for 3 hours
Emergency	-	Per the same methodology used in the draft Master Plan, emergency storage is not required. (See Note 1)
Total Storage Required	0.295 MG	
Active Storage available	0.36 MG	
Estimated Storage Surplus	0.065 MG	

Notes:

1. Per the AWWA Manual of Water Supply Practices: M32, the amount of emergency storage for a system is typically a policy-based decision based on an assessment of risks of failures and the system's degree of dependability. For the purposes of this evaluation, the same methodology from Portsmouth's Master Plan to calculate emergency storage was used to calculate the emergency storage needed for RWD's high-pressure zone. The approach compares maximum day demands with the system's firm pumping capacity (total pumping capacity without the largest source online). In RWD's high-pressure zone, the firm pumping capacity is approximately 0.43 MGD with one booster pump offline. This is larger than maximum day demands of the existing Rye high-pressure zone with the Breakfast Hill service area included (with or without irrigation demands). Therefore, no emergency storage is anticipated.

Based on information provided by RWD staff and the storage calculations above, there appears to be adequate storage capacity in the Breakfast Hill tank to serve the Breakfast Hill service area and an estimated storage surplus of 0.065 MG.

RWD: Fire Flow

Available fire flows were evaluated for the interim Breakfast Hill service area. Based on preliminary calculations, it appears that there will be at least 1,500 gpm and likely more than 2,000 gpm of available fire flow along Breakfast Hill Road. If the interim connection to the service area proceeds to final design phase, it is recommended to run Rye Water District's water model to confirm the calculations.

RWD: Water Age

Extended period simulation water modeling to evaluate water age in the RWD system was not included as part of this evaluation. It is assumed that, compared to existing conditions, the water age in the existing RWD system would only improve due to new demands in the Breakfast Hill service area.

RWD: Preliminary Phasing

Extending the wholesale agreement between RWD and the City of Portsmouth would be required in order to implement this proposed interim connection. Eventually, as provided for in the 2019 Master Plan Supplement, the Breakfast Hill service area would be designed/built with the ability to be converted to the Portsmouth water system. This interim connection to the Rye system would consist of the following estimated quantities (see attached Preliminary Design Drawings):

- 4,000 LF of 12” D.I. Water Main (STA 52+20 to STA 89+00)
 - From first service connection east of the power line on Breakfast Hill Road to Lafayette Road intersection
- 1,750 LF of 8” D.I. Water Main
 - Stone Meadow Way
 - Red Oak Drive
 - Berry Farm Lane
- 34 properties served

RWD: Probable Opinion of Construction Costs

Probable construction costs for distribution improvements to extend water to the expanded wholesale area have been estimated based on linear foot costs for 12” and 8” water main improvements and range between \$2.6M and \$3.2M. Costs include contingency and engineering fees, but do not include storage or treatment improvements. See Attachment “A” for a breakdown of estimated costs.

Attachment "A"

Breakfast Hill Area Water Main Extension

Opinion of Costs

5/21/2019

Item	Scenario No. 2	Scenario No. 2 - Phase 1	Interim RWD Connection
8" Water Main (27,500 LF)	\$ 6.19 Million	\$ - Million	\$ 0.39 Million
12" Water Main (10,600 LF)	\$ 2.86 Million	\$ 2.86 Million	\$ 1.12 Million
I-95 Bridge Crossing	\$ 0.50 Million	\$ 0.50 Million	\$ - Million
Rock Removal	\$ 0.45 Million	\$ 0.45 Million	\$ 0.23 Million
0.5 Million Gal. Tank	\$ 2.00 Million	\$ 2.00 Million	\$ - Million
Booster Pump Station	\$ 1.00 Million	\$ 1.00 Million	\$ - Million
PRV/Meter Vault	\$ 0.30 Million	\$ 0.30 Million	\$ - Million
Greenland Well Pump	\$ 0.10 Million	\$ 0.10 Million	\$ - Million
SCADA Improvements	\$ 0.10 Million	\$ 0.10 Million	\$ - Million
Subtotal	\$ 13.50 Million	\$ 7.31 Million	\$ 1.74 Million
Contingency (25%)	\$ 3.37 Million	\$ 1.83 Million	\$ 0.43 Million
Engineering (20%)	\$ 2.70 Million	\$ 1.46 Million	\$ 0.35 Million
Subtotal	\$ 19.57 Million	\$ 10.60 Million	\$ 2.52 Million
2018 Dollars Total (Rounded)	\$ 20.0 Million	\$ 11.0 Million	\$ 2.6 Million
Range - Low (-5%)	\$ 19.0 Million	\$ 10.5 Million	\$ 2.5 Million
Range - High (15%)	\$ 23.0 Million	\$ 12.7 Million	\$ 3.0 Million
2020 Dollars Total	\$ 21.4 Million	\$ 11.8 Million	\$ 2.8 Million
Range - Low (-5%)	\$ 20.3 Million	\$ 11.2 Million	\$ 2.6 Million
Range - High (15%)	\$ 24.6 Million	\$ 13.6 Million	\$ 3.2 Million